Annual Review 2014

BAE BULLETIN

Department of Biosystems and Agricultural Engineering

Food Quality, Safety and Biosecurity
Renewable Bioenergy Systems
Sustainable Ecosystems

Integrating Engineering and Biology since 1906

In this issue...

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Front cover: Pictured clockwise starting at 12 o'clock, the department's research foci, (1) Food Quality, Safety and Biosecurity, (2) Renewable Bioenergy Systems and (3) Sustainable Ecosystems, are woven together by faculty members and students to form a strong local, national and global educational experience. This is accomplished through classes, laboratories, field work, study abroad, undergraduate and graduate research, and internships, among others. Welcome to the 2014 edition of the MSU BAE Bulletin highlighting educational hallmarks of the department.

Back cover: Students on the Renewable Bioenergy Systems study abroad program in Sweden and Germany stand on top of the Smurfit Kappa plant near Piteå, Sweden, observing the massive feedstock yard and raw material preparations. Smurfit Kappa, one of the world's largest integrated manufacturers of paper-based packaging, is committed to managing operations in a sustainable way. This plant uses bark from the feedstock to generate on-site electricity, and tall oil (a paper byproduct) is converted to bio-diesel.

Since 1906, the Michigan State University (MSU) Department of Biosystems and Agricultural Engineering has responded to the changing needs of society by integrating and applying principles of engineering and biology in a systems context. Today, biosystems engineers at MSU solve complex and rapidly changing problems related to maximizing food quality and safety, preserving ecosystems, protecting health and homeland security, utilizing biomass and developing renewable energy. Articles and information featured in the annual BAE Bulletin newsletter highlight research, teaching and outreach accomplishments achieved during the previous year.

MSU is an affirmative-action, equal opportunity employer.

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MICHIGAN STATE UNIVERSITY Department of Biosystems & Agricultural Engineering

MICHIGAN STATE UNIVERSITY | College of Agriculture and Natural Resources

MICHIGAN STATE UNIVERSITY | College of Engineering

2014-2015 Scholarship Recipients

Undergraduate

F.W. Bakker-Arkema Endowed Scholarship
Carly Head

A.W. Farrall Scholarship
Paige Crosset
Rachel Kurzeja

Clarence & Thelma Hansen Scholarship
Daniel Buhr
Robert Bruhn
Christopher Walker

Howard & Esther McColly Scholarship
Jason Graham
Nathan Mejeski
Jacqueline Thelen

George & Betty Merva Scholarship
Mackenzie Tocco
Allison VanderKolk

DeBoer Family Scholarship/Fellowship Fund
Nicole Kruse
Ryan Ziegler

Galen & Ann Brown Scholarship
Robert Bruhn

Alfred & Mary Murray Scholarship
Natsuki Ikeda

Graduate

College of Engineering Outstanding BE Graduate Student Fellowship
Rui Chen

BAE Endowed Fellowship for Graduate Student Excellence
Sean Woznicki

Merle & Catherine Esmay Scholarship
Mahlet Garedew
Bharathi Murali

Bill & Rita Stout Scholarship
Melissa Rojas-Downing

Outstanding BE Research Fellowship & Fitch H. Beach Award
Zhenhua Ruan

What students are saying about their MSU experience:

"Starting out as a BE major, I was unsure what I could do with a degree in that field. I began working at the MSU Dairy Plant during my freshman year and, over time, it has given me the opportunity to see firsthand the roles I could play in each step of the production process. Then, when given the opportunity to study abroad, I wanted to challenge myself and get out of my comfort zone. I chose to study conservation and tropical biodiversity in the rainforests of Panama this past summer. My experiences abroad have had the biggest impact on my personal growth and introduced me to new cultures and possibilities."

- Alexis Wloch, Biosystems Engineering senior from Flat Rock

"During my internship this past summer with Nestle/Gerber, I was able to work on validating an entirely new production process for the company, something that some engineers never even have an opportunity to do during their entire professional career! It was an amazing learning opportunity within the area of my Biosystems Engineering specialization."

- Kyle Guyer, Biosystems Engineering senior from East Lansing

"I realized early in my career the importance of being involved within the engineering community. Instead of struggling alone, I joined the SWE e-board and have been gradually accepting more responsibilities each year. I was open enough to form part of a study abroad course to Costa Rica to learn about engineering in the tropics my sophomore year, and then upon returning from this trip, to join the engineering sorority, Phi Sigma Rho. After completing a supply chain engineering internship this summer with Frito Lay, I am looking forward to continuing my involvement and becoming a BE 101 mentor! Nothing makes me happier than being involved, meeting new people, and aiding those interested in pursuing a degree in biosystems engineering!"

- Mariana Madrigal-Martinez, Biosystems Engineering senior from Novi

Greetings from the Chair

Dear alumni and friends:

It is always exciting to recollect, document and share news and accomplishments of our students and faculty with our alumni and friends.

Last year was a busy and exciting year. Our student enrollment continued to grow. We had a record number of students in Biosystems Engineering and it appears that we are on track to set another record this coming year with over 200 undergraduates. More importantly, BE graduates continue to be in demand while commanding highly competitive salaries.

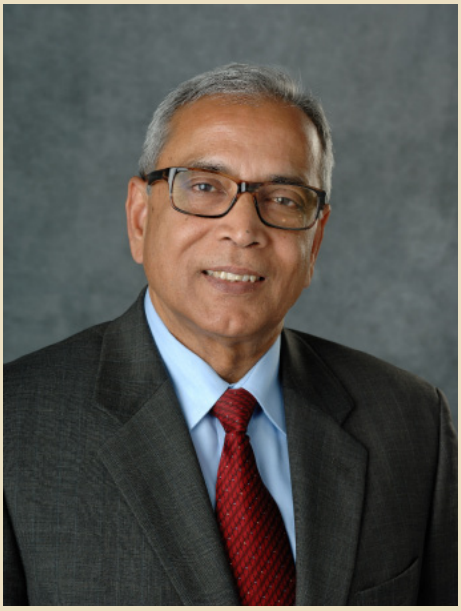
Our faculty and staff members are committed to providing excellent learning experiences to our students both in the classroom and beyond, including study abroad, internships, undergraduate research experiences and the like. Nearly 100 percent of our graduates have participated in more than one such experience before graduation which they found to be extremely valuable. Our Industry Advisory Board continues to be highly active and engaged by meeting twice annually, providing mentoring, and evaluating interesting real-world senior design projects for capstone design courses.

Since the undergraduate degree program is the heart and soul of any academic unit, we take this responsibility very seriously. As you will see in this issue, we have highlighted our approach to educating the engineer for the 21st Century. We sincerely believe that we are uniquely defining Biosystems Engineering and setting it apart from other engineering disciplines.

As we face global challenges, such as population growth, rapid urbanization and climate change, properly trained biosystems engineers will find innovative solutions to problems such as food, water and energy security by taking a systems approach while firmly grounded on the principles of engineering and biology. I applaud a worthwhile effort co-led by Brad Marks at the ASABE annual international meeting in Montreal advancing the core curriculum in biological engineering with the objective to uniquely define contents of our core courses in the program. This is an essential step towards defining the unique identity of our profession.

Our faculty continues to be very successful in securing external grants. We are extremely proud to share that Dr. Jade Mitchell has been awarded a major grant from the National Institute of Health (NIH)—a first for our department. The grant focuses on developing interdisciplinary education and training material for mathematical modeling techniques for quantitative microbial risk assessment, an essential step in understanding and mitigating risks associated with microbial food and environmental contamination. This grant reflects positively on the need for addressing human health implications of factors such as food and environmental quality and safety, which is a natural evolution of our profession for ensuring human health and quality of life, an ultimate mission of our profession.

Earlier this year, I informed Dean Poston of my intention to step down as BAE department chairperson after more than 17 years of service. A search committee has been formed and I am confident that the new chairperson will be selected and appointed in the next few months. I will continue until the next chairperson takes the helm, at which time I will return to my faculty responsibilities. I have immensely enjoyed serving as the chairperson of this nationally esteemed department and am proud of what we have collectively accomplished. Thank you for the support you have given me and to the department.



Dr. Ajit Srivastava

Best regards,
Ajit Srivastava

Industry Advisory Board is unique component of MSU BE program

ABET accreditation adds value to degree program

The Biosystems and Agricultural Engineering (BAE) Industry Advisory Board at Michigan State University (MSU) is a stakeholder group representing employers and an integral part of the BE student experience. The Advisory Board ensures the undergraduate program remains relevant to the employer base and offers students firsthand perspective on diverse career opportunities. Its members meet twice a year — in October and April — and a greater than 90 percent attendance rate at these meetings demonstrates the value the industry places on its role in the College.

Advisory board members interact with students at both the front and back end of the BE program. What is unique about the board is that its members engage and interact — not just consult — with students a minimum of five times during the undergraduate program. This integration is in addition to reviewing curriculum and developing the program educational objectives, which are critical for program accreditation.

The Biosystems and Agricultural Engineering discipline at MSU is also accredited through ABET, a voluntary and intensive accreditation program that verifies the program meets the standards of the profession. An ABET-accredited program is one that is recognized internationally for its quality, promotes best practices in education, involves faculty and staff members directly in self-assessment and continuous quality improvement practices, and bases its program on learning outcomes rather than teaching inputs. Prospective and current students can be assured that MSU is committed to improving their educational experience, using innovative teaching methods, receiving guidance from its industry, government and academic constituents through formal feedback, and considering students' perspectives as part of the ongoing quality improvement process.

Industry evaluators pictured on the left are (L to R): Valerie Novaes, Ashley Thode, Larry Stephens and Joe Tesar. They are providing professional feedback regarding the Algaeneer team's final design report. The students pictured are (L to R): Rick Avery, Julia Otwell, Pat Sheridan and Anh Bui (out of picture).

2013-2014 BE Industry Advisory Board

Michelle Crook, P.E.
Engineering Specialist
Environmental Stewardship Division of the Michigan Department of Agriculture and Rural Development

Cassaundra Edwards (Chairperson)
Research and Development Manager
ConAgra Foods

Bryce Feighner, P.E.
Chief of the Office of Environmental Assistance
Michigan Department of Environmenta Quality

Gene Ford (Past Chairperson)
Vice President of Global Technology Manager, Research and Development
Nestlé Nutrition

Andrew Granskog, P.E. (Ex-Officio)
CANR Alumni Association Board Representative
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USDA Rural Development Community Programs

Charlsey Hoehn (Ex-Officio)
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Department of Biosystems and Agricultural Engineering
Michigan State University

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Michigan State University

Dan King (Ex-Officio)
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Mitch Miller (Chairperson-elect)
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General Mills – Yoplait Plant

Andrew Knowles
Freezer Applications Manager
JBT FoodTech

Valerie Novaes
Project Engineer
Water Resources Department at Tetra Tech

Dr. Fred Poston (Ex-Officio)
Dean, College of Agriculture and Natural Resources
Michigan State University

Dave Prouty
President
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Dr. Luke Reese (Ex-Officio)
Industry Liaison
Department of Biosystems and Agricultural Engineering
Michigan State University

Steve Richey
Director of Morning Foods, Process Engineering
Kellogg Company

Dr. Ajit Srivastava (Ex-Officio)
Department Chairperson and Professor
Department of Biosystems and Agricultural Engineering
Michigan State University

Steve Steffes, P.E.
Vice President of New York Operations
Perrigo

Larry Stephens, P.E.
Owner
Stephens Consulting Services, P.C.

Muluken Tilahun
Associate Principal Engineer
Kraft Foods

Xiaoqing Wang (Ex-Officio)
Graduate Student Representative
Department of Biosystems and Agricultural Engineering
Michigan State University

The 2013-14 Industry Advisory Board paused from their fall business meeting to interact with and encourage 75 eager BE 101 (see related story on page 8) Biosystems Engineering freshmen on the second floor of Farrall Hall. This is the first of many opportunities for BE students to engage with these professionals.

BE 101 reveals breadth of career opportunities and process for solving open-ended problems to first-year students

This fall, 90 students are jumping into biosystems engineering by taking BE 101 taught by Dr. Bradley Marks, professor and associate chairperson of biosystems and agricultural engineering (BAE) at Michigan State University (MSU). The course is a student's first exposure to the field and connects first-year students right from the start of their first semester on campus with senior students from the program and individuals already working in the field.

Along with students who know they want to pursue a BE degree, about a quarter of the students who enroll in the course are undecided engineering students. The BE pro-

What better way to foster critical thinking skills on the first day of class than by building carrot towers as a "metaphor" for the challenges associated with applying engineering principles to biological systems?

gram at MSU embraces biology — it requires completion of at least five biology courses in addition to the engineering core — an extremely progressive program.

"We want students to have an authentic and engaging experience in the discipline and the department early on in the program so we give them real team problems and real, unique BE problems, the type they'll be facing out in the career world, right from the start," Dr. Marks said. "The goal is for students to learn how to figure out how to solve problems conceptually when I give one to them. Engineering is different from science because there's more than one answer or solution to a given problem. When there's a biological component added to the mix, the engineering problem becomes more challenging and unique."

Students get excited very quickly because it is a different educational experience than they've had before. The combination of engineering and biology adds a layer of creativity to the process of finding answers to open-ended problems.

"Of course the technical part makes it a unique course," Marks said. "But working with biological systems adds a higher level of variability and uncertainty, such as incorporating a site-specific wetland or the rice used to make Rice Krispies™. They begin to develop a high level of engineering judgment."

Students who excel in the class are typically strong in science and math, but they also have a desire to make a difference in the world, such as exploring alternate energy solutions or protecting the environment. The goal is to look at how their interests can be applied to the many career paths open to a BE student.

BE 101 is more than just a typical introductory course for students. Dr. Brad Marks (center) integrates authentic technical experiences and numerous opportunities for students to engage with engineering professionals. By semester-end, students have a much greater understanding of and appreciation for the biosystems engineering field.

Interacting with and hearing from the BAE Industry Advisory Board [see pages 6-7], a core group composed of stakeholders representing future employers, is a key part of the first-year BE student experience. Students also hear from panels of recent graduates who relate insight about their time at MSU and their current jobs.

"We have 18-year-old students hearing from 22-year-old recent graduates," Marks said. "The first-year students can more readily relate to this peer group and envision themselves doing what these people did."

At the end of the BE 101 course, students have a solid picture of the wide breadth of careers available, realize that engineering is all about solving problems and making a difference, and know whether pursuing a career in biosystems engineering is right for them — exactly as designed.

BE 101: Introduction to Biosystems Engineering – Introduction to the profession of biosystems engineering. Case studies of engineering design problems with a biological component. Exploration of career opportunities and ethical framework for the profession.

BE 230 challenges students to learn how to tackle open-ended problems

Equips students with fundamental knowledge needed for remainder of program

An optional and non-graded laboratory class is offered for honors students. It includes a field trip to a working plant to learn firsthand about instrumentation and databases.

Just as a solidly built foundation is vital for a structure to remain standing, learning the fundamental concepts for a chosen career field is similarly important. BE 230, Engineering Analysis of Biological Systems, serves as that foundation for students pursuing a degree in biosystems engineering at Michigan State University (MSU). In what's the first technical class students often take, they are exposed to systems engineering, process engineering and fundamental concepts that are illustrated with case studies through both hands-on and on-paper methods. It is assumed students will understand the theory behind these elemental concepts as they advance through the remaining courses of the curriculum.

Coursework introduces students to all biological (bio) systems – food, traditional agriculture and ecosystems; process engineering; and the fundamental concepts of mass balance (mass in and mass out), reactor design, kinetics (how fast a reaction occurs and what it needs to work); dimensional analysis (stringing several factors together); and sustainability, or life cycle analysis (conserving resources). Commonplace examples are used to further illustrate the concepts: a good processing case study is used to demonstrate mass balance; speed of reactions characterizes kinetics; and a bioen-

BE 230, Engineering Analysis of Biological Systems – Biosystems modeling of growth and dynamic interactions. Conservation of mass and sustainability. Steady state and stability analysis. Ecological concepts. Life cycle analysis. Design for environment.

ergy case study is used to typify dimensional analysis. The course also incorporates a biomedical segment on risk that teaches students how to answer what something is, how it's defined, and why it's important.

BE 230 instructor Dr. Steven Safferman, associate professor of biosystems and agricultural engineering, cites that engineers are often challenged to solve unique and open-ended problems that no one has ever been asked to figure out before. He notes there are only so many approaches to solving a problem and it's important for students to learn how to become problem solvers.

"Students should expect to acquire a fundamental knowledge of engineering and engineering science and the basic concepts they'll be expected to know as they move on to more advanced classes," he says. "They figure out more about the learning process itself, have figured out that engineering is about more than math, and are able to embrace open-ended problems and challenges to realize there is often more than one approach to solving a problem."

Safferman adds that even though labratory exercises offer hands-on experience, most engineering problems must be approached through mathematical models and design concepts. In the class, students develop a waste water system using design models and calculating mathematical formulas.

"Though hands-on can be used to illustrate the point, it's often not feasible to spend thousands of dollars on a pilot project, so paper designs and past experiences need to be drawn upon to figure something out," he says. "Developing critical thinking and in-depth analysis skills are key."

Safferman notes that it's important for students to appreciate the soft engineering factors involved.

"There might be five different options for solving a problem, but how do you decide which one to use?" he asks. "Everything may point on paper to building an incinerator, but that decision may not be accepted by community members, and then what? Students have to learn how to factor in all the elements."

"Watching students grow in their ability to learn is rewarding, and when students take this course, (engineering) is still new to them. Many students have been swayed by misinformation received in high school and so they often have a preconceived idea of what an engineer does and assume they need a lot of math and science. This course offers an important introduction to engineering and a fresh and realistic perspective of what engineers really do." – Steve Safferman, MSU associate professor of biosystems and agricultural engineering and BE 230 instructor.

Helping students become more attuned problem-solvers

Understanding and being able to apply the laws of thermodynamics is critical for those in biosytems engineering

An objective of BE 351 is for students to become better problem solvers. When posed with an engineering problem, students are charged with identifying the relevant systems and figuring out the mass and energy balances. Biological problems are complex and sometimes "messy" requiring a little extra tutoring as exemplified by Dr. Saffron's chalkboard illustration.

From the by-gone days of using water-driven grist mills to grind grain into flour and threshing grain with machines powered by steam engines to driving today's more energy efficient automobiles, thermodynamics, or the science of energy change, has existed for centuries. And even though most people have heard about the four laws of thermodynamics and may even be able to recite them, they often fall short when it comes to applying them to engineering processes.

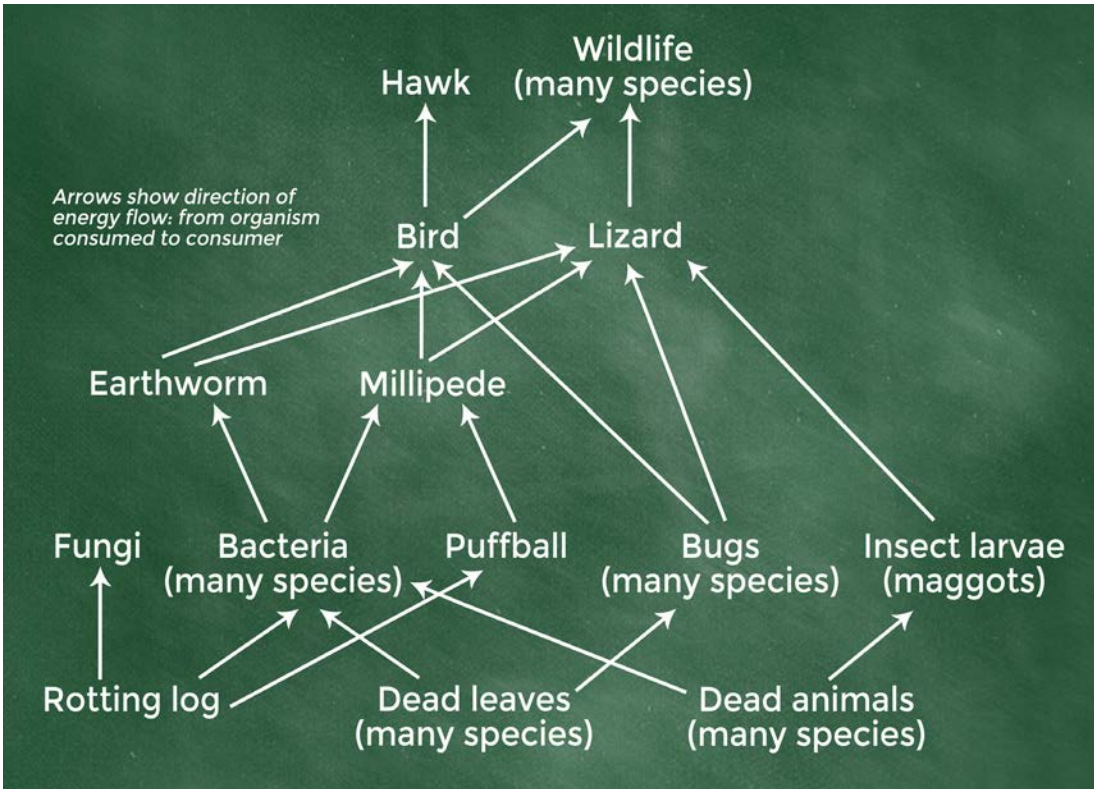
Students taking BE 351 Thermodynamics for Biological Engineering, a course instructed by award-winning Michigan State University (MSU) assistant professor of biosystems and agricultural engineering Dr. Chris Saffron, however, are the exception to the rule. One objective of this class is for students to learn and understand the art of applying the first and second laws of thermodynamics to formulate solutions to problems.

"These laws are real laws and principles of the universe and we haven't seen anyone who can break them," Saffron said. "There is no derivation for either the first or second law of thermodynamics. They just are."

He said this particular concept is especially important for those

in biosystems and engineering to grasp because regardless of the specific field or focus area students opt to pursue, they still have to abide by the laws of thermodynamics. Although students may be familiar with the laws of thermodynamics themselves, they need to learn to apply them to a variety of systems, ranging from pistons to complex living organisms.

"From studying physics, most students know that potential energy is transformed to kinetic energy. A good example is the cartoon character Wile E. Coyote. The stone on the top of the cliff is an example of potential energy, and then when it's pushed off the cliff it becomes kinetic energy. The energy wasn't created or destroyed, but it was changed," Saffron said.



Ecosystems are another example of how energy flows through biological systems. Plants harvest light energy and fix carbon dioxide to grow and reproduce. Primary consumers (herbivores) then eat them, acquire the stored energy by consuming these plants only to be consumed themselves by carnivorous animals. Ultimately this energy is returned to the earth through restoration and the process of decay. Energy flows through ecosystems in an analogous manner as through mechanical systems.

"Living systems obey these laws (of thermodynamics) just as non-living systems do," he explained. "We are charged with bridging that gap of understanding by applying what we know about simple systems to more complex living things. The transition to living systems is what separates us from mechanical engineers."

Dr. Saffron is known for interacting a lot with students in BE 351.

"I tend to employ more Socratic methods of teaching," he admits. "The goal is for students to become more inquisitive in order to develop their critical thinking skills. I can't be there to solve all their problems."

The syllabus also promises an intensive load of coursework and, by the end of the semester, students have a broad repertoire of understanding. They know how a car runs and how a refrigerator works, how the flux of energy mingles throughout their lives to enable them to do what they do from driving to work to heating their apartment and keeping their refrigerator cool so food doesn't spoil and make them ill. More starkly, students see the need for energy conservation because they are confronted firsthand with the many ways by which energy is consumed. Because they have taken the class, some students even shift their daily routines to improve energy use efficiency.

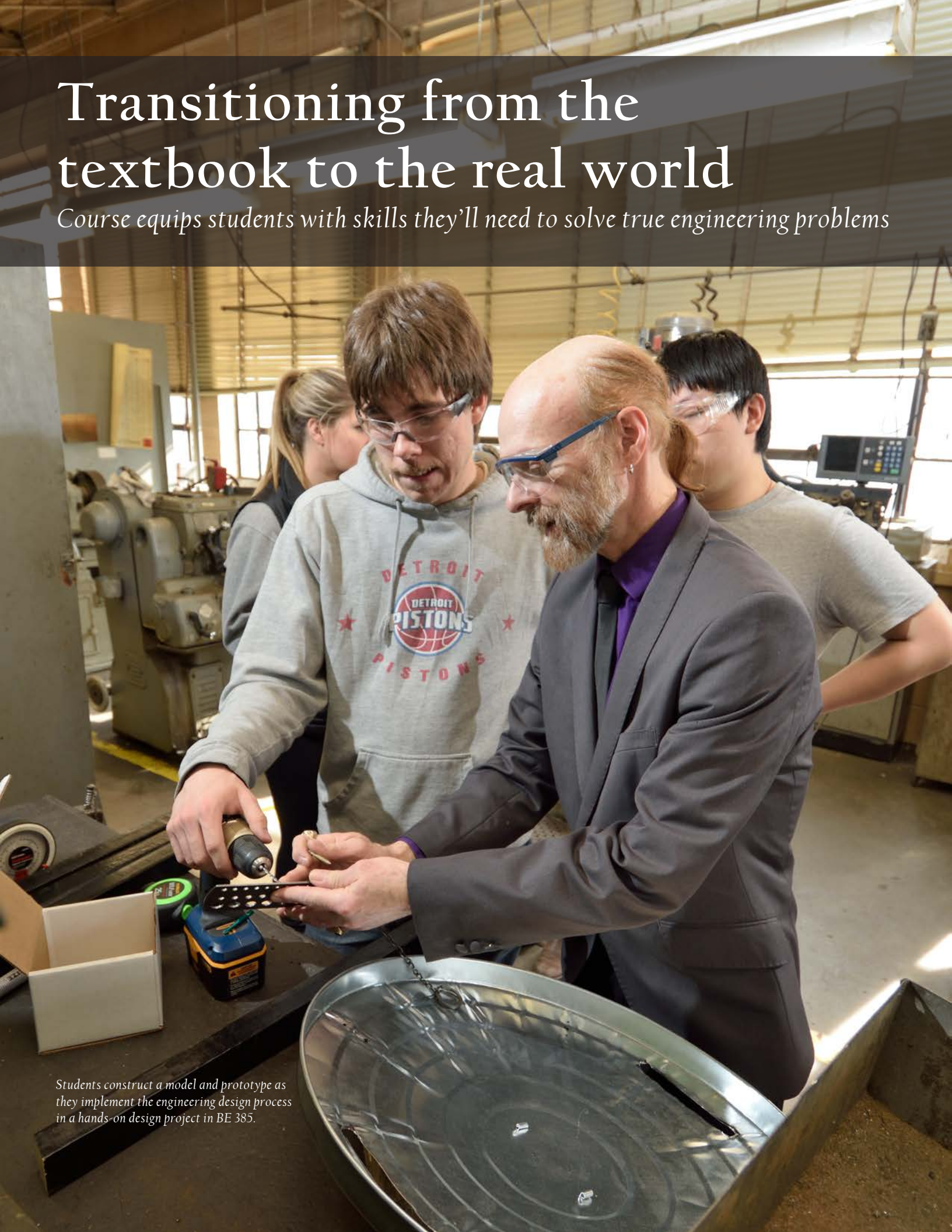
"Students will know how power plants work, and they know why you can only get so much electricity from a ton of coal or a thousand liters of natural gas or 500 pounds of biomass. They can quantify the amount of useful electricity that can be produced and how much heat must be discharged back into the environment," Saffron adds.

"A year or so after the course, students admit to me that they felt they were climbing uphill and challenged the whole way (during the course), but looking back, it all makes sense to them now," he says. "They tell me, "I can't imagine not knowing this material."

BE 351 Thermodynamics for Biological Engineering – Thermodynamics of biological systems. First and second laws of thermodynamics. Power and refrigeration cycles. Water relations and psychrometry. Chemical and phase equilibria.

Transitioning from the textbook to the real world

Course equips students with skills they'll need to solve true engineering problems



Students construct a model and prototype as they implement the engineering design process in a hands-on design project in BE 385.

Real-world problems are not purely technical in nature. BE 385, Engineering Design and Optimization for Biological Systems, covers design, project management, engineering economics, and optimization, a precursor mixture of topics for BE 485/487, the capstone senior design courses.

Unlike other courses in the biosystems engineering program that focus primarily on engineering science or analysis, topics covered in BE 385 relate to decision making required to undertake engineering projects. Students are presented with a variety of tools and techniques for tackling real-world, ill-defined and open-ended problems.

"This course addresses a set of skills required to "practice" engineering – scoping problems, evaluating technical and economic feasibility, and optimizing solutions," explains Dr. Jade Mitchell, Michigan State University (MSU) assistant professor of biosystems and agricultural engineering and BE 385 instructor. "The values in engineering design change from objectivity, rationality and absolute truth to practicality, ingenuity and appropriateness. Students are also introduced to peripheral topics like creativity and communication as well as the social, environmental, legal and ethical considerations surrounding engineering projects through contemporary issues."

Most of the content is practical in nature and acquired through "hands-on" practice exercises with each course module. Students employ the skills they learn by completing a final start-to-finish design project. They learn how to anticipate problems that commonly arise during the planning, design and management steps of engineering projects and how to apply the appropriate tool or technique to address the problem.

BE 385 – Engineering Design and Optimization for Biological Systems: Design and optimization techniques applied to engineering problems with biological constraints. Project management. Engineering economics. Linear programming.

Most engineering coursework requires convergent or deductive thinking and students become very comfortable with solving analytical problems or narrowing down solutions.

"It can be frustrating at first, but this course is designed to help students become more comfortable with ambiguity so that they can transition from textbook problems to real world problems," Mitchell says. "Real world problems require both convergent and divergent thinking and things often change during the process of solving the problem. Our students experience this as they complete their capstone senior design projects and it will occur again and again as their careers progress. I also hope that students begin to realize the impact that economics and contemporary issues play in their engineering projects.

"I really like the active learning components of this class. Because the skills we cover are so practical, it's great to be able to engage students real-time and work through problems or do group work in class," she relates. "When our graduates reflect back on their MSU experience 10 years from now, I hope they say that although the course was a lot of work, it caused them to think in new ways which prepared them for future employment and being able to solve real engineering problems."

BE 385 students (left to right) Xuhao Dai, Andris Grinvalds, Stephen Jones and Nicole Kruse work as a team to propose potential solutions to a real-world problem preparing themselves for the much larger real-world problems assigned in Senior Design.

Capstone project prepares students for careers as professional engineers

MSU program emphasizes unique and interactive team approach

Biosystems engineering disciplines require seniors to complete a capstone project before graduating, but the Michigan State University (MSU) Biosystems Engineering (BE) takes a unique approach. Students still complete a project, but instead of the entire class working on a single problem over the course of a semester, students are assigned to three- and four-member teams, placed according to each person's interests and personality styles. Each team is assigned its own project to be completed over the span of two semesters. A faculty advisor is paired with each team, riding shotgun over the duration of the project as a technical adviser and providing feedback and guidance. Learning to work as part of a team is emphasized as much as actual problem-solving.

BE 485 and BE 487 are offered in fall and spring semesters, respectively, of a student's senior year. They are co-taught by Drs. Dana Kirk and Luke Reese, two faculty members who guide the students as they dive into real-life projects prepared for clients, many of whom are members of the BAE Industry Advisory Board (see related story on pages 6-7).

"Students learn the dynamics of working with clients and transitioning from academics to careers," Kirk says. "They learn about everything from managing content to filing to nurturing client relationships. Some even have to learn how to navigate non-disclosure agreements and intellectual property licenses."

About 40 percent of BE 485 class time is devoted to speakers helping the student teams define standards and think creatively, all while working through issues of quality

Senior design teams present a 30-minute technical presentation to a faculty jury defending their design selection process, selected design, prototype, testing, optimization and recommendations.

BE 485 Biosystems Design Techniques:
Engineering design process. Problem identification, analysis, design, modeling, materials, cost estimation, and final specifications. Safety, environmental, and ethical considerations.

BE 487 Biosystems Design Project:
Individual or team design project selected in BE 485. Information expansion, development of alternatives, and evaluation, selection, and completion of a design project.

standards and budget parameters, intellectual property, patents and copyrights. The teams then shift away from the traditional classroom setting and tackle the project at hand, which includes completing a preliminary design report, determining how to develop and test a prototype, calculating financials, and conducting a feasibility assessment.

"It's not until the second half of the semester that they can start throwing out the net to catch possible solutions and start weighing the pros and cons of the best options," Kirk says.

It's then when the student teams identify their solution and project plan and review it with the client. It also undergoes a review by a faculty jury and an industry panel of evaluators to ensure it meets technical requirements and feasibility. Both groups provide feedback and suggestions for refining the plan.

By the time BE 487 begins spring semester, student teams are meeting either weekly or every other week with their faculty advisor and several times through the semester with their industry advisor (client) as they execute their project plan.

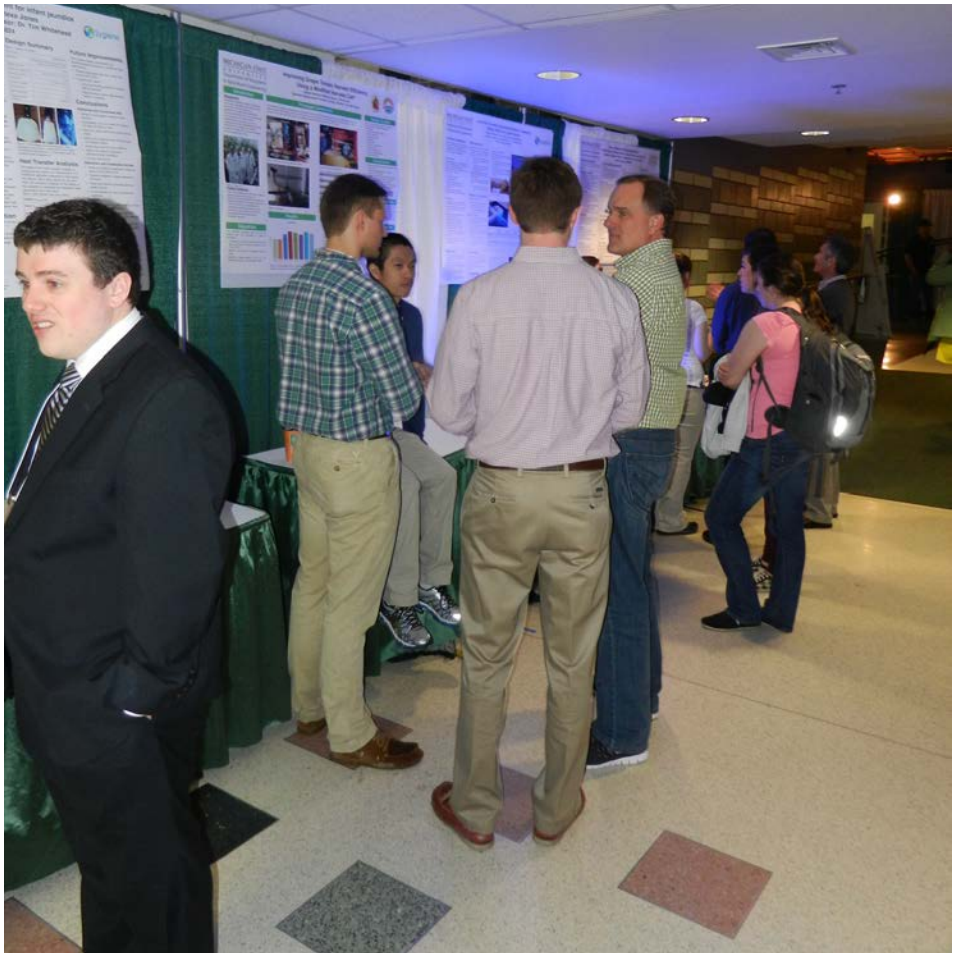
Kirk says the course as a whole is unlike any students have ever taken and forces them to apply all the skills learned up to this point, in addition to discerning how to synthesize information and think outside the box. He adds exposing students to the next phase of life and helping them realize there is not always a book answer to every problem is a goal of the class.

"It's a very interactive experience, and it can also be very awkward for students. It's meant to challenge students to develop their applied thinking skills. They know equations and how to use a calculator, but now they are taking everything out of the book and using it to solve a problem that doesn't have a clearly defined answer," he says. "Successful teams are those who know how to get good information and seek out help. They do an extensive literature search. They network and know how to ask for information. They have good communication skills and good presentation skills."

Grading depends upon a heavy feedback system encompassing 10 to 12 touch points over the course of the year with instructors, other faculty members, industry representatives, peers and graduate students. In addition, the student teams prepare a 20-minute technical presentation for the faculty jury. This report is modified for the lay audience attending the department's annual BE Showcase conducted at the conclusion of the second semester. Students also create and present a poster for the College of Engineering Design Day.

Colleague Reese adds that the experience is very intense for students as they learn to negotiate the nuances of working on teams with clients and integrate classroom learning to real-life scenarios.

"These two courses demand that the entire cast of players be deeply involved in providing the students with as close to a real world experience as we can give them," he says. "Very few universities are doing capstone projects the way we are at MSU, and the industry recognizes how fully we are preparing graduates for the type of work they will be doing when they move into their careers. We are preparing them to become professional engineers."



One week after BE Showcase, senior design teams participate in a public poster session as part of the College of Engineering Design Day.

2014 Senior Design Capstone Projects

Dr. Dana Kirk, PE
Asst. Professor

Dr. Luke Reese
Assoc. Professor

BE program educational objectives

The Biosystems Engineering (BE) undergraduate program prepares graduates who will integrate and apply principles of engineering and biology to a wide variety of globally important problems. To achieve that purpose, the primary objectives of the BE program are to prepare graduates to:

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

Additionally, the Biosystems Engineering program is designed to help graduates succeed in diverse careers by developing a professional foundation that includes vision, adaptability, creativity, a practical mindset, effective communication skills for technical and non-technical audiences, the ability to work in diverse, cross-disciplinary teams, and a commitment to sustainability, continuing professional growth, and ethical conduct.

BE 485 / BE 487 Courses

Biosystems Engineering student teams, enrolled in the two-semester biosystems design capstone experience, BE 485/487, develop, evaluate, and select design alternatives in order to solve real-world problems. Projects are diverse, but each reflects systems thinking by integrating interconnected issues affecting the problem, including critical biological constraints. The engineering design process is documented in a detailed technical report. Teams present project designs to engineering faculty and a review panel of professional engineers for evaluation. Each BE 485/487 capstone design team prepares and presents a design solution in report, poster and oral formats to industry, faculty, peers and the public that:

- Requires engineering design
- Uses a holistic approach
- Combines biology and engineering
- Interprets data
- Solves a real problem
- Evaluates economic feasibility

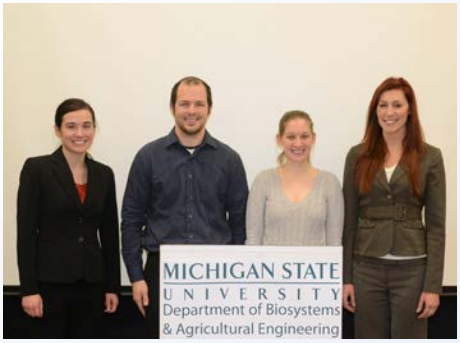
Industry Advisory Board & Project Evaluators

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.

See page 6 for a list and photo of Industry Advisory Board members.

Project Evaluators

Ralph Elias - Terumo Cardiovascular Systems
Todd Forbush - Techmark
Danielle Habitz - Kellogg
Daniel Holcomb - ConAgra
Bob Stacy - JBT FoodTech



(L to R) Charlsey Hoehn, Michael Gisler, Lisa Moncznik & Ashley Andreski

Pork and Bean Process Optimization

Sponsor – ConAgra
Faculty Advisor – Dr. Kirk Dolan
Industry Evaluators – Cassaundra Edwards & Daniel Holcomb

"The Cool Beans" team project is to optimize the Van Camp's Pork & Beans manufacturing process in order to improve product quality and reduce system losses. Currently a brand leader in the value category, the Van Camp's lines produce 4 million cases per year.

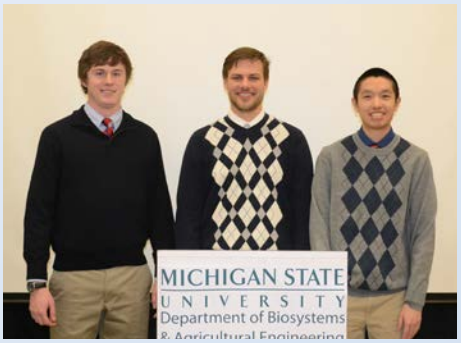
Client deliverables for this project include a full assessment of the current Pork & Bean process, a statistical analysis of process variation and capability and a process optimization plan. Additionally the team will determine loss reduction solutions through experiments and full economic analysis.

Cherry Tomato Harvest Production Improvement

Sponsor – Mastronardi Produce
Faculty Advisor – Dr. Dan Guyer
Industry Evaluators – Juanita McCann & Eric Toye

The "Biosystems Loves Tomatoes (BLT)" team project is to increase operator productivity during the harvest of grape tomato harvest at the Mastronardi Produce facility in Coldwater, MI.

Client deliverables for this project include modified harvest cart prototype with automated drive train and a harvest assist device. Full AutoCAD modification drawings will be provided as well as a full economic analysis including implementation costs and Return on Investment.



(L to R) Daniel Holmes, Matthew Walch & Wilson Yee

(L to R) Royce Sperry, Kelly Rossi & Matt Gammans

Value-Added Fruit Leather Process Line – Ghana

Sponsor – Blue Skies & USAID GFCSI Student Challenge Award
Faculty Advisor – Dr. Brad Marks
Industry Evaluators – Steve Richey & Danielle Habitz

The "Ghana Fruit" team project is to design a fruit leather processing line from raw material to final product, along with initial product formulations.

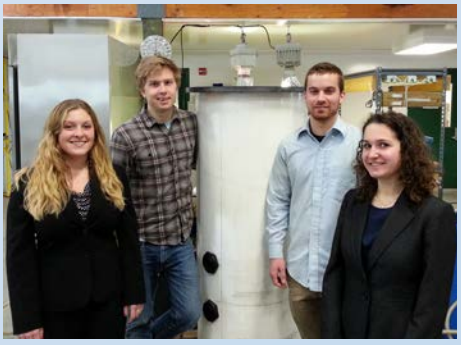
Client deliverables for this project include a product composition and recipes for both mango and pineapple fruit leathers, a design process flow with equipment specifications and a complete economic analysis with ROI and implementation costs. Team members spent Spring Break in Ghana conducting process research, product testing and presenting to Blue Skies company representatives.

Wastewater Treatment Using Anaerobic Digester

Sponsor – Technova
Faculty Advisor – Dr. Wei Liao
Industry Evaluators – Michelle Crook & Bryce Feighner

The "AD Strong" team project is to design and develop a novel, efficient pilot-scale (0.43 m3) up flow and fixed film anaerobic digester to later be connected to an integrated solar-bio-nano-based wastewater utilization system.

As part of a Department of Defense project, client deliverables include a functioning pilot reactor for system performance evaluation and full technical and economic feasibility analysis.


(L to R) Allison Vanderkolk, Matt Coleman, Evan Austin & Danielle Brickner

(L to R) Rick Avery, Anh Bui, Pat Sheridan & Julia Otwell

Algal Photoreactor System for Nitrogen Removal

Sponsor – Quantalux, LLC & USAID GFCSI Student Challenge Award
Faculty Advisor – Dr. Susie Liu & Dr. Jeff Li
Industry Evaluators – Larry Stephens & Valerie Novaes

Current closed animal feeding operations generate emissions containing ammonia and other impurities. A wet scrubber system allows for treatment of this polluted air, however, this generates nitrogen-contaminated water.

The "Algaeneers" team project is to design an algal photoreactor system to uptake and balance the nutrient absorption rate in a wet scrubber system. Client deliverables for this project include a constructing a functional reactor prototype including CAD drawings, bill of materials, system performance analysis and mass balance and complete economic feasibility analysis.

JBT FoodTech ProMix/ABC-III Viscosity Control

Sponsor – JBT FoodTech
Faculty Advisor – Dr. Gail Bornhorst
Industry Evaluators – Andrew Knowles & Bob Stacy

The "Better Batter" team project is to design a viscosity control system for the JBT ProMix/ABC-III automatic batter mixer to reduce the component cost in comparison to the current viscosity pump and pressure transducer control system

Client deliverables for this project include design concept through lab testing, a complete modification budget with bill of material, pilot verification testing and a proven correlation curve of apparent viscosity and a measureable rheological property to implement into JBT's PLC configuration.

(L to R) Christopher Taylor, Keely Chandler & Kirk Gowen

(L to R) Zach Carter, Rachael Sak, Nichole Erickson & Cody Matthews

Biomass Power: Torrefied Wood Briquettes as Station Power Fuels

Sponsor – Heat Transfer International
Faculty Advisor – Dr. Chris Saffron
Industry Evaluators – Dave Prouty & Jeff Mathews

The "Thermal Edge Innovations" team project is to produce briquettes and pellets from torrefied hardwood without binder, and perform optimization and economic comparison studies to determine which has the hygroscopic, friability, and heating value properties that best approach that of coal.

Client deliverables for this project include a briquetting prototype, mass and energy balance data for process, property analysis of torrefied biomass, a supply chain economic model and a techno-economic model.

Design of a Fiber-optic Treatment for Infant Jaundice

Sponsor – Sygiene
Faculty Advisor – Dr. Tim Whitehead
Industry Evaluators – Steve Steffes

The "Bullish Biomeds" team project is to design a wearable treatment for infant jaundice using fiber-optic technology in order to reduce cost of treatment, allow for easy deployment in developing countries, and minimize impact to crucial maternal bonding.

Client deliverables include a working prototype using fiber-optic technology that maximizes maternal bonding and a complete economic analysis for reduced treatment cost and easy deployment to developing countries.

(L to R) Vu Hoang, Alexa Jones & Oliver Bloom

(L to R) David Stromberg, Jessica Palmer & Tim Lauth

Design of a LED Treatment for Infant Jaundice

Sponsor – Sygiene
Faculty Advisor – Dr. Tim Whitehead
Industry Evaluators – Muluken Tilahun & Ralph Elias

The "Bright Ideas" team project is to design a portable, wearable, cost– efficient treatment for infant jaundice using LEDs as a light source that will reduce typical treatment time and not interrupt maternal-infant bonding and breastfeeding.

Client deliverables include a working prototype consisting of a wearable phototherapy device using LED lights allowing portable treatment of hyperbilirubinemia, an economic analysis of the manufacturing and treatment costs associated with the device and a heat transfer analysis of device.

Solar Vapor-Absorption Refrigeration

Sponsor – Michigan Agricultural Electric Council (MAEC)
Faculty Advisor – Dr. Truman Surbrook & Mr. Aluel Go
Industry Evaluators – Gene Ford & Mitch Miller

The "Cool Runnings" team project is to design an efficient, cost effective solar thermal vapor-absorption refrigeration system capable of sustaining consistent temperatures between 2°C and 8°C while being operated off the grid.

Client deliverables for this project include a functional prototype; a feasibility assessment including location compatibility, economic constraints and medical impact; design blueprints for reproduction and a mathematical model for single unit scaling.

(L to R) Travis Collings, Jessica Warvel, Alex Rowland & Steven Cumming

(L to R) Andrew Plouff, John Venn & Robert Kraemer

Student Organic Farm Cold Storage Design

Sponsor – MSU Student Organic Farm
Faculty Advisor – Dr. Tim Harrigan
Industry Evaluators – Andrew Granskog & Todd Forbush

To provide a diversity of vegetables over a long season, local farmers need to utilize energy efficient methods of cold storage to reduce costs and extend the revenue period while maintaining crop quality and freshness. Currently, 95% of the electricity used at the Student Organic Farm (SOF) is for maintaining cool/cold storage for crops.

The "Local Roots" team project is to design an efficient cold storage unit that will store a range of produce at a reduced energy cost for the SOF.

Client deliverables include a full analysis of SOF cold storage energy and ventilation requirements, a complete cool/cold storage unit design and a comparative economic analysis.

Mark your calendars!

Fall Industry Advisory Board Meeting	Oct. 23, 2014
Spring Industry Advisory Board Meeting	April 16, 2015 (morning)
Alumni Awards Luncheon, BE Showcase and Recognition Banquet	April 16, 2015 (afternoon)

If you are interested in sponsoring a BE 485/487 capstone project idea for the 2016 Senior Design Showcase, contact Luke Reese at reesel@msu.edu.

Study abroad programs change lives

Students learn life skills not taught in the classroom

Students on the Sustainable Food, Environment and Social Systems program in Australia canoe the Murray- Darling River learning about human impacts on the environment, including effects of weirs and locks, increased salinity levels, water use and rights, water allocations for environmental services, acid sulfate soils, and related topics.

The impact a study abroad program has on students' lives is sometimes difficult to measure since it may only be fully realized years after the experience when students find themselves working on international teams or for multi-national companies. One aspect that can be measured, however, is that students often report that their study abroad experience was one of – if not the – favorite and most memorable experience from their college years.

"When we put students in a different cultural environment, even if they speak the same language, they quickly learn how cultures differ, how to adapt, and how to be reflective and respectful," says Luke Reese, Michigan State University (MSU) Biosystems and Agricultural Engi-

neering (BAE) Study Abroad Coordinator. "These are all life skills that are not learned as part of a typical classroom setting."

Study abroad programs move students beyond their comfort zones and into different environments to solve problems. Even though problems may be similar to those existing in the United States, because of different economic, social, political or environmental variables, how one approaches solving that problem may be entirely different than how it's done in the United States.

Reese says students learn how to adapt to a new normal rather swiftly, learning about the value of a dollar, (foreign) perceptions of Americans, paying with different colored currency and gaining appreciation for the metric system.

"It's fascinating to see the students in a completely different way," Reese says. "I see a lot of firsts, particularly if they have never been away from home or from cell phones and the Internet. The whole experience is intense and new. Students are immersed as much as possible in the culture. It's not a glorified field trip, but true academic rigor."

Students may choose from three faculty-led overseas study abroad experiences based on their individual interests. Each program links back to food, ecosystems, and international exposure to companies. For each program, the locations and students are well organized and carefully monitored to ensure personal safety.

• Australia: Students may earn integrated social science credits through a joint program conducted with the MSU Department of Community Sustainability. The experience focuses on sustainability and explores how human's decisions affect the environment specifically how natural resources are used, reused or recycled; how the surrounding community is impacted and were the decisions socially equitable. The program covers a full systems approach: economic, social and environmental.

•Sweden and Germany: This study abroad experience focuses on renewable energy. The bioenergy portfolio zooms in on an anaerobic digester in Germany that is using silage to make electricity instead of cow feed. Students are charged with determining if what they learn can be applied back in Michigan.

• Costa Rica: The region's ecosystems provide ample water, but often at such a rapid rate that mudslides and other devastation result. In this program, students explore ways to harness the energy or redirect and redistribute it to avoid destroying the ecosystem.

Reese says that students come back changed.

"With study abroad, you know that you're changing people's lives," he says. "It's no longer unusual for people to work for multinational companies. This experience helps students grow as people and enhances their awareness as global citizens."

Above: Students on the Ecological Engineering in the Tropics, Costa Rica program celebrate successful "floating" of prototype wetland mats. The team successfully designed and assembled five different floating mats using local resources. Left: Students on the Renewable Bioenergy Systems program in Sweden and Germany stand on top of an anaerobic digester located on the Bauer Farm near Frankfurt, Germany. Students learned about digester types, energy crops, grid connectivity and feed-in-tariffs during this site visit.

Helping students become more SUCCESSFUL

Lilly Teaching Fellows Program advances excellence in the classroom

Dr. Reinhold visits a potential site for a study abroad lesson on wind energy near Mt. Arenal, Costa Rica

Educational programs are only as strong as its best teachers, and for instructors committed to growing as educators, Michigan State University (MSU) offers numerous building block opportunities ranging from fellowships and seminars to workshops and symposiums, in addition to resources for assessing teaching styles.

Dawn Reinhold, MSU associate professor of biosystems and agricultural engineering, chose to compete successfully for one of seven fellowships available through the Lilly Teaching Fellows Program at MSU in 2012 when students in her junior-level BE 332, Engineering Properties of Biological Materials course, struggled to apply concepts presented in the classroom to successfully complete assigned homework.

"There was a big gap for students between working on examples in the classroom and then doing homework independently," Reinhold explained. "Not only did I want to improve students' homework performance, but I also wanted to reduce their frustration levels."

The Lilly Teaching Fellows Program is intended to advance the University's continuing efforts to support excellence in teaching and learning. The competitive program offers MSU early career faculty members an opportunity to maximize their teaching abilities through a series of activities designed to focus attention on the scholarship of teaching and learning. Recipients investigate a teaching challenge or innovation and share research findings within their cohort, across campus, at conferences, and in disciplinary journals. Fellows are encouraged to become future faculty leaders and models for their peers.

The fellows program covered material related to learners and learning, motivating students, designing curriculum and syllabuses, understanding the traits of millennial learners, differing teaching methods, collaborative learning, interdisciplinary teaching, teaching critical thinking, teaching with technology, diversity and assessment.

Reinhold said the Lilly Teaching Fellows Program was an embarkation point for discovering how to improve the learning experience for students and demonstrated how expectations differ between those in the social sciences and engineering sciences.

"Many engineering students are considered sequential learners, but not every problem can be solved in a linear process," she said. "If we don't confine ourselves to this teaching strategy, then we can reach and help more students be successful, especially those who respond to cooperative, global teaching styles."

For her teaching and learning project, Reinhold developed a series of pre-assignment quizzes meant to improve student learning, reduce frustration and keep students motivated to do work outside the classroom. The result was that students required less time to complete

Top: Dr. Reinhold helps a elementary school student collect samples for a macroinvertabrate study during a service activity.
Bottom: Dr. Reinhold teaches on the basis of wetland engineering in Panama.

homework and their perception of the level of difficulty of that work also decreased.

"I did spend more time creating the pre-assignments," Reinhold acknowledged, "but I spent less time helping students simply get started on or answering questions about the homework. They were ready to work more independently from the outset."

Reinhold also shared the research with her faculty colleagues in the department and graduate students in informal discussions throughout the semester so everyone can be more engaged with becoming better teachers and learning more about how students learn.

"Our students are not the same as they were 10 or even three years ago," Reinhold said. "We have to be proactive across the department in adapting intelligently to these new students by identifying potential learning challenges and providing a dynamic learning environment."

"There is no such thing as an average student."

Cassaundra Edwards receives 2014 MSU College of Engineering BAE Distinguished Alumni Award

Cassaundra F. Edwards, BS '94, Biosystems and Agricultural Engineering, was awarded the 2014 Michigan State University (MSU) College of Engineering BAE Distinguished Alumni Award.

Edwards is a research and development manager at ConAgra Foods in a strategic customer development role, driving product innovation for warehouse club markets such as Costco, Sam's Club and BJ's.

For nearly 20 years, she has held various roles within the food industry. Her career started as a junior engineer developing innovative frozen meals for Nestlé, and then researching novel non-thermal preservation technologies such as high pressure pasteurization and irradiation for Kraft Foods and leading a product technical team with the integration of two food industry giants, Kraft Foods and Nabisco. Throughout her career, Edwards has touched a multitude of consumer brands such as Stouffers, A.1. Steak Sauce, Grey Poupon Mustard, Lunchables, Oscar Mayer, Banquet and Hunt's.

Edwards holds a Bachelor of Science degree in biosystems engineering from MSU and a Master of Engineering from Case Western Reserve University in Cleveland, Ohio.

She has a great passion for her work in the food industry and developing the careers of young scientists and engineers. She has been a member of the MSU Biosystems and Agricultural Engineering Industry Advisory Board for the past four years and currently serves as its chairperson.

Cassaundra F. Edwards

Edwards attributes her professional accomplishments and development to her family and a network of mentors who have shared their leadership philosophies and ideals and ultimately helped shape her as a leader. Her personal philosophy on leadership is that "great leadership is achieved partly through other great leaders and people helping you along the way."

In addition to driving business growth for ConAgra Foods, Edwards enjoys spending time with her husband, Jay Edwards, eight-year-old son, Miles, and a mischievous Welsh terrier, Coltrane. They currently reside in Omaha, Neb.

Forbush receives Distinguished Service Award from the CANR

The Michigan State University (MSU) College of Agriculture and Natural Resources (CANR) recognized Todd Forbush as its Distinguished Service Award winner during the annual Agriculture and Natural Resources (ANR) Week luncheon at the Kellogg Hotel & Conference Center in March.

Todd Forbush is vice president of Techmark, Inc., a company which originated in 1988 under his leadership and focuses on improving profitability of farmers through the post-harvest storage and ventilation of crops.

Forbush completed his Bachelor of Science and master's degrees in agricultural engineering at MSU. Between his potato storage research, drive and experience, he became a cornerstone in the industry's move from producing potatoes for the frozen potato industry to producing them for other uses. Forbush also promoted a new quality control program, a joint effort between Techmark and the Michigan Potato Industry Commission (MPIC). Techmark also licensed and promoted the Impact Recording Device (IRD) developed at MSU. The company commercialized the use of the IRD to assist the agricultural industry in reducing bruising of produce.

Forbush designed the MPIC-funded Burt Cargill Potato Demonstration Storage Facility at the Montcalm Research Center. He is engaged with potato growers and MSU researchers utilizing the storage.

Forbush is a member of the CANR Alumni Association, serves on the Board of Directors and was president in 2001-02. He was also a member of the Industry Advisory Board for the MSU Department of Biosystems and Agricultural Engineering and a member of the MSU CANR Stakeholder Advisory Board. In 2012, he received the MPIC Distinguished Service Award. He is a long-time supporter of the Michigan 4-H program and attends and supports numerous MSU functions.

Andrew Wedel receives 2014 MSU Department of BAE Distinguished Alumni Award

Andrew Wedel

Andrew Wedel, MS '96, Agricultural Engineering, has been awarded the 2014 Distinguished Alumni Award by the Michigan State University (MSU) Department of Biosystems and Agricultural Engineering.

Wedel is the General Manager of McLanahan Corporation's Agricultural Systems Division where he is part of a team that develops, designs and supplies dairy manure handling systems focused on environmental sustainability and cow comfort. Specific designs include: anaerobic digester pre-treatment systems; conveyance and separation systems; earthen, concrete and HDPE-lined manure storage structures; runoff control structures; and pump and gravity conveyance systems.

Wedel holds a Bachelor of Science degree in Agricultural Engineering Technology from the University of Delaware and a Master of Science degree in Agricultural Engineering from MSU. He is a licensed professional engineer in Delaware, Maryland, Michigan, New York, Pennsylvania, Virginia and Wisconsin. In 2010, Wedel received the Young Agricultural Engineer of the Year award from the Northeast Agricultural and Biological Engineering Conference.

Prior to joining McLanahan Corporation in 1996, Wedel was an Agricultural Engineering Specialist at MSU where he, along with a group of agricultural engineers and dairy producers, researched and developed systems for handling sand-laden dairy manure.

Wedel resides with his wife Ann and their three sons in Duncansville, Penn. Their spare time is spent playing/coaching baseball, boating, ATV-ing and raising chickens.

Danielle Habitz receives 2014 MSU Department of BAE Outstanding Alumni Award

Danielle Habitz

Danielle Habitz, BS '08, Biosystems Engineering, has been awarded the 2014 Outstanding Alumni Award by the Michigan State University (MSU) Department of Biosystems and Agricultural Engineering.

Habitz is a Snacks Process Engineer with Kellogg Company, headquartered in Battle Creek, Mich. She has led various engineering startups throughout the United States, Europe and Latin America, including the recent international startup and equipment training for Kellogg's® Special K® Cracker chips in Belgium. Habitz is engineering leader across various product lines for cookies, crackers, wholesome snacks and on-the-go foods such as Keebler® Fudge Stripes™, Kashi® Soft'n Chewy Bars, Special K® Popcorn Chips and, most recently, Rice Krispies Treats® Crackle Snaps.

Habitz has played an active outreach role for several groups, including the Society of Women Engineers (SWE), Western Michigan University's Senior Design program and Kellogg's Intern Leadership Committee. She especially enjoys recruiting MSU internship candidates and presenting to the Biosystems Engineering Club and introductory engineering classes.

Habitz and husband Neil, also an MSU Spartan graduate, reside in Chelsea, Mich. In her free time, she frequently takes part in alumni tailgate events and spends quality time with family and friends. Habitz is recognized as an exemplary biosystems engineering ambassador who consistently brings her fiercely loyal, determined, caring and passionate attributes to both her personal and professional lives.

Risky business: MSU researcher to build national microbial risk assessment training program

Michigan State University (MSU) biosystems engineer Dr. Jade Mitchell has received a nearly $1 million grant from the National Institutes of Health to develop and provide quantitative microbial risk assessment (QMRA) tools, models and training to university researchers around the nation. One of the goals of the program is to link quantitative scientists such as engineers to biologists and social scientists.

QMRA is a four-step process used by scientists and engineers to characterize the human health risk associated with exposure to various microorganisms. The information is used to assess levels of safety and to develop appropriate plans in case of public exposure to infectious agents in all types of settings.

Though it's more common in mathematics and applied sciences such as engineering, QMRA draws on knowledge created by specialists from a range of disciplines, including biology and the social sciences. Training and expertise are not as common in these fundamental scientific fields as in the applied fields, however, and courses are not available at the graduate level in many academic departments. Mitchell said the training program will strive to fill those voids.

"It's important that we engage more with biologists and social scientists because their work is so important to risk assessment and the application of systems thinking to public health problems," said Mitchell, an assistant professor of biosystems and agricultural engineering. "Especially when it comes to defining and implementing management practices, which rely on how people respond to them."

The training program will help engineers and biologists take a systems approach to food and environmental issues.

"As we continue to integrate engineering with biology, and while taking a systems approach to issues of food and environment, this NIH grant – a first for our department – will give the necessary boost in our efforts towards developing engineering systems for One Health," said Ajit Srivastava, chairman of the MSU Department of Biosystems and Agricultural Engineering. One Health is a collaborative, multidisciplinary movement to attain optimal health for people, animals and the environment.

Dr. Jade Mitchell

Participants in the two-week courses, which are set to begin in the summer of 2015, will learn the essentials of QMRA practice and apply their knowledge in cutting-edge real-world case studies. Mitchell said this will help to develop new methods that can be used to tackle emerging issues in microbial risk management.

"One of the things I like best about this program is that it brings new research into the educational environment," Mitchell said. "Most recently we've looked at biosolids, such as manure, and viruses in drinking water. Those are both pretty hot topics right now, and we're at the forefront of training people for them. We're testing new methods and models, as well as developing the educational materials for these new issues."

Mitchell's program will include leading figures in the field of QMRA teaching multidisciplinary courses on the subject.

"Risk assessment is always a team effort, so to best facilitate learning, this program had to be multidisciplinary," Mitchell said. "People are coming to this course to learn from the people who established this framework and are leaders in the field."

A website, which will feature more information including registration forms, is set to launch in December.

MSU student start-up shines in national, international business competitions

MSU biosystems engineering students (left to right) Oliver Bloom, Alexa Jones and Vu Hoang demonstrate the Swaddle-mi-Bili, a wearable treatment for infants with jaundice.

Swaddle-mi-Bili, the Michigan State University (MSU) undergraduate team of Biosystems Engineering seniors Oliver Bloom, Vu Hoang and Alexa Jones, competed in the International Business Model Competition on May 1-3 at Brigham Young University in Provo, Utah. Forty international teams competed and the Spartans took 4th place overall, winning an $8,000 prize.

"Michigan State University's student start-up teams have ideas and talent that can compete on a global scale," said Paul Jaques, Director of Student and Community Engagement at Spartan Innovations. "We're proud of their innovative ideas, dedication to making a difference and the perseverance it takes to tackle complex medical challenges and bring life-changing solutions to the world."

Swaddle-mi-Bili is an East Lansing start-up biotech company. Their product is a wearable treatment for infant jaundice that promotes maternal-infant bonding and breast-feeding during treatment. This type of treatment provides a less stressful, faster and more cost-effective experience for both mother and infant.

The International Business Model Competition (IBMC) represents the first competition of its kind in the world and is part of a novel approach to entrepreneurship that focuses on the process of improving the inputs into entrepreneurship rather than the outputs. The IBMC is open to all students enrolled at an accredited institution of higher education anywhere in the world.Thousands of student teams from hundreds of schools around the world participate. The competition is sponsored by the Rollins Center for Entrepreneurship & Technology at Brigham Young University and is co-hosted by Harvard and Stanford.

On June 4, members of Swaddle-mi-Bili were finalists in the unique entrepreneur forum Project Startup Live contest in Detroit. Swaddle-mi-Bili pitched their idea and won $2,500 and consulting with the CEO of Rockethub.

Note to readers: The Swaddle-mi-Bili product name has been changed since the initial launch. The company name is now TheraB Medical and the product is now known as SnugLit.

Kristen Henn: Two-time Big Ten Medal of Honor winner, three-time team captain is BE master's degree candidate

MSU field hockey star plans to pursue Ph.D. or career in renewable energy

Kristen Henn

Michigan State University (MSU) biosytems engineering master's degree candidate and field hockey star Kristen Henn's athletic prowess, academic reach and interpersonal impact have earned her elite status as a sportswoman and scholar. This spring she was named MSU's female recipient of the Big Ten Medal of Honor, which for 100 years has been a celebration of the student-athlete experience on conference campuses and a predictor of remarkable post-collegiate performance and achievement in sports and beyond.

Selected to the National Field Hockey Coaches Association Academic Squad (NFHCA) for the fourth-straight year, Henn was voted the MSU Player of the Year and Defensive Player of the Year by her teammates. Her leadership on and off the field was vital, as 12 other Spartans also earned Big Ten and/or NFHCA academic recognition.

After completing her master's, Henn will either pursue a Ph.D. or begin an engineering career in the renewable energy industry.

BAE chairperson and professor receives Distinguished Faculty Award

Michigan State University (MSU) Department of Biosystems and Agricultural Engineering Professor and Department Chairperson Ajit Srivastava was awarded the Distinguished Faculty Award by the College of Agriculture and Natural Resources (CANR) during the annual Agriculture and Natural Resources (ANR) Week luncheon at the Kellogg Hotel & Conference Center in March.

Srivastava's 33 years of service to the CANR includes educational innovations, significant scholarly contributions and outstanding programmatic leadership. His contributions to academic programs in biosystems and agricultural engineering began early in his career, greatly impacting the programs at MSU and across the country. In his current role as department chair, he has remained actively engaged in teaching and academic innovations. He also personally developed and led a bioenergy study abroad program to Sweden and Germany.

Srivastava has made significant scholarly contributions to three areas critical to the mission of the CANR: agricultural machinery, renewable bioenergy and global systems. He has provided significant leadership in developing MSU programs, projects and faculty in the area of bioenergy systems, including leading the development of the successful, multi-departmental Quality Fund initiative for a faculty cluster hire in this area. His most significant contributions have been in assembling teams of individuals and setting them up for success.

(Left to right) College of Agriculture and Natural Resources Alumni Association President Jim Tuinier, Barb Srivastava, Chairperson Ajit Srivastava, Dean Fred Poston and Steven Srivastava.

Srivastava's leadership as principal investigator of the $25 million U.S. Agency for International Development (USAID)-funded Global Center for Food Systems Innovation and his leadership in a wide variety of other programs that build connections between MSU CANR and international partners such as universities in Costa Rica and China demonstrate his commitment to expanding the international reach of the university and the college.

John H. Boldt: A quarter century of bringing hope to those in need

John H. Boldt, P.E., P.S.M. (retired) (Biosystems and Agricultural Engineering, Class of 1961), has served with the Columbus, Indiana-based Engineering Ministries International (EMI) for more than 25 years. Since 1998, Boldt has been on more than 35 EMI mission trips, including 25 trips to Haiti, seven to Central America, one to Kenya, and one to Indonesia after the 2004 tsunami. Boldt has been a national field representative with EMI for 14 years and is closely involved with the Love-A-Child project. He and his wife, Judi, have been married 55 years.

Vernon K. Jones: Moving people to understand the effects of climate change

Vernon K. Jones, Ph.D., (Agricultural Climatology, Class of 1979) has spent much of his career charting the basic principles and applications integrating agriculture, atmospheric science and agricultural policy. His ongoing mission through his work with the Board of Church and Society with the West Michigan Conference of the United Methodist Church is to help people comprehend, understand and anticipate global changes in society as it relates to climate change.

Are you an alumni or former faculty member of the Michigan State University Department of Biosystems and Agricultural Engineering? Do you have news to share?

Please submit all information to Jamie Lynn Marks at marksjam@anr.msu.edu and include appropriate contact information for follow-up.

Honoring Life of Service

Dr. Carl William Hall

Dr. Carl W. Hall

Falls Church, Virginia
Nov 16, 1924 - April 18, 2014

Dr. Carl W. Hall, Ph.D., P.E., former Michigan State University (MSU) agricultural engineering professor and department chairperson (1964-70) passed away April 18, 2014. Hall served as the Deputy Assistant Director of Engineering at the National Science Foundation (NSF) (1982-90) where he played a major role in the development of the new Engineering Research Centers program at NSF. While serving as Acting Assistant Director for Engineering, he worked with the White House Office of Science and Technology Policy, OMB, Congress, the National Academy of Sciences/National Academy of Engineering and numerous groups within NSF, to mold this idea into a viable program to strengthen U.S. engineering research and education. The program represented a major change in the way NSF supported engineering research. Dr. Hall received the Distinguished Service Award from NSF for his leadership in formulating the program and guiding its implementation. He also provided leadership in implementing the 1985 reorganization of the Directorate for Engineering, chairing a task force to develop and implement this plan. In 1986, Dr. Hall was recognized by the National Society of Professional Engineers as the NSF Engineer of the Year. Beyond his work at MSU and Washington State University, he participated in many international delegations and projects in Russia, Libya, China, Japan, Indonesia, South America and Central America. He was a prolific author and was the founding editor of Drying Technology: An International Journal, now in its 30th year of publication. Dr. Hall's career achievements included research in energy, drying, food engineering, properties of materials and biomass. His work was widely recognized by many organizations with awards: Distinguished Alumni, MSU, Ohio State University and University of Delaware; Medal du Merite, France; and the Max Eyth Medal, Germany, among others. As a staff sergeant in the 99th Infantry Division in WWII, Dr. Hall participated in three major campaigns including the Battle of the Bulge, for which he was awarded the Bronze Star and the Combat Infantryman's Badge.

Dr. Hall is survived by his wife of 64 years, Mildred, daughter, Claudia Genuardi, three grandchildren and six great grandchildren.

Dr. George Ellis Merva

East Lansing, Mich.
Aug 20, 1932 – Oct 30, 2013

Dr. George Ellis Merva

Dr. George Ellis Merva, of East Lansing, passed away Oct. 30, 2013. He was born August 20, 1932, in Guernsey City, OH to John and Julianna (Jugan) Merva. Dr. Merva was raised in Southeastern Ohio coal country and enlisted in the Army after high school. He went to school through the G.I. bill and continued on through a Ph.D. program in Agricultural Engineering at Ohio State University. After finishing his Ph.D., Dr. Merva was hired on as faculty at Michigan State University in 1967. He achieved tenure at MSU in three years and was promoted to full professor after seven years. He took pride in teaching all types of students and classes from remedial math to thermodynamics. Dr. Merva was also an avid musician, playing gigs starting at age 15. His primary instrument was accordion; he also played piano, guitar and banjo. He loved 40's ballads, polka music and old standards. His rich, robust bass voice was a staple of the St. Thomas Aquinas choir for more than 40 years. Dr. Merva was introduced to Betty Lou Mnich when she called his household asking him to direct the new church choir at St. Michael's Byzantine Catholic Church in Pleasant City, OH. He pursued her for two years. They wed on Oct. 31, 1959, and he never took his eyes off her during their 54 years of marriage. Most of all, he will be remembered for his life of service. Dr. Merva was a long-standing member of Kiwanis, a founder of the Knights of Columbus St. Thomas Aquinas chapter, a regular reader for WKAR Radio Reading Service for the Blind, and an archivist for Catholic Diocese of Lansing. He was also a frequent musician for nursing homes throughout the Lansing area, using his repertoire of over 1,000 songs to create set lists sprinkled with entertaining trivia. He is survived by his loving wife Elizabeth (Betty Lou); four daughters, Bernadette (Eric), Monica (Frank), Jacquelin (Allen), Jennifer (Curtis) and one son, Michael (Lisa); and nine grandchildren. A man of immense faith and devotion to the church, he joyfully looked forward to passing from this life into the next. Donations may be made to the George and Betty Merva Scholarship Fund or the St. Thomas Aquinas Music Program.

Faculty members

Evangelyn Alocilja

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Areas of expertise: biosensors, nanostructured bio-detection devices, diagnostics for infectious diseases, biodefense, food safety, environmental safety, and electronic nose

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Areas of expertise: basic and applied research in postharvest handling, grading, value-added processing and storage of fruits, vegetables and chestnuts; developing technology and sensors for nondestructive assessment of quality of horticultural crops in the domains of machine vision, spectroscopy, computed tomography, image processing, pattern recognition and specialty crop automation

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Areas of expertise: establishing a pelletized fungal platform for value-added biofuel/chemical production; developing algae strains for recombinant proteins production and nutrient (N, P) removal; and utilizing the symbiotic characters of mix culture (bacteria and fungi) for value added chemicals and enzymes production

Renfu Lu

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Areas of expertise: sensors and sensing technologies for property characterization and quality evaluation of fruits and vegetables; applying state-of-the-art technologies in imaging, spectroscopy, and computer, as well as advanced mathematical/statistical methods for assessing quality and condition of fruits and vegetables before, during and after harvest

Bradley Marks, P.E.

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Areas of expertise: food safety engineering, particularly microbial inactivation modeling and improving methods for validating pasteurization processes for ready-to-eat foods; leads the MSU Food Safety Group, an interdisciplinary group of nearly 30 faculty members focused on microbial food safety

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Areas of expertise: risk assessment: chemical and microbial stressors from diverse environmental exposures including bioterrorism and food safety; quantitative analysis: decision analysis, Bayesian statistics, and systems analysis; modeling: dose-response and exposure modeling including both exogenous and endogenous fate; and risk management and environmental policy: benefit-cost analysis, risk perception and communication

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Areas of expertise: ecohydrology, sensitivity and uncertainty analysis of water quality mitigation approaches to address climate change, environmental impact assessment, soft computing applications in water resources, development of decision support systems (DSS) for human impact evaluation on ecosystem sustainability, evaluation and development of watershed/water quality models, and description, analysis and prevention of non-point source pollution at laboratory, field, watershed and regional scales

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Areas of expertise: system analysis of biomass feedstock supply chain logistics, including computer modeling and simulation in supply chain logistics cost analysis; innovative technologies in woody biomass harvesting, pre-processing, storage, and transportation; and net energy analysis in using woody biomass for biofuel and bio-based products

Wendy Powers-Schilling

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Areas of expertise: (multispecies) diet modification as an economical means of altering odor and gaseous emissions and manure nutrient excretion

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Areas of expertise: information technology, print and web media layout and development, distance-learning technology, study abroad

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Areas of expertise: researching wetlands and vegetated technologies for protecting water quality; using plants for remediation of emerging organic pollutants and hazardous wastes; assessing fate of emerging pollutants and pesticides in vegetated systems; using plant tissue culture and genetic engineering to enhance the capability of plants to address water quality problems

Joan Rose

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Areas of expertise: water microbiology, water quality and public health safety; new molecular methods for waterborne pathogens and zoonotic agents and enteric viruses; water supplies used for food production, coastal environments, drinking water, wastewater treat¬ments and reclaimed water; microbial pathogen transport in coastal systems; climate factors affecting water quality; quantitative microbial risk assessment (QMRA) frame¬works, methods and data sets

Steven Safferman, P.E.

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Areas of expertise: treatment strains to minimize and treat wastes originating from animal agriculture and food processing, converting high energy waste to biogas for renewable energy; novel reactor designs such as anaerobic membrane systems and fluidized bed reactors; modeling and evaluating techniques for anaerobic digestion systems, conducting biogas potential assays, conducting bench-scale treatability testing, evaluating novel farm-scale technologies, and developing decision support guidance

Christopher Saffron

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Areas of expertise: process synthesis and techno-economic analysis of catalytic strategies for biofuels; upgrading lignin by pyrolysis and electrocatalysis

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Areas of expertise: agricultural machinery, renewable bioenergy, bioenergy systems, and global systems

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Areas of expertise: designing and engineering functional proteins; microbial-mediated conversion of biomass to fuels and chemicals that more closely approximate petroleum-derived feedstocks; developing antibody and antibody-like molecules for use as protein therapeutics against viral pathogens

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Campus Happenings

Long-time Farrall Hall employee retires

Glafira Manuell

After 27 years as a Michigan State University (MSU) employee, Glafira Manuell retired March 30, 2014. Manuell was a familiar face to Farrall Hall visitors and staff members: she had been head custodian in the building since June 1996.

Manuell started her career in the MSU Residential Hall system in Nov. 1987 before moving to Custodial Services in March 1995. In June 1996, she assumed the Head Custodian job for the MSU Department of Agricultural Engineering in Farrall Hall.

Manuell is planning to spend much of her retired time with family in Texas.

Michigan State University: the perfect site for President Obama to sign Farm Bill legislation

The Mary Anne McPhail Equine Performance Center at Michigan State University (MSU) was the backdrop for President Barack Obama as he signed the 2014 Farm Bill into law in Feb. He signed the legislation, also known as the Agriculture Law of 2014, after presenting a 20-minute speech focused on the measure's wide-ranging impacts.

Nothing fake about it: MSU BAE researcher's anti-counterfeiting device featured on NBC special

An innovative biosensor designed in the Nano-Biosensors Laboratory at Michigan State University (MSU) was featured recently in one episode of an 11-part series narrated by NBC News correspondent Ann Curry. The series was produced by the National Science Foundation, the U.S. Patent and Trademark Office, and NBC Learn in celebration of the 165th birthday of one of the country's greatest innovators, Thomas Edison. The biosensor, created by Evangelyn Alocilja, MSU professor of biosystems engineering and adjunct professor in the Institute of International Health, is designed for food and water safety. It allows a manufacturer to embed a unique biomarker into its products, helping authorities instantly detect whether it's real or fake. To view the episode, visit http://www.nbclearn.com/innovation/cuecard/62970.

Gold nanoparticles synthesized according to our alkaline-based method. The average diameter is 30 nm.

Advanced Degrees Conferred

Name	Degree	Major Professor	Thesis Title
Fall 2013			
Giri, Subhasis	PhD	Nejadhashemi	Assessing Best Management Practices and Implementation Strategies to Improve Water Quality
Kelkar, Shantanu Mohan	PhD	Saffron	Green Aromatics from Biomass Fast Pyrolysis and Catalysis
Mishra, Dharmendra Kumar	PhD	Dolan	A Rapid Testing Instrument to Estimate Thermal Properties of Food Materials at Elevated Temperatures during Nonisothermal Heating
Rojas-Downing, Maria Melissa	MS	Nejadhashemi / Harrigan	Resource Use and Conservation and Environmental Impacts in the Transition from Confinement to Pasture-based Dairies
Spring 2014			
Bovee, Jonathan Matthew	MS	Saffron	A Study of Switchgrass Pyrolysis: Product Variability and Reaction Kinetics
Hamaamin, Yaseen Ahmed	PhD	Nejadhashemi	Applications of Soft Computing and Statistical Methods in Water Resources Management
Sanchez, Georgina M.	MS	Nejadhashemi	A Framework for Integrated Water Resources Management, Environmental Justice and Stream Health
Summer 2014			
Wang, Yun	PhD	Alocilja	Immunosensors Using Metallic Nanoparticle-based Signal Enhancement for Bacterial Detection and Tuberculosis Diagnosis
Smith, Danielle F.	MS	Marks	Modeling the Effect of Water Activity on Thermal Resistance of Salmonella in Wheat Flour

Bachelor of Science Biosystems Engineering Degrees Conferred

Fall 2013
Laur, Jena Elizabeth
Stark, Stacey Nichole

Spring 2014
Avery, Rick James
Bloom, Oliver O'Connor
Burns, James Wallace
Carter, Zachary Thomas
Chandler, Keely Ann
Coleman, Matthew Dylan
Cumming, Steven James
Gammans, Matthew Theodore
Gisler, Michael Robert
Gowen, Kirk Alexander
Hoang, Vu Minh
Hoehn, Charlsey Meredith
Jandernoa, Nathan Edward
Jones, Alexa Elizabeth
Kraemer, Robert Cody
Lauth, Timothy Stephen
Matthews, Cody Steven
Moncznik, Lisa Ann
Palmer, Jessica Ashley
Rossi, Kelly Anne
Rowland, Alex Mcaleer
Sak, Rachael Kim
Sanburn, Kristin Elizabeth
Sheridan, Patrick Micheal
Sperry, Royce William
Taylor, Christopher Michael
Walch, Matthew John
Warvel, Jessica Ann
Yee, Wilson
Zeltzer, Paul David

Summer 2014
Bui, Anh Phi
Holmes, Daniel Thomas

Selected Examples from Research Grant Portfolio (Total grants last year = $4,427,578)		
Title	**Direct Grantor**	**BAE PI**
Federal Government		
Reclaiming Soil Health and the Natural Productivity of Crop Land	USDA - NRCS	Harrigan
Understanding and Modulation of Interfacial Properties within Plant Cell Wall Pores to Facilitate Enzymatic Deconstruction and Conversion to Biofuels	NSF	Hodge
Understanding Bacterial Dry Transfer Mechanism during Nut Processing	USDA - NIFA	Jeong
Hybrid Bioenergy Production System	USDA - NRCS	Kirk
A self-sustaining solar-bio-nano-based wastewater treatment system for Forward-operating bases	U.S. Dept. of Army	Liao
Development of Imaging Techniques for Defects Detection of Horticultural Products	USDA	Lu & Dolan
Factors Affecting Pasteurization Efficacy for Salmonella in Low-moisture Foods	USDA - NIFA	Marks
QMRA III - Quantitative Microbial Risk Assessment Interdisciplinary Instructional Institute: A Yearly, Intensive Short Course in Mathematical Modeling Techniques for QMRA	NIH	Mitchell
Developing TMDL Implementation Plan for Coon Creek, Mich.	EPA	Nejadhashemi
NSF IRES: and Engineering Sustainable Biological Solutions for Clean Energy and Water in Costa Rica	NSF	Reinhold
Improving Access to Clean Energy in Rural Latin America using On-site Solar-Bio-Power Generation (SBPG)	U.S. Dept. of State	Srivastava
Deep Sequencing to Screen Functional Antibody Epitopes	NIH	Whitehead
State of Michigan/Local		
Development and Demonstration of Scalable and Economic Waste Treatment and Utilization Systems for Small-scale Meat Processing Facilities	Mich. Dept. of Agriculture & Rural Development	Liao
Feasibility of Using Sugar Beet Pulp to Produce Chitosan as A high-Value Bioactive Agent for Food and Agriculture Applications	Mich. Dept. of Agriculture & Rural Development	Liu
A Novel Hybrid BMP Auction Program to Maximize Environmental Outcomes of BMP Implementations	Shiawassee Conservation District	Nejadhashemi
Development of Poplar Plantations for Specialty Crop Processing Wastewaters	Mich. Dept. of Agriculture	Reinhold
Mich. Farm & Rural Business Energy Audit & Renewable Energy Assistance Project	Mich. Energy Office	Surbrook
Associations/Foundations		
Rapid Accurate Detection of Pulmonary Tuberculosis Using a Low-cost Field-operable Biosensor	W.K. Kellogg Foundation	Alocilja
Advanced Technology for Addressing the Challenge of Quality Assurance of Processed Carrot	Mich. Carrot Committee	Guyer
Evaluation of Vertical Tillage Tools for Residue Management, Manure Incorporation and Seeding Cover Crops	Corn Marketing Program of Mich. & Mich. Soybean Promotion Committee	Harrigan
Using High-frequency Nano-amplitude Mechanical Vibration for Preventing and Reducing Salmonella Attachment on Dry Surfaces	ILSI North America Technical Committee on Food Microbiology	Jeong
A Life-cycle Assessment Comparing Soybean Rotation Methods, Equipment Age and Tilling Practices	Mich. Soybean Promotion Committee	Saffron
Industry/Companies		
An Innovative Pilot-scale Anaerobic Digester	Quantalux LLC	Kirk
Evaluating Micro-bubble Facilitated Electrocoagulation-flotation (ECF) Technologies for Cost-effective Treatment of Wastewater from Anaerobic Digestion	Helee LLC	Liu
Dry-and Moist-heat Sanitation of Stainless Steel Surfaces with and without Protein Product Residue	Solae LLC	Marks
Integration of Consumers Energy Transmission and Energy Demand Data with the Mich. Waste Biomass Inventory to Support Renewable Energy Development from Anaerobic Digestion	Consumers Energy	Safferman
Phosphorus Removal and Recovery from Municipal Wastewater Using Nano-enhanced Media	Metamateria Technologies LLC	Safferman
Green Synthesis of BTX as Intermediates for PET Production	The Coca-Cola Company	Saffron

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	A104	Biosystems and Agricultural Engineering Fund
	A1043	Biosystems and Agricultural Engineering Endowed Fellowship Fund
	A1047	Agricultural Engineering Laboratory Enhancement Endowment Fund
	A10426	Biosystems and Agri. Engr. Centennial Endowment Fund
	A10416	F.W. Bakker-Arkema Endowed Scholarship Fund in Bio. Engr.
	A10424	Galen K. and Ann J. Brown Endowment Fund
	A10429	Walter M. and Lillie M. Carleton Endowed Scholarship Fund
	A10431	DeBoer Family Scholarship/Fellowship Fund Biosystems Engineering Fund
	A10402	Electrical Technology for Agriculture Fund
	A10423	Katherine and Merle L. Esmay Endowed Fellowship Fund
	A10404	Arthur W. Farrall Endowed Scholarship Fund
	A10427	Robert Gustafson Endowed Scholarship Fund
	AFF0156	Daniel and Anne Guyer Spartan Cornerstone Scholarship Challenge
	A10401	Clarence and Thelma Hansen Endowed Scholarship Fund
	A10411	Howard F. and Esther L. McColly Endowed Scholarship Fund
	A10412	George E. and Betty L. Merva Endowed Scholarship Fund
	A10432	John and Julianna Merva Undergraduate Excellence Fund
	A10430	Alfred and Mary Murray Endowed Scholarship Fund
	A10428	Deborah and Timothy Spehar Endowed Scholarship Fund
	A10422	Bill and Rita Stout Expendable Scholarship Fund

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