

Agricultural & Biological Engineering



Greetings from the new department head

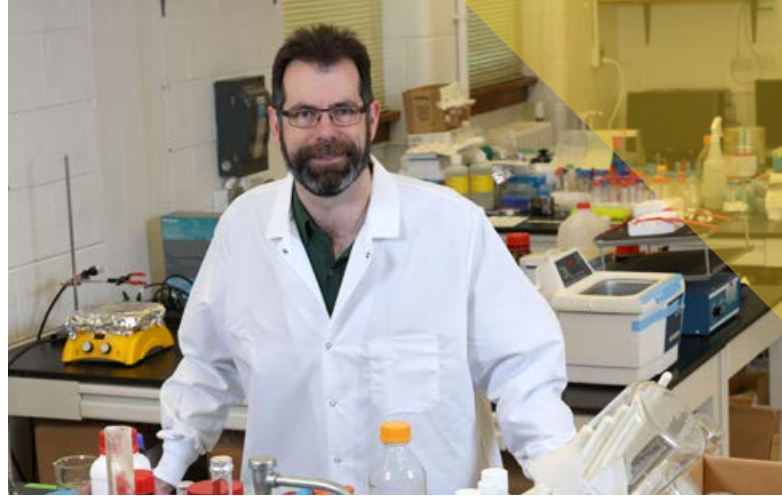
This past year marked the sesquicentennial (150th) anniversary of the founding of Purdue University. The theme of the celebration was Giant Leaps. It's certainly been a year of Giant Leaps in Agricultural & Biological Engineering! In January, our department head of nearly 15 years, Bernie Engel, became the Associate Dean for Research and Graduate Education in the College of Agriculture here at Purdue. Since January I've been serving as interim head and I am deeply humbled that the Glenn W. Sample Dean of Agriculture Karen Plaut has offered, and I have accepted, the permanent position.

For those who haven't had a chance to meet me yet, I've been on the faculty in ABE since 2003 and have taught biological engineering courses and conducted research on biofuels and bioplastics. I've been chairing our graduate programs committee for the past few years and am pleased to serve the department now as the head. The search committee interviewed a great slate of candidates and we appreciate their diligent efforts.

We've welcomed several new faculty to the department this past year. Somali Chaterji is a research assistant professor in digital agriculture and bio-informatics. Shawn Ehlers is a clinical assistant professor in our ASM program with extension programs in agricultural safety and rural emergency preparedness. Ankita Raturi is an assistant professor in digital agriculture. These new, talented faculty, along with the other hires over the past few years, strengthen our programs across all of our core areas.

You might have noticed the word "digital" multiple times in the preceding sentences. We're taking Giant Leaps in making sure our students have a grounding in – and that our faculty expand the boundaries of – applications of information technology and data sciences in making smarter machinery; data-driven innovation in food, plant, and animal agriculture; water/climate modeling for agriculture; and better tools sensors and data infrastructure in agriculture.

This year also brought Giant Leaps in our facilities. Our new and renovated building construction is



well underway. The shell of the building is nearly complete, and progress is on track to allow us to move into our new home in December 2020. These new facilities will provide outstanding offices, classrooms, laboratories, and workspaces for nearly all of the faculty, students, and staff in ABE. It has been many years since we have been able to fit into the old facilities. Even more exciting are the new state-of-the-art spaces to enable research, education, and student projects across all of our areas – machine systems, digital agriculture, agricultural systems management, water and natural resource engineering, food and bioprocess engineering, and biological engineering. Larger classrooms, teaching labs, and machine labs will greatly enhance the educational experiences for our students. We are excited for our five new makerspaces tailored for student projects, including capstone design, that cover the breadth of our program – from water resources to sensors for machines on the ground and drones in the air, and to synthetic biology.

For those of you who contributed to our building project, thank you! There are still opportunities to contribute as we finish the construction and outfit these facilities with new equipment. We are in the early planning stages to showcase the new building as part of our departmental celebration of alumni and seniors (and their projects) in April 2021. Coincidentally, this happens to also be the centennial anniversary of the founding of agricultural engineering at Purdue University. I hope many of you can make it back to campus to visit old friends, make new ones, and see what Giant Leaps are in store for ABE in our next 100 years!

Boiler Up,

Nate

Nate Mosier



A year from now ...

As you know, our \$80 million construction/renovation project is well underway. The new building towers over the old ABE building. We are scheduled to move in next December. To keep up with what's happening, visit www.purdue.edu/ABE and click on "ABE is on the move."

Credits

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'ANAONGEA KISWAHILI!'

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NOISE: LESS IS BETTER

For nearly a decade, Paul Kalbfleisch has tracked down the sounds that result from fluid power. He's closing in on his doctorate and starting a new job. **Page 15**

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Purdue's historic ties to the World Food Prize include student participation in the Borlaug Dialogue. Mari Leland, a sophomore, shares her observations after attending this year's gathering in Des Moines.

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agBOT CHALLENGE

‘Real consequences.
... It’s not a simulation’



Creativity a plus, teamwork a must for agBOT Challenge team

In early September, a Purdue team started preparing for the 2020 agBOT Challenge. The faculty advisors, Roger Tormoehlen and Richard Fox, are hopeful that the dozen or so students from several departments can successfully defend their title – worth \$25,000 – in the Weed and Feed category. But if history is an indication, the team won't coast to the starting line unless time management skills significantly improve.

"On that they don't do so well," Tormoehlen says, laughing. "They don't," Fox quickly agrees, "but in the end they do." Again and again the students are reminded that what looks like a five-minute task almost certainly isn't – and that no one works alone.



*Troy Honegger, Matt Gobel, Aaron Etienne,
Patrick McDonnell, Elliott Sass*



Upper left: Troy Honegger (seated) debugs the controls

Left: Matt Gobel, Aaron Etienne, and Elliott Sass adjust the 3-point hitch

Below: Boiler on the move!

Below left: Patrick McDonnell with microphone





"We have a complex system," Tormoehlen says. "If one group changes something on their part of the machine, it's likely to impact the other parts. No team is allowed to change something without telling the group. That's why we have weekly meetings. They start to learn how to work as a large team through subgroups. They have to talk it through."

"There are real consequences to their actions. It's not a simulation. If a group makes a decision without talking it through, there can be significant consequences to the project."

"We don't get a lot of projects like that," Tormoehlen says. He and Fox have been involved since the beginning. It's stressful and time-consuming "but it's a good experience for the students, and worthwhile," Fox says. "I wouldn't give it up."

Purdue finished second in the Weed and Feed category in 2017, tied for second in 2018, and won this year.

The team was once all seniors – it was a popular capstone project – but opening it up to all ages brought in diverse ideas and opinions. "It also allowed us to reach out to other disciplines," Tormoehlen says. "One of the freshmen last year was a computer science major. A lot of coding and software is involved in robotics. That was an area we weren't strong in. This year we have a person in electrical engineering. Our agbot has wires and electrical components running everywhere."

"I'd love to see more students from engineering backgrounds, computer science, technology. If we had more diversity than we have now, that would tremendously help our team."

Members choose an area to focus on; some work on more than one of the four: trailer system (weed removal items, sprayer system, mechanical removal system, rototiller/multivator); weed identification system (cameras, imaging); navigation and speed control; and the power system.

"Speed control has been a thorn in our side for a couple of years," Tormoehlen says. At 3 or 4 miles an hour, the camera system has time to identify a weed and transmit the information. However, the transmission needs more RPMs to smoothly engage, and the cruise control system is cranky. There are voltage issues to overcome, too. It's always something.

Prize money and department support have eased financial concerns. Generous donations have helped, too. Yamaha donated the \$17,000 platform; the guidance system is a loaner from Trimble; an Ohio company donated the rototiller/multivator.

"My approach is, don't worry about the budget," Tormoehlen says. "We'll deal with that later. If it's not manageable budget-wise, we'll scale it back. But we haven't come up with anything we couldn't afford." Not even when the cost seems high to students. One recently fretted at a \$120 price tag. "Don't worry about it," Fox told him.

Teams don't bring perfect machines to the agBOT Challenge. Successes often are modest. But the event is in its infancy, and given the pipeline of academic talent, it seems inevitable that results will improve. Meanwhile, Tormoehlen likes the big picture.

"To the best of my knowledge, there's no other such college- or company-level competition," he says. "Not of field-scale size. The agBOT Challenge fits well with one of our strategic focuses: big data and digital agriculture. And it provides students with an avenue to look at cutting-edge technologies. One thing I like is it's very open. Very few rules and regulations are related to the contest, which allows students a chance to be creative, to think outside the box."

Simple tasks? No.

Step by step, how the agbot works:

<https://ag.purdue.edu/stories/agbot-2019/>

Who and what

agbot: agricultural robot; an autonomous robot used in farming to help improve efficiency and reduce reliance on manual labor.

agBOT Challenge: Founded by Steve Gerrish and his daughter Rachel. Competition from 2016 to 2018 held at Gerrish Farms in Rockville. Held May 16-18, 2019, at Purdue's ACRE – Agronomy Center for Research and Education. Core intent: Envisioning a future with rural high-speed broadband service; how robust broadband would allow robots to analyze crop environments and initiate action.

Capstone: A senior design project. Companies are involved. The course is structured so that students provide realistic, timely answers to the sponsor's problems.

NextGen Expo: An interactive STEM event held in conjunction with the agBOT Challenge.

Prize money: \$25,000 for first place, \$15,000 for second, \$10,000 for third.

Roger Tormoehlen: torm@purdue.edu; professor, Agricultural and Biological Engineering.

Purdue Weed and Feed team members, 2019-2020: Aaron Etienne, Agricultural Engineering. Aaron Shwartz, Agricultural Engineering. Alex Chrisman, Electrical and Computer Engineering. Charlie Discoe, First-year Engineering. Elliott Sass, Agricultural Engineering. Jackson Kenyon, Agricultural Systems Management. Manuel Perez, Agricultural Engineering. Matt Gobel, Agricultural Engineering. Mitchell Moore, Agricultural Systems Management. Nikira Lane, First-year Engineering. Troy Honegger, Computer Science. Uel Palmer, Agricultural Systems Management. Varun Aggarwal, Agricultural Engineering. Zhuoxiang Chen, Agricultural Engineering. Bryce Oliver, Agricultural Systems Management.



Richard Fox: foxrj@purdue.edu; computer analyst, Agricultural Sciences Education and Communication.

Sponsors, agBOT Challenge: airBridge, BATS, Blue River Technologies/Deere, Case IH, Coalliance, Conservis, Corteva, Gerrish Farms, Indiana Soybean Alliance, Ivy Tech, Linak, Prairie Robotics, Purdue Agriculture, Purdue Agronomy, Purdue Foundry, Qmira, Solinftec, Tom Farms, Thompson Farms.

Soil task: Actually, Mining for Microbes and Microfauna. Teams autonomously gather soil samples and prepare them for diagnostic evaluation while in the field. The process involved drilling into the soil, and several mechanical steps winnowed the collected soil down to ready-for-the-lab sized samples. Tasks in previous years: Plant corn (2 years), watermelon harvesting.

Soil teams: Indiana State, IUPUI, Matt Droter (Texas), Muchowski (Canada), Pee Dee (South Carolina), Rogo (Indiana), Virginia Tech (first place).

Weed and Feed task: Build automated vehicles capable of treating ragweed, foxtail and cocklebur with herbicides, and corn with nitrogen. Plants were identified while cameras and sensors produced imagery matched against onboard, digitized images. All this was done as the bots moved down rows of simulated no-till ground laced with small weeds and small sprigs of corn.

Weed and Feed teams: Colorado School of Mines, IUPUI (second place), Matt Droter (Texas), Muchowski (Canada), Purdue (first place), Robo Hub (Egypt), University of Manitoba (third place), Virginia Tech.

BIRS finds a home in ABE

'It fits here. Not a stretch at all. It belongs here.'

Occasionally, academic programs take a while to settle in. It's not a question of worth, but of fit. It can take time to find an environment where a program may best flourish and grow.

This summer, Agricultural and Biological Engineering became the third home for Biotechnology Innovation and Regulatory Science (BIRS). Expect this program, which until now has flown under the radar, to become better known – and to stay awhile.

"It fits here. Not a stretch at all. It belongs here," says Nikki Zimmerman, ABE's graduate program administrator. She oversaw the nine-month transition from the program's second home – Purdue Polytechnic Institute.

The program began in the College of Pharmacy as a graduate certificate program called Regulatory and Quality Compliance (RQC). Dr. Kari Clase, head of the program and Director of the BIRS Center, began her Purdue career when she was hired by Purdue Polytechnic to create a biotechnology program. She helped RQC transition to Purdue Polytechnic, where it was part of the Department of Technology Leadership and Innovation (TLI), and the name of the program changed to BIRS.

"The name shifted to BIRS because it was biotechnology innovation now," Clase says. Also, the Food and Drug Administration and national academies "had issued reports defining this emerging space of regulatory science, which was calling for academic, regulatory, and industry professionals to work together. I would say that's very much our model."

Gradually, biotechnology was less of a focus in TLI. In October 2018, the move to ABE began.

"Strategically, the transition made sense in order to best serve the students," says Clase, whose expertise is also in curriculum design, development, and implementation.

"From a research perspective it was a natural evolution. The molecules that we focus on are biological molecules. The research and understanding of what it takes to manufacture those molecules, what the industrial applications look like – all of that is the core expertise of biological engineering.

"It's not that another department on campus could not administer the program. But if you really want to make sure that the content and the courses stay current and are cutting-edge, I think it's very critical that it is grounded in a department like ABE that has those core research strengths."

How BIRS became part of ABE. Page 10



Dr. Kari Clase is the director of the Biotechnology Innovation and Regulatory Science (BIRS) Center.

RQC, Africa, IPAT, BIRS and ABE: A short history



When Dr. Stephen Byrn was the head of the Department of Industrial Physical Pharmacy in the College of Pharmacy, executives from the pharmaceutical giants Abbott (now AbbVie) and Eli Lilly sought his input to develop a program that would strengthen the skills of their employees in regulatory science and quality, and additionally ease the transition for work in such a highly regulated industry. This desire ultimately became a live three-course graduate certificate program called RQC: Regulatory and Quality Compliance, which then evolved into a master's degree program. Students came to campus three weekends a semester, or attended at a site near Abbott. All course material was provided face to face, and it took four years to earn a master's.

Shortly after the three-course program was initiated, Pharmacist Sister Zita Ekeocha sought to find out if it was possible for Africans to manufacture their own medicines. East Africa receives a lot of donated medicine, some of which is substandard. No European universities were willing to do training in Africa, so her search led her to Purdue University's Dr. Byrn, and he went to Africa for the first time in 2007. What began essentially as a missionary effort became a four-course certification – Industrial Pharmacy Advanced Training (IPAT) building on the original three courses in the RQC program.

Back in West Lafayette, Dr. Kari Clase, whose training is in biochemistry, was hired by Purdue Polytechnic Institute to implement a collaborative biotechnology program across the colleges of Pharmacy, Agriculture, and Technology. Clase soon received support from the Howard Hughes Medical Institute (HHMI) to enrich the biotechnology courses with a research experience. Drs. Clase and Byrn began collaborating to deliver a capstone course to biotechnology students in Regulatory and Quality compliance. The RQC program underwent a formal evaluation in the College of Pharmacy, but the recommendation was to close the program due to the lack of a sustainability plan. However, a plan emerged for Clase to become the new director. With her background in course and curriculum design in STEM areas and expertise in biotechnology, she was soon able to leverage current educational technology for course delivery and incorporate professional competencies.

“Strategically the transition made sense in order to serve the students,” Clase says. Students were looking for flexibility in courses and ways to decrease the time it took to get a master's, so Polytechnic's professional master's degree program was a plus. The new program utilized both live and online education; students could achieve a master's degree in two years with significantly reduced travel. Also, a new name – BIRS: Biotechnology Innovation and Regulatory Science – reflected the shift in focus.

Almost simultaneously with this new blended education BIRS plan, Merck and Co. Inc., another global healthcare giant, provided two years of funding to bolster Purdue's African efforts through its own foundation. In 2014, students in the program began studies that would lead to a master's. Clase traveled regularly to Africa to implement this program, and in spring 2016, in Moshi, Tanzania, 22 students completed their Master of Science in Technology Leadership and Innovation, with a concentration in biotechnology innovation and regulatory science (BIRS). In spring 2018, a second cohort of MS students completed their program, bringing the total to 43. These programs would not have been possible without Clase's new method of delivery, which blended the live sessions with an online education, and she quickly became an expert in international education.

The BIRS Africa project is currently supporting 54 students who are on track to get their master's degrees next year, and the capacity building efforts are currently being supported by the Bill and Melinda Gates Foundation. Abigail Ekeigwe and Mercy Okezue, who were members of that first cohort, are on the Purdue campus earning their Ph.D. Purdue's program still relies on a partnership with the Medical Missionaries of Mary and Sister Zita, who leads the program initiatives within Africa, including marketing to African students, handling logistics, and all the other considerations for coordinating the twice-a-year trips to East Africa.

Clase, who is the director of the BIRS Center, has long had a relationship with ABE. In October 2018, BIRS began a nine-month transition to ABE.



‘We don’t fund projects.’ But ...

In 2017-2018, the BIRS program in Africa continued despite a lack of funding. Dr. Kari Clase and others, including industry officials donating their time, still made twice-yearly trips to Tanzania. “We were just trying to continue through the residual funding we had,” Clase says.

At a session where students – who weren’t formally Purdue students at the time – were making PowerPoint presentations, explaining their projects and asking for advice, representatives from the Bill and Melinda Gates Foundation, in the region for other reasons, stopped by and listened.

“They’d already told us, “We’re not here to fund you. We don’t fund projects. We build partnerships.” Clase says. “The next day they said, “You know, we’ve seen a lot of PowerPoint presentations. Yesterday, we’d never seen anything like that.’ They said they wanted to support the program.”

That funding started in 2018 and continues through August 2020.

A solid core

Whether the BIRS students are in West Lafayette, studying in the Indianapolis area while working full-time for Roche, Merck, etc., or in the African program, the curriculum content doesn’t vary much.

“The students in Africa don’t get an Africa-special program,” says Dr. Kari Clase, who heads the BIRS program. “We might have lectures that address special topics that are appropriate for the audience, but the core content, the core competencies, don’t change.

“You still get the core courses of devices and diagnostics, drug development, good regulatory practices, and, because the industry is global, they still learn about the regulatory agency from an FDA perspective – because it’s relevant. We have students in different places, but the content and courses, the core, haven’t changed.”

THE NUMBERS

ABE undergraduates: **573**, as of Fall 2019.

ABE graduate students, before August 2019: **107** master’s and Ph.D. students

Graduate students brought in by addition of BIRS: **31**

Graduate students in the BIRS African program: **54**



Dateline: Eldoret, Kenya

Right place, right time: Her aflatoxin research matters to Kenyans

As if Margaret Hegwood needed a reminder that what she's doing is important.

"Last week, multiple maize flour brands and six peanut butter brands were recalled for aflatoxin contamination," she said in an early November email from Eldoret, Kenya. "A lot of Kenyans are curious about my research, and when I tell them it involves aflatoxins, they have lots of questions about how they can stay safe."

Aflatoxins are carcinogenic compounds made by molds. Hegwood's master's thesis is on optimizing extrusion processing parameters for aflatoxin decontamination in Kenyan staple crops. "In particular, with the mini extruder designed by my faculty member, Dr. Martin Okos," she said. "There is also a lot of ag econ-esque work included. I correlate aflatoxin infection rates with storage practices, location, origin, vendor type, etc."

Some research never leaves the lab. Not hers. And she's glad.

"I can actually help with that," she said. "I can give them advice. I can tell them safer ways to harvest maize, or which peanut products to avoid to avoid high aflatoxin contamination rates. It's great to know that my research not only has relevance in

the academic world but also in the lives of everyday people."

Hegwood is in Kenya for a third time, this time on a Boren Fellowship for national security and strategic language studies. The fellowship is through the U.S. Department of Defense. Learning the language is an expectation.

"Three of my Swahili lessons are with a formal teacher," she says. "The other two are with a friend who I practice speaking with for an hour straight.

"One of the coolest things that happened: I was buying maize from a vendor (all in Swahili) and when I turned around I heard them say, 'Anaongea kiswahili!' Which means, 'She speaks Swahili!' I felt really accomplished in my language skills at that moment, especially because languages don't come naturally to me."

Improving or maintaining positive foreign relations is one reason for the Boren Fellowship's language requirement. Hegwood seeks to become a globally competent biological engineer.

"For me, global competency means building three things: empathy for others, self-awareness, and emotional resilience," she said. "The last one is



Esther Wairimu, head primary schoolteacher at Tumaini Innovation Center in Eldoret, Kenya, is helping Margaret Hegwood learn Swahili.

***Ninaongea kiswahili kidogo.
Nina somo tano kwa wiki.
Pia, ninaongea kiswahili kwa
utafiti yangu na wakulima.***

(I speak a little Swahili. I have 5 lessons per week. Also, I speak Swahili for my research with farmers.)

especially hard. Learning how to live and thrive in a new environment means being OK with making mistakes and receiving criticism. You're trying to simultaneously fit in to a new culture while also finding a version of yourself there that doesn't compromise your own beliefs or values. This balance – maintaining self while also achieving personal growth – is really difficult, but that makes it one of the most important pieces of global competency."

September Purdue News Service story:
purdue.ag/2P4X8BE

Purdue's National and International Scholarships Office assists with applications to extraordinary and prestigious programs, such as the Boren Awards. www.purdue.edu/niso/

Hegwood was featured in the 2018 newsletter ("More PUPS for Kenya") and the 2017 newsletter ("Dear ag industry: Talk up tech"). Visit <https://engineering.purdue.edu/ABE>, click on "About Us" and scroll down to "ABE Newsletters."

In her own words: Hegwood's life in Kenya. Page 14

First, a relationship. 'Then you can ask'



We asked Margaret Hegwood to describe her life in Kenya. Here's what the South Windsor, Connecticut, native said:

Something you'll learn when you live in a place like Kenya is that no day is the same. Normally, I try to keep a schedule of three days a week at the University of Eldoret and two days a week working at home/practicing Swahili at the Tumaini Innovation Center, where I have worked previously on the PUP project.

However, I don't stick to this very easily. Some days I spend all day in town finding research equipment or the right person to help me do research. For most of October, I was traveling all across the county conducting fieldwork. Those were long days – 8, 9, 10 hours out and about meeting with farmers, millers, and market vendors. A strict budget is also a factor. Transportation costs – since I can only take taxis for safety reasons – can add up quickly.

Adjusting to the food and water is easy. Eldoret town has large supermarkets with almost everything you need. I think adjusting to the culture is more difficult than physical needs. Kenyans live in a very connected culture. They thrive off community and bonding with their friends, family, etc. So, to get things done, you have to be willing to form relationships. For example, when you walk into the store and you want help, you don't immediately ask for something. First, you say, "Hi, how are you? Good? That's great. I'm also good. How is your day going?" Then you can ask for something you need help with.

This is even more important when working on big projects, like with the farmers I meet. It takes about 30 to 60 minutes to collect each sample from farmers simply because I spend so much time just talking to them.

Honestly, it can be exhausting at times to form these relationships, but they're invaluable. I think my persistence in building relationships (and therefore trust) with Kenyans is what has allowed me to be so successful here thus far. It's the reason I've been able to engage local government and private industry on my project.

I won't discredit my effort to speak the local language either. When I say "Habari yako?" ("How are you?") it changes people's entire perception of me – it switches the question in their mind from "Why are you here?" to "How did you come to learn Swahili?", which is a question that offers more room for collaboration.

(A good friend of mind recently pointed out this nuanced difference between why and how. He made a good point: "Why?" is often loaded with judgment. "How?" is a question with more possibilities for learning about someone and their perspective/experience.)

In terms of progress, I definitely feel like I'm getting somewhere, even if it's slower than I would like some days. It makes me really glad to have such an integrated Kenyan team. I'm the only American working on my project (excluding my advisor, technically), so I work entirely with Kenyans. It's pretty awesome actually. I'm also excited that the local government is supportive of my work. I worked with county extension officers to do all of my fieldwork. All of my results will be shared with them in a report so they can target weaknesses in the supply chain. I also work with the lab tech at the local flour factory to test my samples.



Where's that noise coming from?

Researcher has a 'score to settle' with fluid power

Once Paul Kalbfleisch realized that fluid power acoustics was his niche, he was willing to spend years seeking ways to reduce noise. The world's largest academic hydraulics laboratory in the United States – Purdue's Maha Fluid Power Research Center – was an ideal place for that research.

In a mid-September profile posted at the College of Agriculture website, Kalbfleisch, who has a master's degree in Mechanical Engineering, said he planned to complete his doctorate this fall. But the graduate research assistant in ABE now says that should happen next semester. He'll be wrapping up his research while in Arizona, not West Lafayette.

"The agricultural industry is a huge part of the push for fluid power," Kalbfleisch says. "The farming community, as customers of this technology, has been continuously advocating for advancements. For example, people know about the (Toyota) Prius and its fuel efficiency. A lot of that comes from a power-split transmission, which first showed up predominantly in tractors. Fluid power technology is everywhere, but nobody realizes it."

Kalbfleisch's research hopes to identify and reduce noise created by fluid power, allowing for additional applications of the technology.

"The number one preventer of fluid power implementation is noise," he says. "When it comes to the long hours of agriculture, noise fatigue can play a lot into a machine user's quality of life.

Paul Kalbfleisch recently moved to Tucson, Arizona, to work for Sargent Aerospace and Defense.

"Interestingly, there is not a lot of research on fluid power noise. To be able to control the noise, you first have to know where it comes from. That is why I keep working at it. It's discovery and diagnosis before treatment, like in the medical field."

His research has made conventional reductions in sound easier, but he would like to push to a new state of the art. "It has the potential to be a huge contribution to pump noise. I just have to take a little more time for that to happen. It also is a personal score to settle, as I've been slowly progressing toward a higher level of understanding for 10 years now at Maha."

A few weeks ago, his plans took a dramatic turn. Sargent Aerospace and Defense (www.sargentaerospace.com) "found me and found a way for me to join their R&D, focusing on hydraulic noise," Kalbfleisch says. "I'm excited to join right before Sargent's 100-year anniversary of producing quiet hydraulic components for the U.S. military."

He started work in Tucson on Nov. 18. Next semester, he intends to return to campus, defend his research and add "Dr." to his name.

To read the September online article: purdue.ag/2syZ4dP

‘We cannot push people to accept science’

At Borlaug Dialogue, sophomore gains perspective on ‘massive challenge’



Mari Leland, a sophomore from Minnesota, is majoring in Biological Engineering.

‘While that is concerning, it doesn’t discourage me.’

Global food security is a goal that seems to require unceasing effort and continuous progress. An ability to look on the bright side helps.

“I always tend toward optimism,” says Mari Leland, one of 12 College of Agriculture undergraduates who attended this year’s Borlaug Dialogue International Symposium in Des Moines, Iowa. “I believe that as people start to realize the severity of the issue they will become more accepting of solutions.”

The Borlaug Dialogue is part of World Food Prize week, a mid-October event that draws more than 1,200 people from 65-plus countries. Last year Leland, a sophomore in Biological Engineering, was a delegate at the Global Youth Institute, another program offered by the World Food Prize Foundation.

Pax Agricultura: Peace through Agriculture was the theme for this year’s Borlaug Dialogue.

“The challenge of feeding a population of over 9 billion by 2050 is certainly a daunting task,” Leland says. “We have reached a kind of crossroads when it comes to solving this challenge. We have the technology, and we can create GMOs and we can do all sorts of things, but we cannot push people to accept science. We can educate and we can do everything in our power to encourage people to accept and use the technologies we produce, but the consumer pull has to be greater than the technological push.

“While that is concerning, it doesn’t discourage me. The ability for everyone around the world to understand the importance of coming together and discussing past failures, current successes, and the future makes me hopeful. Global problems require global solutions, and the World Food Prize summit cements the idea that global leaders and people across the world know this and are more than willing to work together to benefit humanity as a whole.”

Lawrence Haddad, the 2018 World Food Prize laureate and a mediator for a panel at this dialogue, made an impression on Leland.

“Two of his most distinctive quotes,” Leland recalls, “were ‘The future is here. It is just unevenly distributed,’ and, ‘In a world with less and less certainty, we need more and more diversity.’ Both of these quotes were very profound to me.

“The first deals with the fact that we can solve global issues with current knowledge and efforts. Although we may need to keep pushing, we already have the technology to create and grow GMOs that can increase crop yields, avoid disease, and are resilient enough to survive varying weather patterns. We have the technology in the United States to harvest small farms with machines. The future of agriculture is concentrated in countries with strong STEM market shares, and it needs to be spread. Smallholder farmers in Africa and South America could greatly benefit from small machines that increase the ease with which they harvest. Roads that are so established in some countries are rarities in others.

“With respect to diversity, through the lens of climate change, this is of utmost importance. Crops need to be diverse; farmers need to be diverse in their approaches. Because weather patterns and climate are so uncertain, they jeopardize the world’s food supply, and it is important to be proactive. As we are faced with increasingly erratic weather that risks large proportions of food supplies, we need to adjust and adapt.

“However, the most important quote of the entire conference, in my opinion, came from Ambassador Kenneth Quinn, the president of the World Food Prize Foundation during his keynote speech: “Where the road ends is where poverty, hunger, conflict, insurgency begins.” Communication, connection, and access is the root of so many problems we are seeing. Climate change jeopardizes food security, which creates conflict and further restricts food supply. The people suffering don’t have the ability to leave, and desperate times create further instability.

“When solving the massive challenge that is world hunger, it is important to investigate and create solutions for every factor, since they are so closely related.”

About Mari Leland

- Hometown: Medina, Minnesota.
- Sophomore. Biological Engineering, with a Cellular and Biological concentration. Minors in Spanish, Food Science, Global Engineering, Political Science.
- Possible future plans: Graduate school, Peace Corps. “Anything that helps people. Whatever I do I want to be contributing to efforts that are helping people become more food secure.”

Also:

- Purdue boasts three World Food Prize recipients: Professor Emeritus Philip Nelson (2007, Food Science); Distinguished Professor Gebisa Ejeta (2009, Agronomy); and alumnus Akinwumi Ayoejui Adesina, (2017, president, African Development Bank Group.)
- www.worldfoodprize.org/en/borlaug_dialogue/
- Other Purdue undergraduates attending the Borlaug Dialogue: Caroline Edmonson, Agribusiness Management and Food Science; Grace Johnson, Natural Resources and Environmental Sciences; Brett Leisure, Agronomic Business and Marketing; Rio Lemkuil, Food Science; Cameron Matthews, Biochemistry; Grant Sanchez, Agricultural Education; Claire Schloemer, Agronomy: International; Lauren Schreck, Marketing and Agricultural Economics; Emma Swain, Agribusiness; Rowan Wallar, Food Science; Morgan Winder, Agricultural Education and Agricultural Economics.



OATS Center update

Apps, ‘powerful’ credentials, growth in corporate support

The Open Ag Technology and Systems Center (OATS) opened in January 2018 as a three-year collaboration among faculty and is led by faculty in the College of Agriculture and the College of Engineering. Three sub-teams – engineering, software and computing, and food and agronomy – are led by a core of 19 Purdue researchers. The plan was to create an open source framework and community for sharing data and algorithms, with a goal of improving sustainable food and agricultural systems.

As the project closes in on its final year, ABE Professor Dennis Buckmaster, OATS Center Co-Director and Dean’s Fellow for Digital Agriculture, provides an update on OATS’ achievements and plans.

Have the goals changed in the past two years?

Our mission remains:

“The Open Agricultural Technologies and Systems Center works to enhance agricultural innovation in the areas of sensing, control, logistics, analytics, and data management via the catalyzing effects of open source technologies and educational outreach

Depending on corporate support and the exact student mix, we do shift specific projects a bit. The ISOBlue open source telematics unit remains a focus and is part of our larger efforts with North Carolina State in the AERPAW (aerpaw.org) project. Our work with location tracking has led to some interesting developments regarding grain traceability, logistics

efficiency, and activity identification. We have related work in extending connectivity in rural spaces, use of video as a sensor in food and livestock systems, and improving access to public data through a much improved interoperable data model.

What does OATS seek to accomplish in 2020?

We have been increasing our presence in other activities, such as the AgGateway conference, the MidWest Big Data Hub, and related large research projects in cooperation with collaborators at other institutions. We will continue to do that. We are continually hoping to gain more corporate involvement and as the realms of work and graduate student counts grow, we need to consider having a manager.

Is there a resistance to open source communities? If so, is proprietary information the reason for that, and can that be overcome?

The best application – and our focus with the open source effort – really is the “middle ware” that enables interoperability among systems. The promise of data in agriculture has largely been unmet simply because machinery data, weather data, soil data, crop sensing data are not working together for strategic nor logistical decisions. There is a growing recognition of the need for improvement, and this is reflected in the growth in corporate support for the OATS Center. We have received significant support from over 10 companies or organizations to move this work forward.

ABE Professor Dennis Buckmaster is the OATS Center Co-Director and Dean's Fellow for Digital Agriculture.

A year ago you said, "This center's activities, in addition to the research and outreach, will facilitate better graduates in the digital agriculture realm." Is that a reality yet?

We have about a dozen graduate students in the OATS Center with majors of ABE, ECE, and CS. Several will be graduating in the 2019-2020 academic year with a unique and powerful set of credentials. One of the very successful programs led by four center faculty was the Research and Extension Experiential learning for Undergraduates (REEU). In that 10-week "summer camp for agricultural data science" these students learned and applied some advanced data approached in Excel, Python, ArcGIS, and more. They wrapped up their experience with an independent project. Participation was from six states and six institutions.

What is your main mode of outreach?

We hold an annual conference; at this meeting, we give updates on most all of the projects and engage participants in conversations about needs and priorities through the ag data pipeline. A highlight of the 2019 conference was the Event Storming with two channels (food systems and cropping systems). OATSCON20 will be March 26-27 at the Big Ten Conference Center in Rosemont, Illinois, right next to the O'Hare airport.

Do you have anything released for public consumption yet?

It is actually a simple thing, but one of our students, Alex Layton, coded up the CONTxT app quite quickly. His skills and ability to do this are a reflection of the talent of the group. That web app, available at <https://openatk.com/CONTxT>, is an open source app (look it up on github or contact us if you want to contribute!) but works pretty well as is. It is a simple metadata or contextual information collector app that saves your data to your Google Drive. We strongly believe that if producers and researchers alike would use this diligently, they would rapidly find many more insights from their operations and data.

We have other apps in assorted levels of development, demonstration, and release (Water Plane, Watershed Delineation, Fieldwork, TrialsTracker). Some of these use public data, some use private data, but all are open source efforts.

Of what you have done to date, what caught the most traction?

I'd say the two highly visible and reasonably disruptive efforts have been ISOBlue (open source telematics) and the Trellis framework for produce inspection audits. ISOBlue (isoblue.org) units have been built and used around the world, and it provides us a platform to extend edge computing and connectivity as well as serve as a data collection hub directly on machinery. The Trellis framework (trellisframework.org) has the endorsement and strong involvement of the Produce Marketing Association and is a demonstrated active deployment of our Open Ag Data Alliance (openag.io) API.

More online

purdue.ag/2LaUdWT

<https://oatscenter.org>

OATS Team

Co-directors: James Krogmeier, associate head, professor, Electrical and Computer Engineering with courtesy appointment in ABE; Dennis Buckmaster, Dean's Fellow for Digital Agriculture, ABE professor.

College of Agriculture Members:

Professor James Camberato, Agronomy.

Assistant Professor Somali Chaterji, ABE.

Professor Melba Crawford, Agronomy, Civil Engineering, Electrical and Computer Engineering.

Clinical Assistant Professor Amanda Deering, Food Science.

Bruce Erickson, Clinical Assistant Professor for Digital Agriculture, Agronomy.

Assistant Professor John Evans, ABE.

Professor Richard Grant, Agronomy.

Assistant Professor Jian Jin, ABE.

Associate Professor Haley Oliver, Food Science.

Assistant Professor Ankita Raturi, ABE.

Associate Professor Dharmendra Saraswat, ABE.

Professor Mark Tucker, Agricultural Sciences Education and Communication.

2018 Outstanding Alumni

KATHRYN “KITT” FARRELL-POE, MS 1984, PH.D. 1990, CE

Kathryn L. “Kitt” Farrell-Poe is a Department Head, Extension Specialist, and Professor in the Biosystems Engineering Department and an Extension Water Quality Specialist in the College of Agriculture & Life Sciences and the College of Engineering at the University of Arizona. The Ohio native was the first woman to earn a bachelor’s degree in Agricultural Engineering at the University of Nebraska–Lincoln in 1979. She finished her Ph.D. at Utah State University, then joined the Agricultural Systems Technology & Education department as its first woman faculty member. Dr. Farrell-Poe joined the Agricultural & Biosystems Engineering Department as its first female faculty member and has been with the University of Arizona for 20 years. She became the department’s first female department head in 2014.



Paul Miller, Kitt Farrell-Poe, Scott Strickland, Amy Penner, Steve Poe

PAUL S. MILLER, PH.D. 2003

Paul S. Miller is the Head of Science and Analytics at Nutrien Ag Solution’s Champaign, Illinois, campus of Nutrien Digital, which was Agribility Inc.’s headquarters prior to Agribility’s acquisition by Nutrien Ag Solutions. Paul was a co-founder, and from 2012 to 2018 was the Chief Science Officer and Head of Product Development since the inception of Agribility Inc., a software development company. Paul earned a Ph.D. in ABE at Purdue. Later, he pursued the creation of Agribility Inc. The science and technology stack created at Agribility was the first of its kind and attracted more than 20,000 grower-users. Nutrien Ag Solutions, the world’s largest agricultural retailer, acquired Agribility Inc. in one of the top 10 ag tech business deals as of 2018. Paul is married to Sang S. Lee and they live in Champaign.

AMY PENNER, BS 2007, MS 2008

Amy, who grew up in Wabash, Indiana, graduated with Purdue degrees in Biological and Food Process Engineering. Amy started at Kraft Foods in R&D in Chicago and later moved to Oxford, UK, to launch new technology for an instant coffee product. After a restructure, she stayed with the newly formed Mondelez International to drive global process development of chewing gum. Then she led a team for an instant coffee manufacturing plant. Mondelez created the world’s largest pure coffee company, Jacobs Douwe Egberts (JDE), in 2015. Amy led the Technology Applications team for instant coffee across six plants. She completed her MBA at Oxford Brookes University. She spent two years in Singapore as Head of R&D Asia. In December 2018, Amy moved to Amsterdam, Netherlands, where she leads the Global Procurement team for Raw Materials at JDE.

STEPHEN “STEVE” E. POE, PH.D. 1987

Dr. Stephen E. Poe is a Professor and Extension Specialist in Biosystems Engineering and Agricultural Education at the University of Arizona. The Roan, Indiana, native earned BS and MS degrees in Agricultural Education at Purdue. While working as a lab assistant for AgEn 201, he became a graduate instructor for the Agricultural Engineering department in 1981. In 1987, he finished up one of the first graduate programs to focus on computer simulation and modeling. During his graduate teaching assistantship, Steve taught/co-taught 36 courses. Since 1998, he and his wife, Kitt, have been with the University of Arizona. Steve has become an accomplished instructor in high demand. In 39 years of teaching college, he has taught almost 8,000 students in 173 classes. He has authored nearly 100 publications, created dozens of computer programs, and has educational videos with more than 3 million views.

SCOTT STRICKLAND, ASM, BS 2004

Scott Strickland works for CGB (Consolidated Grain and Barge Co.), whose core business revolves around the grain and transportation industries along inland river systems. Scott is in the Grain Division as a General Manager of the Midwest Region. After graduation he started working for CGB as a trainee in Mount Vernon, Indiana, then joined the Merchandising team. He managed a leased facility in Uniontown, Kentucky, then was Group Manager of the Western Ohio Valley Region. In summer 2011, Scott joined the Ohio Valley Regional Trading Team at Jeffersonville, Indiana. Two years later he became Group Manager of three facilities in the Northern Illinois Region. In spring 2015, Scott took on his current role, which has expanded to 35 grain facilities, 11 of which are river terminals. Scott resides in Princeton, Illinois, with his wife, Abby, and three children.

2018 Outstanding Students

Graduate Student, Ph.D.



GABRIELLA MENDES CANDIDO DE OLIVEIRA

She's a graduate of University of São Paulo in her native Brazil. Her Ph.D. research provides tools to relate the survival of microorganisms of importance to public health with

processing conditions used in traditional and innovative food processing technologies. She was a graduate teaching assistant for ABE 308, Heat and Mass transfer, and ABE 303, Application of Physical Chemistry to Biological Processes.

Graduate Student, Master's

AARON ETIENNE

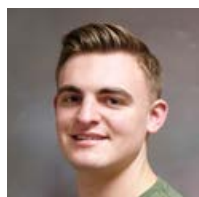


Aaron Etienne is a second-year master's student, studying under Dr. Dharmendra Saraswat in the Digital Agriculture Discovery group. Aaron earned his bachelor's degree from Southern Illinois University Carbondale in Agricultural Systems and Education. He will begin

a doctorate degree under Dr. John Lumkes. For his master's research, Aaron is developing an object detection system capable of spotting specific weed species in row crop fields.

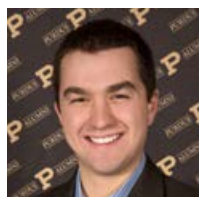
Seniors

ZANE GOTTSCHALK



The Rossville, Indiana, native will work for the mining division of Caterpillar in Decatur, Illinois, in the Engineering Rotational Development program after finishing his degree in Agricultural Engineering with a concentration in Machine Systems.

GRANT KNOBLOCH



After two summer internships with John Deere & Co. as a marketing intern, after graduation he'll stay with Deere as a Customer and Product Support Representative. The Wolcott, Indiana, native is majoring in Agricultural Systems Management with a minor in

Food & Agribusiness Management.

MARK GEE



A triple major (Biological Engineering, Biochemistry, and Agronomy) will help steer the Johnston, Iowa, native toward his goal of becoming an expert in engineering biological systems to improve water quality. In Biological Engineering, his focus is biomolecular

and cellular engineering. Mark was the Greenhab officer for the Purdue crew to the Mars Desert Research Station.

Juniors

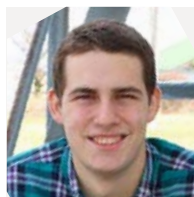
ADAM HEMMELGARN



After graduation the Noblesville, Indiana, native plans to get a job with an equipment manufacturer in product evaluation in testing. Adam is pursuing a degree in Agricultural Engineering with a concentration in Machine Systems Engineering. He is also working

toward earning a Certificate of Entrepreneurship and Innovation through the Krannert business school.

JEROD PUTT



The Agricultural Systems Management major grew up in Francesville, a small town about 40 miles north of West Lafayette. He worked on the family farm, a hog and grain operation, through high school. He has served as president of the Purdue Young Group, a

Christian organization on campus.

REED TRENDE



He is pursuing a dual degree in Biological Engineering and Biochemistry and has spent summers working for a medical device company and a University of Minnesota research lab, exploring immunological therapies to aid in organ allotransplantation. Reed

hopes to go on to graduate school to learn more about how engineering and biochemistry can be used to combat and eliminate diseases such as malaria and tuberculosis.

Sophomores



MEGAN CASEY

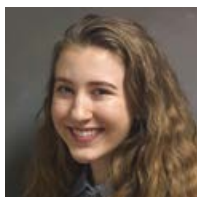
The Mason, Ohio, native is studying Agricultural Engineering with a concentration in Environmental and Natural Resources Engineering. She started an independent research project and presented her work at the ABE-GSA

Poster Symposium. The project goal is to determine if there is a correlation between access to urban green space and socioeconomic factors.



CHASE GRIPP

The Agricultural Systems Management major grew up on a 6th generation family farm in rural western Illinois. He's part of the National Agri-Marketing Association, Issues-360, Ag Council, and Dean's Scholars.



MARINA MEHLING

Marina Mehling is a Cellular and Biomolecular Engineering student within Biological Engineering and is pursuing minors in Biochemistry and Biotechnology. Marina has worked as a lab technician at a U.S. Department

of Agriculture facility outside her hometown of Phoenix, Arizona.

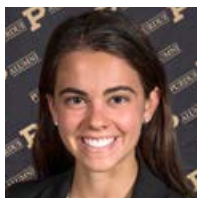
Freshmen



JAMIE WU

Jamie hopes to learn how to analyze data and utilize modern digital devices to improve crop production. The Agricultural Systems Management student grew up in an urban city in Taiwan, but volunteering at a sustainable

farming camp in the countryside piqued his interest in agriculture.



EMMA KEESLING

Emma is pursuing a degree in Food and Biological Process Engineering with a minor in Foods and Nutrition. She grew up on a corn and soybean farm in Modoc, Indiana. She hopes to work with World Vision, Compassion International

or similar organizations, teaching people in developing countries how to grow nutrient-rich food more sustainably.

New Faculty



DR. SOMALI CHATERJI

schaterji@purdue.edu

Assistant Professor Chaterji works in the areas of data science and engineering for digital agriculture and genomics and in building

cyberinfrastructures for these domains. She is a part of the WHIN (Wabash Heartland Innovation Network) leadership team, working to bring IoT to advance agriculture. As a second thrust of her work, she is extracting insights from epigenomic data for predictive and personalized healthcare, one in which health and vitality is the focus.

Degrees: Ph.D. in Biomedical Engineering from Purdue University, winning the Chorafas International Award (2010), College of Engineering Best Dissertation Award (2010), and the Future Faculty Fellowship Award (2009). Post-doctoral Fellowship at the University of Texas at Austin in the Department of Biomedical Engineering.



DR. ANKITA RATURI

ankita@purdue.edu

Assistant Professor Raturi most recently worked as a post-doctorate researcher at the Sustainable Agricultural Systems Lab at USDA

ARS. Her research areas include software engineering to model sustainability, energy management, remote sensing and hydro-meteorology. Generally, her work uncovers how to engineer programs for modeling sustainable agriculture.

Degrees: University of California Irvine, Ph.D. in software engineering, 2017.



DR. SHAWN EHLERS

sehlers@purdue.edu

Clinical Assistant Professor Ehlers joined the department in June 2019. Previously he held a post-doc position with the National

AgrAbility Project, where he served as the National Technology Outreach Coordinator. There he developed technical resources and identified products to assist farmers and ranchers with disabilities to regain the ability to perform agricultural tasks with a heightened level of independence.

Degrees: Purdue University, ABE, 2016; with specific focus in Agricultural Safety and Health.

Faculty/Staff Awards

Dr. John Lumkes

- Promotion to Assistant Dean, Office of Academic Programs
- Outstanding Department Teacher (Engineering)
- Dean A.A. Potter Faculty Excellence Award for Undergraduate Teaching
- Book of Great Teachers

American Society of Agricultural and Biological Engineers

- **Bernard Engel**, ADS/Hancor Soil and Water Engineering Award
- **Dharmendra Saraswat**, Standard Development Award
- **Klein Ileleji**, AESO Product Design Award

Kevin Solomon

- U.S Department of Energy Career Award

Daniel Ess

- Outstanding Department Teacher (Agriculture)

Martin Okos

- Outstanding Department Counselor

Jiqin Ni

- Outstanding Graduate Mentor

Ganesan Narsimhan

- Outstanding Mentor for Graduate Students
- Book published: "Aerated Foods, Principles, Formation and Stability"

Nate Engelberth

- Outstanding Service to Students

Abigail Engelberth

- Faculty Excellence Award for Early Career Teaching

Dennis Buckmaster

- 2019 NACTA Educator Award

Natalie Carroll

- Frederick L. Hovde Award of Excellence in Educational Service to the Rural People of Indiana, from Indiana Farm Bureau

Patents

Michael Ladisch, Brad Spindler, Brian Stater: Flow process for pretreatment of lignocellulosic biomass. No. 10,125,454. November 13, 2018.

Andrea Vacca, Gabriele Altare: Miniature high-pressure pump and electrical hydraulic actuation system. No. 10,138,908. Nov. 27, 2018.

Michael Ladisch, Nathan Mosier, Youngmi Kim, Justin vanRooyen: Liquefaction biomass processing with heat recovery. No. 10,144,785; Dec. 4, 2018.

Monika Ivtantsynova, Meika Ernst: Positive displacement machines and methods of increasing load-carrying capacities thereof. No. 10,247,177. Apr 2, 2019.

Gary Krutz, Grant Knies, Brittany Newell: Hydraulic hoses with life-sensing capability and methods thereof. No. 10,359,387. July 23, 2019/

Jonathan Claussen, Timothy Fisher, David Porterfield, David Jaroch, Anurag Kumar, Ronald Reifenberger, Guoping Xiong, Rajib Paul: Methods and apparatus for the fabrication and use of graphene petal nanosheet structures. No. 10,319,537. June 11, 2019.

Andrea Vacca, Ram Sudarsan Devendran: Variable delivery external gear machine. No. 10,393,114. August 27, 2019.

Student Accolades

Graduate

Femeena Valappil Pandara, New Faces of ASABE 2019

Femeena Valappil Pandara, Outstanding Research Award, College of Engineering
Val Schull, 2019 Staff/Graduate Student Unsung Diversity Hero Award, Diversity Action Team in Agriculture

Emma Brace, 2019 Emily M. Wadsworth Graduate Mentoring Award, Purdue Women in Engineering Program

Emma Brace, Outstanding Service Scholarship Award, College of Engineering

Stephen Miloro, Estus H. and Vashti L. Magoon Award

Zhihang Song, Estus H. and Vashti L. Magoon Award

Jennifer Stevens, National Science Foundation Graduate Research Fellowship

Casey Hooker, National Science Foundation Graduate Research Fellowship

Jennifer Stevens, Andres Fellowship, College of Agriculture

Mahmoud Nour, International Society for Agricultural Safety and Health (ISASH) Conference Student Award

Sarah Daly, Bilsland Dissertation Fellowship

Gnana Prasuna Desam, Bilsland Dissertation Fellowship

Nathaniel Brown, Ross Fellowship

Tae Sup Lee, Ross Fellowship

Gabe Wilfong, Graduate Teaching Award

Undergraduate

iGEM teams – Bronze medal in 2018, Bronze medal in 2019

Adam Hemmelgarn, K.K Barnes Student Research Competition, 3rd place (ASABE)

Marina Mehling, Research and Innovation Pillar, Purdue Homecoming Pillars of Excellency

Lauren Oparah, Elizabeth Tedder – Student Soybean Innovation Competition People's Choice Award (glitter)

Jamie Arabshahi, Ashley Otero, Janice Chan, Elena Haskins – Undergraduate Research Poster Symposium

Retirements

Dr. Daniel Ess was a part of the ABE faculty for nearly 25 years. He officially retired on May 15, 2019, after teaching thousands of hours and mentoring/advising thousands of Agricultural Systems Management students, several of whom returned for the celebration. Dr. Ess is Missouri-bound – "back home again." ABE wishes him all the best.

Obituaries

Ed Kirkpatrick's final Purdue paycheck was issued in November 2017. He was 95. He was 97 when he died on Feb. 27, 2019, in West Lafayette. He worked for Breaking New Ground/AgrAbility in ABE for more than 25 years as the primary shipping coordinator for BNG resources and as an editor of BNG publications. Prior to his BNG/AgrAbility work, Ed was an editor/writer for 19 years with the Agricultural Communication Service at Purdue.



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STAY IN TOUCH

We are always looking for news about our alumni and friends. Please send updates and news items to Carol Weaver, cmweaver@purdue.edu.