

Annual Review 2012

BAE Bulletin

The Department of Biosystems and Agricultural Engineering

Food Quality, Safety & Biosecurity
Sustainable Ecosystems
Renewable Bioenergy Systems

Integrating Engineering and Biology Since 1906

MICHIGAN STATE
UNIVERSITY



2012 Graduates

From the Chair

BAE Bulletin

Since 1906, the 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, rapidly-changing problems related to food quality and safety, ecosystems protection, homeland security and health protection, biomass utilization and renewable energy development.

Biosystems & Agricultural
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RESOURCES



Greetings Alumni and Friends,

2012 has been an exciting year for us in *Biosystems and Agricultural Engineering*. Student enrollment, both undergraduate and graduate, continues to increase. We have a record enrollment in Biosystems Engineering this year and the job prospect continues to look bright for BE graduates. Biosystems Engineering continues to attract high caliber students as evidenced by high profile awards they receive.

BAE faculty are playing key roles in critical areas such as food, water, and energy. BAE faculty were successful in obtaining major grants, especially in the area of food safety. Prof. Brad Marks is providing leadership in the area of food safety not only at MSU but in the Tri-state region including Purdue and Ohio State University. Assistant Professors Pouyan Nejadhashemi and Dawn Reinhold played a part in developing the MSU Global Water initiative. As a result of this initiative MSU will invest in 16 new faculty positions in the various aspects of water. Dr. Dana Kirk played a major role in MSU's efforts towards increasing campus sustainability. From initial feasibility studies to the final engineering design, Dana guided the process to build an anaerobic digester on campus. The digester will co-mingle campus food waste from student cafeterias, animal manure from MSU farms, and food processing waste from local food retailers to produce biogas that will be used to run a ½ megawatt electric generator. Turning waste to resources is a step toward making MSU a sustainable campus. Assistant Professor Chris Saffron is developing torrefaction technology to convert woody biomass to green coal as a "drop-in" fuel for the MSU power plant which currently burns coal. This technology when developed will significantly reduce carbon emissions and improve air quality. Assistant Professors Wei Liao and Dawn Reinhold are co-PI's of a grant funded by Department of State with the goal to develop and demonstrate solar-bioreactor to convert waste to electric power and treat waste water by constructed wetlands in rural Costa Rica, Nicaragua and Panama. This project has caught the attention of MSU President and it will be included in a video program "Spartans around the World". A MSU film crew will travel to Costa Rica in January 2013 to film the commissioning of the digester. So as you can see BAE faculty are making an impact not only here at MSU but around the world.

It gives me a great pleasure to tell you that I am a co-director of a \$25 million USAID grant to create a "Global Center for Food System Innovation". The MSU Center is a part of the USAID *Higher Education Solutions Network* that includes a total of seven universities. These universities include MIT, University of California, Berkeley, College of William and Mary, Texas A&M University, Duke University, and Makerere University in Uganda. The MSU Center will focus on innovations in food system to respond to megatrends such as climate change, population growth, and urbanization. I am very excited about this opportunity to engage in international development work. On a personal note, having graduated from Pantnagar Agricultural University, the first agricultural university in India established with assistance from USAID, this grant "closes the loop" and gives me an opportunity to give back to a program that has transformed my life so immensely.

I am very pleased to inform you that we have a new dean of the College of Agriculture and Natural Resources. Dr. Fred Poston was appointed in this position by the MSU Board of Trustees and will take over the helm on January 1, 2013. Dr. Poston had served the college as the dean for eight years before taking on the position of Vice-President of Finance and Operations at MSU about 14 years ago. We are excited about this development and look forward to working with him in moving the college forward.

I hope you enjoy reading this newsletter and that it gives you an idea how MSU BAE is *generating knowledge and transforming lives*. As always we would love to hear from you and if you are in the area please stop by and say hello.

Best regards,

Ajit Srivastava



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The Science Behind the Safety

BAE Critical to Food Safety Research

Bridging biology and engineering has long been the cornerstone of the research Michigan State University Department of Biosystems and Agricultural Engineering. Using this approach, the department has launched into ground breaking research in the field of food safety. Delivering safe food from the field, to the processor, to the store and eventually family dinner tables requires important check points along the distribution channel. Researchers at MSU are investigating critical control points along the chain that ultimately lead to a safer food supply.

The BAE department is just one of a handful of departments at MSU brought together to tackle the challenges in food safety through the Food Safety Initiative at MSU. BAE professor Bradley Marks leads the 28-member faculty group at MSU that brings together a multi-disciplinary approach to this critical subject.

“Food safety has been identified as a central priority at MSU; it is a hallmark topic for researchers on campus,” Marks says. “This movement reaches across disciplines and is a faculty-led grassroots effort on our campus. We are fortunate at MSU to have the broadest, deepest portfolio of food safety research in the country, and the BAE Department plays a critical role in that success.”

Marks’ and his colleagues’ research in the area of food safety has brought millions of dollars in research grants to the university. Researchers in the BAE department are exploring food safety at various points in the production and processing level.

“In our role as engineers, we can analyze the processing and distribution systems and tie it into our knowledge of food production and processing,” Marks says. “We are looking to developing tests to help detect pathogens and examining processes that can eliminate hazards. Ultimately the burden of proof of making foods safe falls on the processor and we are looking at ways to help eliminate hazards in the processing.”

One key factor in the department’s success in grant awards is the biosafety level-2 pilot plant housed within the department. The pilot plant provides a space where



The MSU biosafety level-2 pilot processing facility in Farrall Hall.

researchers can work with foodborne pathogens in actual food products in pilot-scale versions of commercial processing equipment. The pilot lab is equipped with small-scale equipment that mimics the equipment used in industrial food processing plants.

“Clearly our pilot plant is unique,” Marks says. “This plant allows us to run real-time tests, not just develop equations and work in a Petri dish. We need the equation and Petri dish work, but it takes a leap of faith to take the Petri dish results to a large-scale food processing facility. With our lab, we are able to validate that research and bridge the gap from the laboratory to real-world systems.”

The real satisfaction in the research, according to Marks, is knowing they are making a difference in the safety of the food we eat.

“Giving the food industry the tools and solutions to keep our food supply safe is very rewarding,” Marks says.

Improving the Safety and Nutrition of Food

MSU AgBioResearch 2011 Annual Report, Feb 8, 2012

Food processing involves various methods that either transform raw ingredients into food or food into other forms for consumption, often extending the shelf life of the product. Examples date back to prehistoric times, including smoking and salting meats and fermenting fruit. Techniques became more modernized in the 19th and 20th centuries, largely to meet the needs of the military. But it was pasteurization, discovered in 1862, which brought the industry to a whole new level with the ability to secure the micro biological safety of the food.

Today, the Michigan food processing industry generates nearly \$25 billion in overall economic activity and employs some 134,000 workers at nearly 1,600 licensed food processors, according to Michigan Department of Agriculture data (2011).

There to help guide the industry is Michigan State University AgBioResearch scientist Kirk Dolan, associate professor in the departments of Food Science and Human Nutrition and Biosystems and Agricultural Engineering. Dolan has been providing valuable insight through his research on topics ranging from securing food safety to adding nutritional value — for the past decade.

“Consumers want foods that are more toward the fresh side and have more nutrients but still have the proper level of safety,” Dolan said. “In response, food companies are developing or improving products with higher nutritional levels and, for safety, heating foods at higher temperatures for short periods of time or using a combination of mild temperature with nonthermal processing, such as high-pressure processing. My lab is

developing the computational tools needed to predict the fate of these nutrients.”

For example, Dolan said his team is currently constructing an instrument to measure the thermal properties of foods heated at elevated temperatures. Additional tools will include the use of commercial software for computations and statistics.

“Computational tools are needed to predict the fate of nutrients in our food,” he said. “Engineers working for food companies can’t perform trial and error because it wastes too much time. They have to get to market fast and need computational tools that will speed up the design process and improve their competitive status.”

Dolan’s work is especially beneficial in a state with such major food-processing giants as Kellogg’s, Nestle-Gerber and Post. Developing relationships with the companies has helped in ways beyond Dolan’s research.

“Our students are getting internships and they’re getting hired,” he said. “That speaks volumes to the value of our research and the job we’re doing in education. We strive to make sure MSU students are well represented at Michigan-based companies. There’s no reason why there should ever be more out-of-state graduates at Nestle-Gerber in Fremont, Mich., than MSU grads. That’s not the case now, and hopefully that will never be an issue.”

Partnering with researchers from other areas of expertise continues to be a top priority for Dolan. In recent years, his lab has helped:

- Develop a high-fiber, healthy snack made from beans that is similar to honey-roasted peanuts



but containing less fat.

- Create a powder made from discarded grape pomace that can be used as a supplement in various products such as cereals and pastries, confections and baked goods.
- Analyze the impact that heating has on destroying E. coli K-12 in meat.
- Measure antioxidant capacity of asparagus in new vacuum sealed packaging aimed at extending shelf life.
- Produce powder from beans to be used as a gluten-free alternative to flour.
- Determine methods to extend the shelf life of cherry juice concentrate, a high-value processed product, while at the same time preserving antioxidant levels.

“As you can see, we’re not a lab that does everything within its own four walls,” Dolan said. “In my lab, we focus a lot on collaboration. We provide a lot to others and they provide a lot to us. We’re digging down deep for the benefit of food companies, whether it’s food safety or nutrition.”

The Science Behind the Safety

Conquering Detection Problems with Water- and Food-Borne Pathogens

AgBioResearch

MSU AgBioResearch scientists are exploring new frontiers in the detection of water-related diseases by developing sensors that can detect harmful pathogens in food and water before they cause widespread disease.

“From farm to table, there are numerous opportunities for food and water to become contaminated with pathogenic bacteria,” said Evangelyn Alocilja, a professor of Biosystems and Agricultural Engineering.

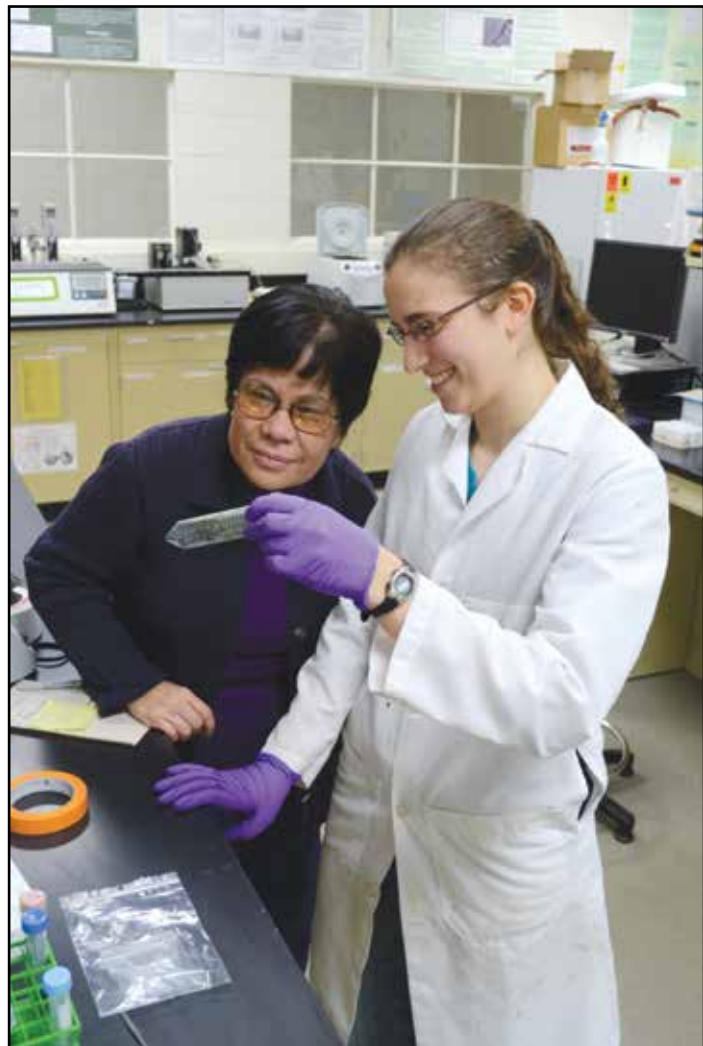
To help address this issue, Alocilja has developed a nanostructured biosensor that promises speedy detection of deadly pathogens and toxins, especially in water. This hand-held device can be used in a farmer’s field to test, for example, for *Escherichia coli* (*E. coli*), a bacterium that is commonly found in the intestines of warm-blooded organisms. Most strains are harmless, but some, such as *E. coli* O157:H7, can cause serious food poisoning in humans and can be responsible for product recalls. The biosensor also can be used for the rapid detection of a broad range of other threats such as *Salmonella*, anthrax and tuberculosis.

Alocilja’s idea for the biosensor originated more than 10 years ago when she attended a conference on biodefense where the concept of a biosensor was presented. She believed that she had the expertise to develop a sensor and was driven by a desire to save lives.

A continuous cycle occurs when an animal with *E. coli* leaves excrement on the soil. Rain sends the contaminated soil into surface water, including irrigation water and recreational lakes and rivers, or it is leached into groundwater. When crops come in contact with that water -- especially fruits and vegetables that are grown close to the ground -- they are contaminated. As crops move through processing and/or packaging, there are opportunities for further contamination.

“If a farmer can find out that the water being used on his crops contains, for example, *E. coli*, he can take action and stop the contamination,” Alocilja said. She points out that there are costs involved not only in sending products to market but also in pulling contaminated products out of the marketplace.

“It can become a double jeopardy situation,” Alocilja said. “Many times, a recall caused by something such as *E. coli* can bankrupt a company and threaten the whole industry. For example, an outbreak of *E. coli* in spinach in 2006 caused not only the company that was the source of



Dr. Evangelyn Alocilja and NSF Graduate Research Fellow Hannah Miller working in biosensor laboratory.

the contamination to suffer, but the whole spinach industry suffered because no one wanted to eat spinach.”

In related work, James Tiedje, at the center for microbial ecology at MSU is part of a team of researchers led by MSU civil engineering professor Syed Hashsham that has developed a device called Gene-Z. This device differs from Alocilja’s biosensor in that it is made with pieces of DNA that match those from the target pathogen. If the pathogen is in the sample, its DNA binds to the complementary DNA in the sensor gives off a florescent signal.

“DNA testing can be sensitive, rapid and inexpensive,” Tiedje explained. “It can detect various strains of bacteria and viruses as well as antibiotic resistance in the pathogens.”

Tiedje and Alocilja agree that there is room for both types of sensors.

“It’s critical that we have the necessary tools to address this challenge at every level,” Tiedje said. “We will definitely need a ‘detection train’ as we become more sophisticated in our detection efforts.”

“Every detection device has an important role to play in the fight against water-borne and food-borne diseases,” Alocilja added.

Using Alocilja’s biosensor involves putting a reagent in a sample of water. Then the sample is separated with a magnet. The magnetized product is reconstituted and put into a small biochip. This chip then goes into a handheld reader, which provides a final readout in about an hour. Each test costs about \$2, significantly less than currently available technology. A new biochip has to be used for each test.

To use the Gene-Z device, farmers and food and water quality inspectors would take a sample, extract the microbes or DNA, and transfer it to a microfluidic chip, which is inserted into the device. Used with an iPod Touch or Android-based tablet, Gene-Z can identify the pathogen, its genotype and its amount in 10 to 30 minutes and transmit the results to a central data center. To fully develop this approach, the sample processing step needs to be more efficient. That work is under way. Gene-Z is ready to be field tested, and the researchers are working with MSU Technologies, the office that manages technology transfer at MSU, to bring the product to market.

Alocilja’s biosensor is now in the hands of a commercial company, nanoRETE, which is funded in part by MSU Technologies. Alocilja decided to take this major step when a colleague said, “If you are doing this to save lives, you will never save lives if it stays in your lab.” She also realized that putting the product in the commercial marketplace will validate its usefulness and

point out its weaknesses so that improvements can be made.

“In the lab, everything is in a controlled environment,” Alocilja said. “If we send it out as a commercial product, we can see exactly what is needed in the field and we can revise the design if necessary.”

While one of her designs for a biosensor is well on its way to the marketplace, Alocilja knows there will always be new designs.

“We are looking for better performance, faster results and a less expensive device,” she said. “It will be a lifetime quest.”



Professor Evangelyn C. Alocilja, Department of Biosystems and Agricultural Engineering, received the 2012 Innovator of the Year award for biosensor technology. The Innovator of the Year award recognizes an MSU researcher who has been actively involved in intellectual property creation and technology transfer activities at MSU. More than 180 people attended the second annual MSU Innovation Celebration Wednesday, April 11, 2012, in the MSU Union. The networking reception showcased 11 of the innovative technologies being developed in campus labs, honored MSU researchers who reported an invention during the academic year, and recognized the winners of the first awards for innovation and achievement in technology transfer.

The Science Behind the Safety

Research Grants Boost BAE Department Food Safety Work

Several BAE researchers have been awarded research grants in the area of Food Safety and Biosecurity

Title: An Integrated Approach to Enhance the Microbial Safety of Fresh-Cut Fruit and Vegetable Products During Processing, Packaging and Retail Distribution.

Faculty Researchers: Elliot T. Ryser (PD), Bradley Marks, Eva Almenar and Kirk Dolan.

Project Summary: The overall goal of this multi-disciplinary, multi-institutional, multi-functional special emphasis project is to enhance the microbial safety and quality of ready-to-eat, fresh-cut produce via integrated research and outreach/training targeted at the processing, packaging, and retail distribution segments of the produce chain. The multi-disciplinary project team integrates expertise from Michigan State University, California Polytechnic State University, Rutgers University, Ohio State University, and the International Food Protection Training Institute (Battle Creek, MI). Five project modules target: 1) processing - quantify and develop predictive models for pathogen transfer during slicing/dicing of fresh-cut produce, 2) packaging - develop and validate optimal packaging systems for safety of fresh-cut produce, 3) retail distribution - evaluate and model potential pathogen survival/growth in packages at retail, 4) risk modeling and economics - develop and validate a risk model for pathogen transfer and survival/growth in packaged fresh-cut produce through retail, and conduct a benefit-cost analysis for processing and packaging interventions, and 5) outreach/training - develop, implement and assess outreach/training programs on the safety of fresh-cut fruits and vegetables for processors, distributors, retailers, and regulators. Critical data gaps to be filled from this work, as identified in the RFA, include: 1) identification of commercial slicing/dicing practices that increase risk for cross-contamination of fresh-cut produce, along with various mitigation strategies, 2) development of novel packaging strategies for minimizing pathogen growth/survival in the cold-chain, and 3) reduction of risk of foodborne illnesses from fresh-cut produce through a series of training activities aimed at processors, retailers, foodservice workers, and regulators. Overall, this integrated project will serve to enhance the safety and quality of fresh-cut fruits and vegetables and reduce the number of produce-related outbreaks.

Title: A Generalized Phenomenological Model for Bacterial Transfer to/from Fresh Produce

Faculty Researchers: Bradley Marks (PD), Elliot Ryser

Project Summary: There is a growing body of literature addressing bacterial transfer to/from food products and contact surfaces; however, it is almost exclusively empirical, resulting in transfer models that are purely probabilistic or empirical curve fitting, unconnected to the underlying governing mechanisms. Although adhesion/transfer processes are organism- and substrate-specific, general principles must govern the observed phenomena. Therefore, there is a need for a unifying modeling framework that bridges micro- and macro-scale knowledge in this domain.

The overall goal of this project is to develop a conceptual framework for modeling bacterial adhesion and transfer to/from food products, which will enable improvements in future experimental studies, process models, and risk assessments. The specific objectives are to: (1) Aggregate existing bacterial transfer data associated with foodborne pathogens across a range of food products; (2) Conduct a meta-analysis of those data to elucidate the relative importance of various factors affecting attachment/transfer; (3) Formulate and test a generalized phenomenological model for bacterial attachment/transfer among multiple components of a food processing environment; and (4) Utilize that model to theoretically analyze the relative impact of multiple bio/chem/physical factors on the overall attachment/transfer process.

This project will build a theoretical bridge across the existing gap between the body of previous, basic research on bacterial adhesion and the growing body of empirical work focused on high priority foodborne pathogens on "at risk" foods. Such a bridge will significantly increase the probability of basic research impacting real practices and of future applied work being based on a consistent and phenomenologically sound framework.

Title: Factors Affecting Pasteurization Efficacy for Salmonella in Low-Moisture Foods

Faculty Researchers: Bradley Marks (PD), Elliot Ryser, Sanghyup Jeong.

Project Summary: Salmonella contamination of low-moisture foods is an emerging and vexing food safety challenge, reflected in recent nationwide outbreaks/recalls (e.g., nuts, cereal products, and spices). Although Salmonella is known to be extremely resistant to lethal treatments on low-moisture foods, there is an acute lack of data and tools for reliable pasteurization validations for these products.

The overall goal is to reduce the risk of salmonellosis associated with low-moisture foods, by accounting for critical product and process factors affecting Salmonella resistance to interventions across multiple product types. The specific objectives are to: (1) quantify the relationship between Salmonella inactivation rate and (a) product factors (composition and structure), and (b) time between contamination and pasteurization, (2) expand and validate novel inactivation models accounting for the significant intrinsic and extrinsic factors, via Salmonella-inoculated, pilot-scale challenge studies using multiple pasteurization technologies, and (3) develop pasteurization scale-up and validation strategies that account for inherent uncertainty in the inactivation models.

The overall plan will entail: (1) bench-scale inactivation trials with Salmonella cocktails on three classes of products (large particulates, powders, and pastes), with varying compositions, inoculation methods, and post-contamination storage periods, and using multiple intervention processes (moist-air heat, radio frequency energy, and low-energy X-ray), (2) modification of novel inactivation models, (3) pilot-scale validation trials, and (4) development of recommendations for appropriate application of the lethality models to commercial pasteurization processes.

This multi-disciplinary project will generate and validate Salmonella lethality data and tools to fill a critical industry need related to pasteurization of low-moisture foods.

Title: Improving Process Validation Methods for Multiple Pasteurization Technologies Applied to Low-Moisture Foods

Faculty Researchers: Bradley Marks (PD), Elliot Ryser, Sanghyup Jeong

Project Summary: Salmonella contamination of low-moisture foods is an emerging and vexing food safety challenge, reflected in recent nationwide outbreaks/recalls involving dry products. Additionally, Salmonella is known to be extremely resistant to lethal treatments on low-moisture foods. However, there is an acute lack of data and tools for reliable validation of commercial pasteurization processes across low-moisture food categories.

The overall goal is to reduce risk of salmonellosis associated with low-moisture foods, by giving the industry the necessary data, knowledge, and tools to ensure the effectiveness of processing interventions. The specific objectives are to: (1) Develop mathematical models quantifying the effect of water activity on Salmonella inactivation rate, for multiple pasteurization methods and product categories, (2) Validate the inactivation models via inoculated, pilot-scale challenge studies, and (3) Develop, deliver, and assess training programs targeted at professionals responsible for validating pasteurization processes for low-moisture foods.

The overall plan will entail: (1) bench-scale inactivation trials with Salmonella on three classes of products (powders, large particulates, and pastes) habituated to a range of water activities and subjected to multiple intervention processes (fluid-based heating, radio frequency energy, and low-energy X-ray), (2) development of novel inactivation models, (3) pilot-scale validation trials, and (4) development, delivery, and assessment of training programs in venues selected to specifically reach professionals responsible for validating interventions for low-moisture foods, but who generally lack information and tools needed to meet this specific challenge.

This multi-disciplinary project will generate, validate, and communicate process validation tools to fill a critical industry need related to pasteurization of low-moisture foods.

For more information see: news.msu.edu/story/10097

Sustainable Ecosystems

Prof Helps Devise Method to Remove Phosphorous from Wastewater

ANR Communications

A professor at Michigan State University is part of a team developing a new method of removing phosphorous from our wastewater – a problem seriously affecting lakes and streams across the country.

In addition, Steven Safferman, an associate professor of Biosystems and Agricultural Engineering, and colleagues at Columbus, Ohio, based-MetaMateria Technologies, are devising a cost-effective way of recovering the phosphorous, which then can be reused for fertilizer products.

Although its use is regulated in many states, including Michigan, in items such as detergents and fertilizer, phosphorous is part of all food and remains a critical problem as it is always present in human and animal wastes.

Discharge from human and industrial wastewater and runoff into lakes and streams can cause what is known as eutrophication – making the water unsuitable for recreational purposes and reducing fish populations – as well as causing the growth of toxic algae.

What MetaMateria Technologies and Safferman have figured out and tested over the past 10 years is how to produce a media, enhanced with nanoparticles composed of iron, that can more efficiently remove larger amounts of phosphorous from water.

“Phosphorous that is dissolved in wastewater, like sugar in water, is hard to remove,” Safferman said. “We found that a nano-media made with waste iron can efficiently absorb it, making it a solid that can be easily and efficiently removed and recovered for beneficial reuse.”

Safferman added there are indications that their method of phosphorous retrieval is much more cost effec-



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tive than processing phosphate rock.

“Research suggests that it is significantly cheaper to recover phosphorous this way. So why would you mine phosphorous?” he asked. “And, at the same time, you’re helping to solve a serious environmental problem.”

The material should be commercially available for use within two years, said J. Richard Schorr, MetaMateria CEO.

“Phosphorous is a finite material,” Schorr said “Analyses show that the supply of phosphorous may become limited within the next 25 to 50 years. This is an economical way to harvest and recycle phosphorous.”

This research is funded, in part, by a National Science Foundation Small Business Innovative Research Grant. Safferman’s research also is supported by MSU AgBioResearch.



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Department chairs/head of biosystems/biological/agricultural engineering departments from North America met with their European counterparts at the University College Dublin (UCD) to explore areas of cooperation and exchange ideas to advance the profession.

Sustainable Ecosystems

Using “One Man’s Waste” to Produce Energy AND Clean Water

AgBioResearch

A project in Central America is linking water and energy in an innovative way to help reduce agricultural pollution. It’s a partnership between MSU and the University of Costa Rica that holds a great deal of promise for rural farm communities, said Dawn Reinhold assistant professor in the MSU Department of Biosystems and Agricultural Engineering.

“What we’re striving for is economically, environmentally friendly, more sustainable ways to address some of the pollution issues associated with animal agriculture,” said Reinhold. “With this project, we’re using an anaerobic digester and following it with a filter system of a wetland with the belief that we can produce not only energy with the digester but also clean water.”

The project, called Decentralized Clean Energy Production for Rural Latin America, launched last fall in Costa Rica, Nicaragua and Panama. Central America was chosen because it’s a region where agriculture is the second leading industry and more than half the population — 19 million people — lives in rural areas, according to project organizers.

The project team, led by MSU Department of Biosystems and Agricultural Engineering assistant professor Wei Liao, will work over the next several years to develop an integrated small-scale, self-sustained system for converting waste to clean energy, while producing value-added by-products such as fertilizers for local farming applications and reclaiming water. The system works by leveraging solar power that is captured through a thermal collector. Animal manure, crop residues and food wastes go into the unit, generating heat and electricity. It also produces solid and liquid effluents that can be converted into fertilizer.

Another research focus for Reinhold is the understanding and engineering of plant-based ecosystems for the protection and treatment of water resources. She and members of her lab are examining the abilities of food crops to phytoaccumulate (a process by which a plant takes up chemicals) antimicrobials from biosolids (nutrient-rich organic materials resulting from the treatment of sewage sludge, often used as fertilizer) and wastewater used for irrigation in agricultural fields.

“Antimicrobial agents are used in soap and many other consumer products,” Reinhold explained. “Most of these products get washed down the drain and are not transformed in conventional wastewater treatment plants. Untransformed, these chemicals enter the environment

through wastewater treatment effluent and biosolids. These agents adversely affect ecosystems and, at high concentrations or with continuous exposure, can potentially affect human health.”

To help address this problem, Reinhold and members of her lab first conducted vegetated soil column studies to look at biosolids application, which

introduces antimicrobials to soil and water resources. The findings from these initial studies showed that pumpkin and zucchini reduced concentrations of antimicrobials in agricultural fields, and that the consumption of these crops presents minimal risk to human health. More recently, she found that chili peppers, of all the crops examined, exhibit the highest capability of removing antimicrobials left in the soil after the application of biosolids.

Reinhold and her team are now investigating the relevance of bioaccumulation of antimicrobials from irrigation waters to human health risk and environmental fate.

“Repurposing treated municipal wastewater for irrigation could also help remedy the negative impact that antimicrobials have on aquatic ecosystems when the wastewater is discharged into surface waters,” she added.

Like most of her colleagues studying water, Reinhold is examining several aspects at once.

“There is no way to look at water as a completely separate entity when you talk about agricultural systems,” she said. “You may ask, ‘Why do you really need clean water to grow crops?’ The answer is that there might be human health implications. And when you start talking about treating the water, there are energy implications as well.”



Research Highlight

MSU Develops Flu Fighting Protein

From WKAR Studios

A Michigan State University scientist is the lead author of a paper that outlines MSU's work in manufacturing a protein that's showing promise as an effective agent against serious flu viruses. MSU performed the study in partnership with the Baker Laboratory at the University of Washington and the Wilson Lab at the Scripps Research Institute.

Tim Whitehead is an assistant professor of Chemical Engineering and Materials Science as well as Biosystems Engineering at MSU. He spoke with WKAR's Melissa Benchmark about the research.

TIM WHITEHEAD: What we've done is taken an idea of genes that don't exist in nature and being able to design those genes from first principles.

MELISSA BENCHMARK: When you say, "from first principles," that means...

WHITEHEAD: That means that we don't rely on hints from nature for the design of these proteins.

BENCHMARK: So it's not patterned on anything that you're familiar with in nature.

WHITEHEAD: That's right, yeah.

BENCHMARK: The paper just came out in the publication "Nature Biotechnology," actually you were the cover story, it sounds like. And the material you've been working on is effective against H1N1, you're thinking, which was the outbreak in 2009 and also 1918, which was that really, really big one...as well as H5N1, which is commonly known as the bird flu virus. That sounds like a really big deal, especially coming out with something that's potentially good against the biggest flu pandemic in the history of the United States. How big is this, do you think?

WHITEHEAD: Well, let's just clarify for a second. We've tested the efficacy of these designed proteins against the H1N1 pandemic viruses, and they neutralized them with efficacy. The H5N1, and different subtypes, we suspect they're going to work, because we can show from just simple biochemistry that they work. But we haven't tested them.

But we're pretty excited about the potential of these proteins in general to actually make it as a treatment for, if--God forbid--

-there was a pandemic in the future related to these subtypes. We think that this protein could be an effective treatment for the general populace.

BENCHMARK: Did you set out to come up with this as a treatment? Or did you find it in the course of working on something else?

WHITEHEAD: Well, this is the fun thing. We can design these proteins to do pretty amazing things now. So we set out to actually attack where we wanted to attack on the virus, and it incapacitated the virus the way that we set out to do that.

If you asked me at the beginning of this project if it would have worked out, I would have given it pretty low odds. Long shot at the Kentucky Derby odds. But we're really ecstatic that it worked out as well as it did.

BENCHMARK: If a person was looking through advanced equipment at a flu virus, and saw this protein in the vicinity, what exactly happens? What would you actually see when it was going after the flu virus?

Continued on page 13



Whitehead and Chundawat Awarded NSF-funded Grant

BAE Assistant Professor Tim Whitehead and Adjunct Professor CHEMS Shishir Chundawat received a \$300,000 3-year funded grant to investigate ways to prevent cellulase enzymes from inactivating during biomass deconstruction. To accomplish this, they are using state-of-the-art computational protein design and protein engineering strategies to change the sequences of these cellulases.

Biological-mediated conversion of cellulosic biomass to useful fuels and chemicals is a promising avenue towards energy sustainability. A critical impediment for this avenue is the cost of the cellulase enzymes needed to deconstruct biomass to fermentable sugars. Under current conditions the cost per gallon of fuel produced from lignocellulose would still be at least an order of magnitude higher than the enzymes required to degrade corn starch, even if the enzymes could be produced as cheaply as soy protein. One of the major reasons for the cost is that the enzyme is inactivated during biomass deconstruction, preventing recycle steps.

Continued from page 12

WHITEHEAD: The best that I can explain is that, the flu virus is absolutely a modern marvel of evolution. And there are components on the flu virus that—I don't want to use an anthropological term, but they're pretty smart.

So, what it can do, there's a protein that can hijack its way into a cell. And it goes into a compartment called (an) endosome, which you can think about as a trash heap. But what happens is that, there's a different environment in that endosome, so it can sense that, and trigger a change in the protein, that can actually put the payload of the virus into the healthy portions of the cell. So, what we're doing is, we're just gumming up the works.

We can bind a specific patch on this protein that changes shape to trigger this entry, and by binding it, we're preventing it from actually doing its job. So, if you think about it, it's almost like we're just throwing sand in the gas tank.

BENCHMARK: So, what kind of a road does a discovery like this go down from here to the ending up at the business end of a needle?

WHITEHEAD: There's a long road ahead. Not only that there's time as well as there's capitol. So, to go from an idea like what we have, to an actual drug, where we can manufacture it en masse, is the work of global pharmaceutical companies and hundreds and hundreds of millions of dollars to do that. And many years. So, we're hopeful that these proteins or proteins that look similar to these we've presented in this paper are going to make it, but again, it's going to be a long road.

MSU to Lead Global Food System Innovation Center

Michigan State University will use a grant from U.S. Agency for International Development to improve agricultural production and reduce poverty in areas of the world suffering from rapid urbanization, population growth and skills gaps. Receiving up to \$25 million throughout five years, finding solutions to the problems that affect global food production will be the focus of MSU's new Global Center for Food Systems Innovation. The center is part of USAID's Higher Education Solutions Network – a partnership with seven American and foreign universities designed to develop solutions to global development challenges.

"If we 'bend the trend' toward equitable and sustainable development and build the body of knowledge on how to harness these trends, we can have the largest impact on the productivity of global food systems," said Ajit Srivastava, chairperson of MSU's Department of Biosystems and Agricultural Engineering and co-director of GCFSI.

Reitumetse Mabokela, professor in MSU's Department of Educational Administration, is also co-director.

GCFSI will engage a team of specialists from multiple disciplines around the world. Participating institutions include MSU; Sokoine University of Agriculture, Tanzania; Wageningen University and Research Centre, The Netherlands; and The

Energy and Resources Institute, India. It will be housed within MSU's International Studies and Programs.

Undergraduate and graduate students will form the Translational Scholars Corps, and as future leaders will be key to the center's success, Srivastava said.

GCFSI will work with food and agricultural sciences, engineering and education experts to discover, test and implement new solutions for food systems in Central America, East Africa and Southeast Asia, he said. In addition, the center will increase the involvement of women in global food security.

Solutions will be disseminated to stakeholders, such as USAID, agro-industry businesses, farmers, traders and other food system workers throughout the globe.

"By collaborating with top universities around the world, we hope to tap today's brightest minds and focus ingenuity on global development challenges," said USAID Administrator Rajiv Shah. "With the right ideas, we can reduce extreme poverty by more than 60 percent in just one generation."

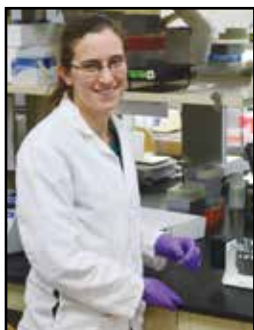


The MSU Global Center for Food System Innovation Team

Each of the seven universities will establish Development Labs that will work with USAID's field mission experts and Washington, D.C., staff to apply science and technology to address problems in areas such as global health, food security and chronic conflict, he said.

"We have great experience drawing upon the multidisciplinary talents and bilateral connections within our own global network to address some of the world's most pressing and complex problems," said Jeffrey Riedinger, dean of International Studies and Programs at MSU. "As part of the Higher Education Solution Network, GCFSI will dramatically increase our potential."

Miller Awarded NSF Award



Hanna Miller, December 2011 BE graduate, was recently notified of her selection to receive a 2012 National Science Foundation (NSF) Graduate Research Fellowship Program (GRFP) Fellowship. Her selection was based on outstanding abilities and accomplishments, as well as her potential to contribute to strengthening the vitality of the US science and engineering enterprise.

Suehr First Place in Poster Section

Quincy Suehr, an undergraduate student working with Drs. Sanghyup Jeong and Bradley Marks was awarded 1st place in the Engineering-Group 1 Poster Section of the MSU University Undergraduate Research and Arts Forum. Quincy's poster was entitled "Monte Carlo Food Irradiation Simulation Analysis and Comparisons". Quincy is a second-year physics student from Marshall, Michigan.

BAE Graduate Students Honored at the College of Engineering Awards Reception

BAE students were among the honorees at the 2012 Graduate Student Awards Reception held March 28, 2012.

Graduate students receiving recognition include: Outstanding Graduate Students: **Zhenglong Li**, (advisor Christopher Saffron), **Fitch H Beach Awards: Michael Anderson**, Honorable Mention (advisor Evangelyn Alocilja). Graduate Research Symposium Awardees: **Michelle Packard**: Rapid DNA-Based Bacterial Identification Using Amplification-Free Fluorescent Resonance Energy Transfer (FRET) With A Single Rep. **Irwin Donis-González**: Relation of Computerized Tomography Hounsfield Unit Measurements and Internal Components of Fresh Chestnuts (*Castanea spp.*). **Xiaoqing Wang**: Comparison of Metabolism of *Rhizopus oryzae* Culturing on Glucose and Glycerol.

2012 Graduate Scholarship Recipients

Outstanding BE Research Fellowship
Michael Anderson

Outstanding BE Graduate Student Fellowship
Zhenglong Li

Merle & Catherine Esmay Scholarship
Niroj Aryal

Bill & Rita Stout Scholarship
Zhenhua Ruan

Galen & Ann Brown Scholarship
Ibrahim Greiby

Engineering Graduate Research Symposium Awardees
Irwin Donis-Gonzalez
Michelle Packard
Xiaoqing Wang

2012 Undergraduate Scholarships

F.W. Bakker-Arkema Endowed Scholarship
Rachel Kurzeja

A.W. Farrall Scholarship
Ethan Nussdorfer
Kristin Sanburn
Maddie Saylor

Clarence & Thelma Hansen Scholarship
James Burns
Nathan Jandernoa

Howard & Esther McColly Scholarship
Danielle Brickner
Matt Gammans
Robert Kraemer
Rachel Kurzeja
Allison VanderKolk

George & Betty Merva Scholarship
Elyse Kutsche

DeBoer Family Scholarship /Fellowship Fund
Jena Laur
Sarah Steudle

BAE Students Design Solar-Powered System for Rural Central American Community

Demand for alternative fuel is a hot topic in the United States. But does a high demand for energy systems more efficient than traditional methods exist in other parts of the world? A group of Michigan State University (MSU) Biosystems Engineering (BAE) students has focused a senior capstone project on this issue. The students are exploring the possibilities of cleaner energy sources in Central America.

The capstone project is part of a larger project funded by the US Department of State Western Hemisphere Affairs division (DOS-WHA) titled “Improving Access to Clean Energy in Rural Central America Using On-site Solar-Biopower Generation.” The project integrates both the bioenergy and ecosystems concentrations within biosystems engineering. The students designed and built a small solar-bio-power unit, gained an understanding microbiology of anaerobic digestion and the energy balance of the reactor. Building on the student team’s achievement, a pilot scale facility will be designed and built in Costa Rica.

Students involved in the project include David Hochhalter, Grosse Pointe, Mich.; Eric Werner, Kalamazoo, Mich.; Lauren Deitz, Clarkston, Mich.; Katie Balaze, Canton, Mich.; and Miranda Sperry, Mason, Mich.

Ajit Srivastava, chair of the Department of Biosystems and Agricultural Engineering, and Wei Liao and Dawn Reinhold, assistant professors in the department, are the principal investigators of the DOS-WHA project. Liao is the faculty adviser of the senior capstone team project (see page 19).

Economical on-site renewable energy systems using agricultural waste streams will help rural communities in Central America increase access to affordable clean energy and alleviate environmental impacts of the waste streams. The goal of the project is to develop and deploy an integrated small-scale self-sustained waste-to-clean energy generation system producing value-added by-products such as fertilizers for local farming applications and reclaiming water. The use of this technology will change the status of waste treatments and will eventually turn



Actual solar-powered anaerobic digestion system being installed based upon student design work, Fabio Baudrit Experiment Station, Alajuela, Costa Rica.

municipal and agricultural wastes from an environmental liability into a public asset. With efforts to extend further technology into rural communities of Central America, an outreach program will be established at the University of Costa Rica, a collaborating partner in the project, which will provide workforce training, technology transfer and business development.

“The project is part of our effort at MSU to develop a self-sustained bioenergy system. The success of the project will make it able to be extended to a wider range of applications, not only in Central America but also many places around the world, including the U.S.,” Liao said.

The team of five seniors says they have benefitted greatly from this project in gaining real-world experience in engineering.

“Our team received invaluable hands-on experience learning how to combine present technology into a functioning waste treatment system. This simulated a real-life engineering atmosphere and allowed us to better understand the technology,” Deitz said.

Senior Design Showcase

Eutrophic Pond Restoration and Toxic Cyanobacteria Mitigation



Team members: (l-r) William Stieber, Harrisonburg, VA; Jeffrey Crandell, Grand Blanc, MI; Emily Campbell, Fraser, MI; Joseph Horbatch, Northville, MI; Gretchen Merkel, Marshall, MI.

Sponsor/Mentor: For Better Independence

Academic Advisors: Dawn Reinhold, MSU BAE

For Better Independence, a non-profit organization located in Leslie, Michigan, is losing useable land due to the excessive expansion of an existing pond wetland system, resulting in economic loss. Furthermore, excess nutrient inputs have resulted in highly eutrophic conditions in the body of water, therefore raising concerns of toxic cyanobacteria blooms, negating its use. The team's project design was three-fold: restoring the pond to non-eutrophic conditions, reclaiming land, and mitigating potential health risks from toxic cyanobacteria through prevention and detection. To restore the pond system to initial capacity, a stretch of effluent tile drain was identified for replacement.

A vegetative buffer strip and best management practices were developed to rehabilitate the ponds to non-eutrophic conditions. Furthermore, the team has researched and recommended cyanobacteria inhibition methods along with a decision tree to identify the potential presence of toxic cyanobacteria, which can be implemented immediately.

Automated Aquaculture Feeding System for Yellow Perch



Team Members: (l-r) Andrew Franco, Dexter, MI; Tara Sliwinski, Fraser, MI; Kevin Swahn, Dearborn Heights, MI.

Sponsor/Mentor: Aquaculture Research Corporation

Academic Advisors: Yan Liu and Steve Marquie, MSU BAE

Yellow perch are in high consumer demand in the northern United States. A commercial fishing ban on yellow perch in the Great Lakes has made aquaculture systems a popular source of this fish. Unlike other species, little research has been done to optimize growth of yellow perch in aquaculture farms including the amount of feed, time of feeding, and water quality parameters. This created the need for a data collection system to identify parameters for optimal and healthy fish growth and the development of an optimization approach.

The objectives of the project were to design an automated feeding and sensor system to reduce labor intensity and collect all data needed to create a predictive feeding system maximizing fish growth while minimizing feed waste. Benefits of optimization include more consumer acceptable fish and reduction in wasted feed, leading to a higher profit.

An automated feeding system was constructed and placed in a growout tank at the sponsor's facility. Sensors were selected. A harness was built to house the sensors in the tank. Data is collected through LabVIEW and can be viewed remotely over the web. An email alert will be sent if any parameters are out of bounds. Recommendations on how to proceed with optimization will be made based on a simple nitrogen mass balance and statistical analysis.

Senior Design Showcase

Beneficial Utilization of Apple Pomace by Means of Extrusion and Tray Drying Methods



Team Members: (l-r) Philip LaMothe, Lake Orion, MI; Pawel Kargol, Canton, MI; Claire Schuurmans, Byron Center, MI; Juliana Henriques, Sao Paulo, Brazil.

Sponsor/Mentors: PepsiCo

Academic Advisors: Kirk Dolan and Bradley Marks, MSU BAE

PepsiCo has large amounts of fruit and vegetable by-product waste that accumulate each year and is sold as cattle feed. The by-product of apples, known as apple pomace, has significant amounts of total dietary fiber and quercetin. Once stabilized, the pomace can be added as an ingredient to existing and future products for increased nutritional value. The objective of this project is to provide PepsiCo with economic analyses of three processes to stabilize the apple pomace, as defined by reducing the moisture content to less than 10% to inhibit the growth of microorganisms.

Three processes will be analyzed for stabilization effectiveness and nutrient content. Cost will be calculated by determining energy usage and equipment specifications. Pomace will be pressed prior to processing for each of the three following processes: tray drying; tray drying and extrusion; tray drying and extrusion with added flour.

A final report with details of the cost and a sensitivity analysis for each process will be provided to PepsiCo. This data can be used as a starting point to decide if it is feasible to stabilize the by-products for future use as an ingredient.

Water Purification System for a Developing Country



Team members: (l-r) Lindsay Reynolds, Royal Oak, MI; Megan Robb, Gaylord, MI; Sarah Fink, Wixom, MI.

Sponsor/Mentors: Aqua Clara International

Academic Advisor: Theodore Loudon, MSU BAE

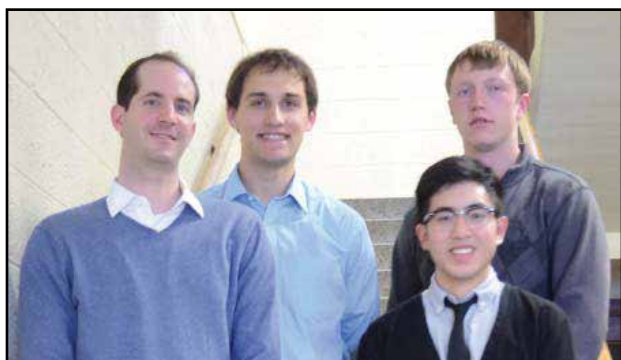
Over 1 billion people, typically in the developing world, do not currently have access to safe drinking water. The poorest inhabitants of the world survive on less than \$2 a day and live where average conditions do not provide for adequate wastewater treatment and sanitation. This lack of water access leads to widespread illness, disease, and death.

Teaming up with Aqua Clara International (ACI), a non-profit organization based in Holland, MI, the team worked to develop a community-sized water purification system. This system will provide 4,000 liters per day for a developing country. Aligning with the goals of ACI, the water must be clean and safe according to the World Health Organization standards, cost less than \$0.001 per liter to operate, and be effectively utilized by the local residents.

A system was created that incorporated a primary filtration method and secondary disinfection component. The primary filtration method is a sand filter and the secondary disinfection component is an ultra violet light system. A prototype was constructed to perform tests on. The team hopes to travel to Nicaragua in May to implement the system at a location familiar to Aqua Clara International.

Senior Design Showcase

Tank Cleaning System Optimization



Team: (l-r) Michael Zanotti, Traverse City, MI; Ian Hildebrandt, Ionia, MI; Michael Huarng, Northville, MI; Dylan Comer, Traverse City, MI.

Sponsor/Mentors: Perrigo Pharmaceuticals

Academic Advisor: James Steffe, MSU BAE

Perrigo is the largest manufacturer of private label over-the-counter pharmaceuticals in the United States. Production of a bismuth-based stomach relief medication results in residue buildup on the walls of mixing tanks, necessitating workers to enter the vessel and manually scrub the interior. This practice raises issues such as worker safety and increased production time, labor, and energy costs.

In order to address the cleaning issues, a holistic method was developed that examined both production and cleaning practices. Computational fluid dynamics, a modeling approach involving numerical methods, was used to analyze mixing. In addition, an experimental approach was used to examine how multiple factors affect removing residue build up.

A bench-top experiment was developed in order to simulate the mixing and cleaning process steps. Optimal detergent concentration, time, and temperature were determined through statistical analysis of experimental data, and a mathematical equation was developed describing the impact that each factor has on the cleaning process.

Additionally, COMSOL's computational fluid dynamics model was used to improve the quality of mixing, and to determine areas of concern.

After analysis of empirical and theoretical results, recommendations were proposed to improve the manufacturing protocol of Perrigo's bismuth-based, stomach relief medication.

Model of Torrefaction Bioenergy System and Supply Chain



Team: (b-f) Kevin Messing, Ubly, MI; Corey Scheffler, St. Joseph, MI; Lara Ejups, Bay Shore, NY; Jessica Emery, Rockford, MI.

Sponsor/Mentors: Mark Seamon, MSU Extension

Academic Advisor: Chris Saffron, MSU BAE

Public Act 295 (PA 295), also known as the "clean, renewable and efficient energy act" of Michigan, was signed into law in October 2008. This legislation promotes clean and renewable sources of energy by 2015, and requires providers to deliver 10% of power from renewable resources. Because of PA 295, the burning of biomass, a biological material from plant material, is being considered for use in the current energy generating infrastructure, including coal-burning facilities.

Biomass has a lower energy value than coal; however, pretreatment can increase its energy value to become more similar to coal. Torrefaction is a thermochemical reaction of biomass that produces a water-resistant material with a high energy value. This pretreatment process is being considered because biomass retains 90% of the energy in 70% of the original mass. The product of torrefaction is a hydrophobic, brittle, high-energy material. While torrefaction is a relatively new concept, still in the research phase, a desire exists to better understand the entire bioenergy supply chain. The team's goal was to create a model to represent the torrefaction bioenergy system from tree harvest to end use in the coal plant.

Information was gathered from external sources and experimental data. This included equipment and operating costs as well as mass and energy balances on the torrefaction system. A final Excel model was produced in which users can input energy requirements or available harvesting land to understand the requirements to support their bioenergy system. The end user of this model will likely be an individual or group considering the use of torrefied biomass as an energy source.

Senior Design Showcase

Integrated Solar Heated Anaerobic Digester and Treatment Wetland



Team: (l-r) Miranda Sperry, Mason, MI; David Hochhalter, Detroit, MI; Kathleen Balaze, Canton, MI; Eric Werner, Kalamazoo, MI; Lauren Deitz, Clarkston, MI.

Sponsor/Mentors: US Department of State

Academic Advisor: Wei Liao and Dawn Reinhold, MSU BAE

Livestock and agricultural production generate large amounts of organic waste. In Central America, 20% of GDPs are from this sector. Converting this material to clean and affordable electricity through anaerobic digestion can increase the amount of reliable energy available to this region. Anaerobic digestion is the microbial conversion of organic carbon into biogas in the absence of oxygen. Combining this process with solar heating will increase the overall efficiency of the system, creating higher energy yields. Biogas, a product of digestion, can be combusted to produce energy but typically 30-40% of the biogas produced is used to heat the system, required to maximize biogas yield. The combination of solar heating with anaerobic digestion eliminates the use of biogas for heating, thereby maximizing the amount that can be converted to electricity. Utilizing a treatment wetland in conjunction with anaerobic digestion further reduces the adverse environmental impacts associated with organic waste streams. Solar heating, anaerobic digestion, and wetland treatments have been extensively studied; however, integration of these components has not. The team designed and constructed a lab-scale system that integrated a solar-heated anaerobic digester and a wetland suitable for digester effluent. Additionally, the team developed a LabVIEW program to monitor and control the system. For the next two years, the system will be used to collect data for feedstock variability and scale-up in Central America.

Senior Design Students at Work



International Activities

BAE Around the Globe

Biosystems and Agricultural Engineering has been particularly busy in the study abroad arena in 2012 with 3 programs running: Renewable Bioenergy Systems in Germany and Sweden; Sustainable Food, Environment and Social Systems in Australia and our new winter-break Ecological Engineering in the Tropics in Costa Rica.



Renewable Bioenergy Systems study abroad students visit an anaerobic digestion facility - Bauer Farm, Butterstadt, Germany.

Germany/Sweden

David Hodge, Dana Kirk and Luke Reese co-instructed the Germany/Sweden program which extensively studied anaerobic digestion in Germany and woody biomass in Sweden. Specifically, students focused on German and Swedish case studies/site visits/lectures that provided perspective on the development of bioenergy systems through the relationships between:



Renewable Bioenergy Systems study abroad students visit a combined heat and power/wood pellet facility - Skellefteå Kraft, Skellefteå, Sweden.

- Biomass Resources: potential, quality, geography, sustainability;
- Private Industry: markets, supply chain, commercialization, intellectual property;
- Research: technology development; and
- Government/Policy: policy and market development.

Australia

Jim Lucas, Office of the Associate Provost for Undergraduate Education, and Luke Reese co-instructed the Australia program which extensively studied human impacts on the environment/ecosystems. Offering University level credits in ISS 310 and ISB 202, this program caters to a broad range of majors



Sustainable Food, Environment and Social System study abroad students learn about water quality, quantity and rights - Riverina Water County Council, Wagga Wagga, New South Wales.

and seeks to help students explore broad questions related to sustainability. Through targeted site visits, lectures, course readings, analytical



"The cost of no water." Students learn about the Adelaide desalination plant built to provide 50% of Adelaide future potable water needs - Adelaide, South Australia.

essays and a personal research project, students connect their learning experiences back to their lives as students, future professionals, engineers, scholars, and citizens. Students address questions such as:

- What is sustainability? How can it be defined and measured?
- How do social and economic issues influence humans' interactions with their environments?
- What are our personal and collective responsibilities toward promoting sustainability?

Costa Rica

Dawn Reinhold and Luke Reese will co-instruct our new study abroad program to Costa Rica with University of Costa Rica colleagues, Biosystems Engineering Chair Jose Francisco Aguilar, Engineer Jose P. Rojas and Fabio Research Station Manager Werner Rodríguez. This Ecological Engineering in the Tropics program will utilize the facilities constructed through the Department of State grant as our experiential learning laboratory studying solar assisted anaerobic digestion and treatment wetlands. This program seeks to help students:



Treatment wetland which will be used as a learning laboratory for Ecological Engineering in the Tropics study abroad - Department of State grant supported - Fabio Baudrit Experiment Station, Alajuela, Costa Rica.

- Understand major themes related to clean energy, water and climate and the interactions among these systems in Costa Rica as compared to the U.S.;
- Develop their critical, creative, design and reflective thinking skills related to clean energy, climate, water and ecosystem services; and
- Enhance their ability to interact with cultural differences, understand issues of socio-economic equity, and consider issues from diverse perspectives for engineering designs and installations.

Continued on page 21

International Activities

Engineers without Borders Travel to Las Vegas

By Kelsey Downey

Toward the end of March, four students from Michigan State's Engineers Without Borders (EWB) chapter travelled to Las Vegas to celebrate EWB's 10th anniversary. During the international conference, students and professionals involved with this organization come together to share their stories and learn how to improve their own chapters.

Speakers are invited to this event to help inspire and prepare individuals for the future they face through involvement with EWB. Every year the founder of this organization, Bernard Amadei, gives a speech to open the conference and for this special occasion he expressed how important sharing one's story truly is. Another speaker that shined at this conference is best-selling author Dan Roam. Being involved with an organization where communication is always an issue with other cultures, Dan shared with us that communication through drawings can actually be much more effective than vocal expression. Besides hearing speeches from these interesting individuals, industry leaders, such as John Tracy who is the chief technology officer and senior vice president of engineering, operations, and technology with Boeing, share the importance EWB has when pursuing careers.

Although listening to these speeches is informational, the most remarkable part of this conference is being able to participate in the sessions. At the conference, members listened to different topics that

were designed to prepare individuals and organizations to better understand and respond to emergent global issues. For instance, one session that our chapter sat in on was about how universities prepare students to make meaningful global contributions. Another type of session that members participated in were learning sessions that gave attendees the chance to walk away with real-world problem solving skills and lessons from others. The conference then ended with chapter presentations where volunteer chapters share their project and data collection.

One of the Biosystems Engineering students from the Michigan State chapter was able to attend a presentation on a hybrid food dryer that was implemented to provide the community with a way of sustainable living and the implications that arose.

This opportunity to attend this event was not just an educational experience, but the opportunity to network and socialize with people who share similar goals that you have. The conference offers multiple social events where members are able to mingle and get to know other chapters on a name to name basis. Also, the conference puts on a small career fair where major companies and sponsors of EWB, like Boeing and CH2M Hill, get to interact with the participants.

Currently working on a sanitation project in El Balsamar, El Salvador where the Michigan State EWB Chapter will be

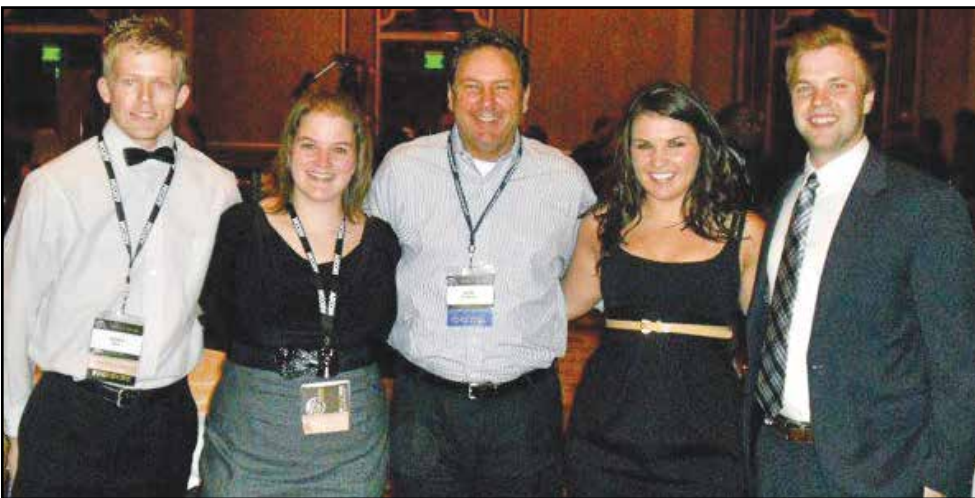
educating the community on the importance of sanitation practices and will be designing and constructing compost latrines for this rural community. On top of our international involvement, throughout the school year we partake in local activities and arrange an alternative spring break (ASB) for our members to get involved. Last year the MSU EWB chapter organized a day for local Boy Scouts to come earn their engineering badges and those that participated in the ASB trip assisted the National Relief Network with rebuilding a community in North Carolina.

If you are interested in joining or supporting our Michigan State University Engineers Without Borders chapter, please contact us at engineerswithoutbordermsu@gmail.com.

Continued from page 20

Studying abroad takes the student out of their comfort zone and forces critical thinking. Even if traveling to an English speaking country, the culture, context, diction and customs are different, forcing students to think outside their shells. While it usually takes time to sink in, students return from study abroad as global citizens putting things more in the context of the whole versus the individual. Engineers use ideas, materials, designs, equipment, parts and supplies that are created and made all over the world. By default, engineers require international knowledge and savvy.

BE students can have international learning experiences without crossing international borders. International experience and sharing can occur within the confines of Farrall Hall. Over two thirds of the BE graduate student demographics for fall 2012 is international. BAE has graduate students from China, Columbia, Costa Rica, Egypt, Guatemala, India, Iraq, Libya, Mexico, Nepal, Thailand and Turkey. In addition, BAE has undergraduate students from China and Korea. BAE welcomes all international experiences as enrichment to our classes, students and ultimately global citizenship.



Michigan State students Kelsey Downey (l) and Alexa Jones (r) with Dale Rimmey, Lockheed Martin Campus Relations Manager.

Srivastava Receives Gilley Academic Leadership Award

Ajit K. Srivastava, P.E., ASABE Fellow, is the recipient of the 2012 James R. and Karen A. Gilley Academic Leadership Award in recognition of his exemplary and sustained academic leadership, and for his outstanding contributions to teaching and research; and dedicated service to the profession and ASABE.

Srivastava, professor and chair, Department of Biosystems and Agricultural Engineering, Michigan State University, has provided positive and impactful academic leadership as chair of the department for more than 15 years. He has always assumed a servant leadership approach to his responsibilities, with a clear dedication to elevating and improving the academic programs, scholarly activities, and the professional growth and success of the faculty, staff, and students.

In 1999, Srivastava initiated a faculty-led strategic planning process that resulted in significant focusing and redirection of the departmental mission. His foresight and vision proved invaluable in leading the department through very challenging administrative times. The outcome has been a department that is growing, dynamic, and sharply focused. As a result of his leadership, undergraduate and graduate enrollment and external funding has greatly increased, academic programs are thriving, strategic hires are enhancing core program areas, and the department has received the vast support of faculty, stakeholders, and university administration personnel. He has also provided critical leadership in serving on multiple task forces that are guiding the future of the MSU College of Agricultural and Natural Resources.

Srivastava has developed and taught undergraduate and graduate courses in Biosystems and Agricultural Engineering, and has served on guidance committees of more than 40 MS and PhD students. For his dedication to teaching he was awarded the Withrow Excellence-in-Teaching award by Michigan State University's College of Engineering. His research has focused on machinery systems for improving the productivity and profitability of the American farmer. Most notably, his research on rotary grain-straw separation has contributed to the development of rotary combines. Additionally, he has worked on soil compaction,



ASABE Award Recognition (l-r) James and Karen Gilley, Barb and Ajit Srivastava and ASABE President Sonia Jacobson.

fruit and vegetable mechanization, including post-harvest engineering, and value-added processing. For his work in these areas, he has received two patents. Srivastava has authored or coauthored more than 50 publications. He was the lead author of the major textbook *Engineering Principles of Agricultural Machines*, published by ASABE and in use by more than 30 universities in the U.S and abroad.

A 39-year member of ASABE, Srivastava has provided leadership to numerous committees within the Power and Machinery division and Food and Process Engineering Institute, as well as P-515 Textbook and Monograph and ED-210 Department Administrators committees. He has also served on the Publications council, and as a trustee on the Foundation board. In addition to various teaching awards, Srivastava has received Distinguished Alumni awards from Rutgers University and the Ohio State University, and a Dean's Honor and College Merit certificate from the U.P. Agricultural University, India. His ASABE recognitions include a Paper award and election to Fellow in 2009. He is a member of the American Institute for Medical and Biological Engineers (AIMBE) and two honorary societies.

Retirement of Dr. James Steffe

Congratulations to Dr. James Steffe on his retirement last June. Our department will miss him greatly, after his more than 30 years of service at Michigan State University. He inspired both faculty and students to strive for excellence in all areas.

Dr. Steffe was heavily involved in teaching, research, and outreach. His main area of research was basic and applied food rheology, an area in which he is recognized as one

of the world experts. He was major advisor to 40 MS/PhD graduate students, and has published four books and 120 refereed journal articles. His graduate students are found all around the world, and many are in influential positions in academia, food companies and government agencies. Two of his books are available free on-line, and are downloaded and used internationally by faculty, students, and company researchers. Dr. Steffe is also a licensed Professional Engineer in Michigan, and has consulted for many food companies.

Dr. Steffe taught numerous undergraduate and graduate courses in food and bioprocess engineering, and food rheology. One of the classes, Food Engineering: Fluids, was developed by him during the construction of the GREEN-funded Dairy Plant, and has been taught for over 15 years. Students consistently rated the class very highly because of Dr. Steffe's outstanding teaching style, and the combination of hands-on lab time with theory, leading to jobs after graduation. As the BE Director of Graduate Studies the past three years, Dr. Steffe oversaw a rapid rise of graduate students from 15 to 35, the fastest-growing graduate program in the College of Engineering.

We will miss him also because of his friendliness, care for the students, and mentoring of faculty. He always had time to talk with someone who asked. We wish Dr. Steffe and his wife, Susan, all the best as they settle in their new home in North Carolina.



Jim and Susan Steffe greet guests at his retirement reception.

Mervas Establish Endowment

George and Betty Mervas have established a fully funded endowment to honor George's parents John and Julianna Merva. John Merva was an immigrant from Slovenia, who, despite of receiving no formal schooling and working full-time in ore mines, was able to teach himself three different languages. It is in this spirit of education that George and Betty Merva want to reward educational drive and excellence through this scholarship.

Dr. George Merva is an Emeritus Professor in the MSU Department of Biosystems and Agricultural Engineering. The Mervas live in East Lansing.

The faculty and staff in the BAE Department thanks George and Betty for their generous gift to the department and for their on-going support of our program.



Pictured (l-r) Fred Bakker-Arkema, Larry Walker, Betty and George Merva, Ajit Srivastava.

BAE Welcomes New Faculty Member, Dr. Jade Mitchell

Dr. Jade Mitchell joined the Biosystems and Agricultural Engineering Department faculty as an Assistant Professor at the beginning of the fall semester. Prior to arriving, she completed an appointment with the USDA Food Safety Inspection Service and a post-doctoral fellowship at the US EPA in the National Exposure Research Laboratory. Her educational background consists of a PhD in Environmental Engineering (2010) and a Masters in Civil Engineering (2007) from Drexel University in Philadelphia, PA. She obtained a BS in Civil and Environmental Engineering from the University of Pittsburgh in 1997.

Dr. Mitchell's research program will include the development of computational tools to facilitate risk based decision making across several areas. She plans to expand her work in dose-response modeling using molecular and systems biology for human health and plant pathology. Her research group will focus on applications of QMRA and chemical risk assessment for food safety and water quality including antibiotic resistance. This work will encompass both human health and ecological endpoints which relate to human health. Several funding agencies have active research programs for which her work is competitive, including NSF, US EPA, NIH and USDA.

Dr. Mitchell will teach the spring BE 385 – Introduction to Design and Optimization course and plans on offering a new graduate course titled - Quantitative Modeling and Risk Analysis for Biophysical Systems.



Alumni Awards

BAE 2012 Distinguished Alumni Award

Steve Richey

BS '80, MS '87

Agricultural Engineering

Upon graduation in 1980, Steve Richey took a position as a design engineer with Bolens Outdoor Power Equipment in Port Washington, Wisconsin, designing and testing walk-behind mowers and snowblowers. He returned to MSU in 1982 to begin work on his master's program under Dr. Ajit Srivastava on a project funded by John Deere Harvester Works to simulate the performance of small grain combines.



In 1984, Steve began his career at Kellogg Company in the Advanced Technology Group and progressed through Engineering and Research Groups over the next 20 years. Responsibilities he had on some recognizable new products included project manager and process engineer on the first Rice Krispies Treats Squares®; and process engineer on the first multi-colored, flavored Mini-Wheats® (Maple & Brown Sugar MiniWheats®) and Fruit Twistables®. He has received three patents for equipment, products, and processes; has been recognized with multiple internal awards; and was inducted into the Kellogg 25-Year Club in 2009.

In 2005, Steve became a director in Morning Foods Process Engineering at Kellogg's. This group provides process engineering for cereal projects in the United States and Canada, as well as technical expertise to North America, Asia-Pacific, Europe, and Latin America business units. He provides engineering expertise for cereal manufacturing network strategies and has made significant contributions to training programs for cereal process engineering and development of engineering managers.

Steve maintains a connection with MSU's Department of Biosystems and Agricultural Engineering (BAE) by volunteering to promote food engineering to freshman classes, speaking to the engineering student clubs, and helping to organize Kellogg participation in MSU Engineering Week activities. He has been a member of the BAE Department Industry Advisory Board since 2007 and chaired the board in 2010.

Steve and his wife of 34 years, Mary, reside in Marshall, MI. They have three children: Eric, 26; Megan, 26; and Peter, 16. They are members of the Marshall United Methodist Church.

BAE 2012 Outstanding Alumni Award

Janelle Clark Boosi

BS '07

Biosystems Engineering

Janelle Clark Boosi graduated with a Bachelor of Science in Biosystems Engineering in May 2007. She is currently employed by Kellogg Company as the Morning Foods Business Unit Manager in their Research and Development Pilot Plant in Battle Creek, MI. Prior to her current role, Janelle spent time as a Process Engineer in the Morning Foods Division, an Associate and Assistant Food Technologist in the Core Technology & Cost Optimization group (focusing on the Snacks platform) and a 6-month intern with the Snacks R&D Core Maintenance team.



Janelle manages eight Process Leaders who organize and execute testing in the pilot plant. On a daily basis, she is working with her team, contracted personnel, and customers (developers, food technologists, and engineers) to ensure R&D testing is completed successfully and in a timely fashion. Another integral part of her role is the development of the individuals reporting to her, for whom she focuses on knowledge management, training, and career development.

At Kellogg, Janelle has spent the last 5 years on the team organizing the company's involvement in the Annual Society of Women Engineers (SWE) conference. As a number of positions were added to the Engineering team in 2011, she also spent a large portion of the year leading a team to develop a new on-boarding program.

Outside of Kellogg, Janelle stays involved with multiple causes including a leadership role within the Great Lakes Section of the Institute of Food Technologists, Vice President of the South-Central MI Chapter of SWE, outreach activities with local groups, including Girl Scout troops and Habitat for Humanity and the Western Michigan University SWE Student Chapter.

In addition to her outstanding professional success and service, Janelle is an extraordinary ambassador for the BAE department, as she often can be seen at MSU speaking to BE classes, student clubs, and Engineering Expos about internships, life after college, her personal career path, and Kellogg's in general. Her enthusiasm is contagious and definitely has had a positive impact on hundreds of students in recent years.

BAE Alumnus Receives Presidential Honor

Two U.S. Environmental Protection Agency (EPA) scientists were named as recipients of the 2011 Presidential Early Career Award for Scientists and Engineers (PECASE). This award, which is being given to EPA's Dr. Mehdi Hazai and MSU BAE Alumnus Mr. Adam Eisele, (pictured right) is the highest honor bestowed by the U.S. government on outstanding science and engineering professionals in the early stages of their independent research careers. The purpose of the award is to encourage the development of science leaders and highlight the importance of science and technology.



Dr. Hazari was nominated for demonstrating how inhalation of low levels of air pollutants like particulate matter and ozone could increase susceptibility to cardiac events, such as heart attacks. His research is receiving international recognition and is under consideration for inclusion in the update of worldwide standards.

Mr. Eisele developed and used automated air sampling instrumentation in a project that was the first to identify and characterize local sources of air pollution in high altitude areas (5,000 to 10,000 feet above mean sea level). His research is being used to identify community health risks due to air pollution, and to develop a mobile measurement approach that allows for remote emission assessment of oil and gas production sources.

In addition to their innovative research, which is advancing EPA's mission to protect the environment and public health, both Dr. Hazari and Mr. Eisele have also demonstrated strong commitments to community service through their leadership in various mentoring, teaching, and community outreach activities. They will be presented the award with other recipients at a ceremony to be held shortly in Washington, D.C.

President Obama named 96 researchers across the Federal Government as PECASE recipients. The PECASE awards embody the Obama Administration's commitment to producing outstanding scientists and engineers by granting recipients a five-year research grant to further their study in support of critical government missions.

Scott Piggott Named Michigan Farm Bureau's (MFB) Chief Operating Officer

Piggott's MFB career began as the organization's natural resources and Right to Farm specialist. In October 2002, he was picked to manage the Agricultural Ecology Department.

Piggott has represented MFB on more than 20 boards and committees, and chaired both the MAEAP Advisory Council and the Water Resources Advisory Council.

A graduate of Michigan State University with bachelor's and master's degrees in Biosystems Engineering, Piggott resides on his family's crop and livestock farm near Fowler with his wife Donna and their children Danielle, Kaitlin, Anthony and Andrew. Outside farm and family, he is active in his church, local schools and enjoys wood-working.

Appreciation from Alumni...

Over the past 4 years I have worked in the food industry, even though I graduated with an Ecosystems Cognate in the BE program I feel I could not have done this with any other degree. The experience I gained in the BE program allowed me to do so. This was one of Dr. Steffe's big points when he taught us; that with a BE degree you can go into any industry, even if you specialized in a different area. I am living proof of this, and I attribute it to the broad based, fundamental engineering education I received when I was in the BE program. The BE faculty helped me to build a foundation in which I have been able to thrive in positions that encompassed Applications Engineering, Mechanical Design, Operations, Project Engineering, and Project Management.

Going beyond that, in an economy where it is tough to find jobs, I am not limited to asking myself "where can I find a job", I am able to ask myself where do I want to go? This is a very powerful paradigm shift that is hard to come by in recent years. I feel that every BE graduate can ask themselves this question. Again, this is because of the BE program and faculty, and the foundation that was built during my time there. Thank you!

Best regards,
Matt Klein

BAE Hosts UN Conference on Sustainable Energy for Sustainable Development Conference, Oct. 21-23, 2012

Recognizing the importance of energy for sustainable development, the United Nations General Assembly has designated the year 2012 as the International Year of Sustainable Energy for All.

The Michigan State University (MSU) Department of Biosystems and Agricultural Engineering (BAE) and the Greater Lansing Chapter of the United Nations Association teamed up to highlight the linkage between sustainable energy and economic development, locally and internationally by holding a 2-day conference. Conference session themes included:

- Sustainable Energy, Food Security and the Environment
- Promising Approaches and Technology for Developing Economies
- Economics, Value Chains and Impacts of Sustainable Energy Systems
- Sustainable Energy, Business Development and Entrepreneurship

National and international speakers included:

- Melinda Kimble, Sr. Vice President UN Foundation;
- Prof. Anna Sittenfeld, University of Costa Rica;
- Gerald Ostheimer, USDA and Global Bioenergy Partnership;
- Hans Gullikson, "European Green City" Vaxjo, Sweden;
- Bruce Dudley, Delphi Group Sustainability Services (Canada);
- David Dennis, Director of Business Development, Fleet Advantage, Inc.(Canada); and
- Numerous MSU Faculty experts.

For copies of most presentations, please visit www.egr.msu.edu/bae/2012-un-sustainable-energy-conference to review and download.



2012
INTERNATIONAL YEAR OF
SUSTAINABLE
ENERGY FOR ALL



In Memory...

Graduate Student Michelle Packard

Biosystems and Agricultural Engineering is deeply saddened to report the tragic and untimely death of Ph.D. student Michelle Packard. In another section of this newsletter, Michelle was announced as a winner in the 2012 College of Engineering Graduate Student Awards. Michelle was killed on July 4th while waiting for fireworks when she was struck by a senseless stray bullet in a Lansing park. The BAE faculty, staff and students extend their most heartfelt condolences to Michelle's family and friends.

William Splinter, Researcher and Administrator

William "Bill" Eldon Splinter, 86, George Holmes professor emeritus of Biological Systems Engineering at the University of Nebraska, passed away on Sept. 26, 2012 in Lincoln. He served UNL as a professor, department head, dean, vice chancellor and museum director.

Splinter was an active scientist and a leader in exploring the applications of solar energy to agricultural systems. He believed it was imperative that alternative energy sources be developed to offset limited supplies of fossil fuels.

Leonard Cassell Price

Leonard Cassell Price, Jr., age 85 of Howell, passed away August 20, 2012. Leonard was a 1944 graduate of East Lansing High School; attended Cornell University and graduated from Michigan State University with a B.S. in Agricultural Engineering; retiring as an engineer from General Motors.

Support BAE With Your Gift

A gift to BAE is an investment in future generations for the environment, food safety and the planet.

In support of the MSU Department of Biosystems and Agricultural Engineering, I am enclosing \$_____ and designate the gift to the selected account(s).

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