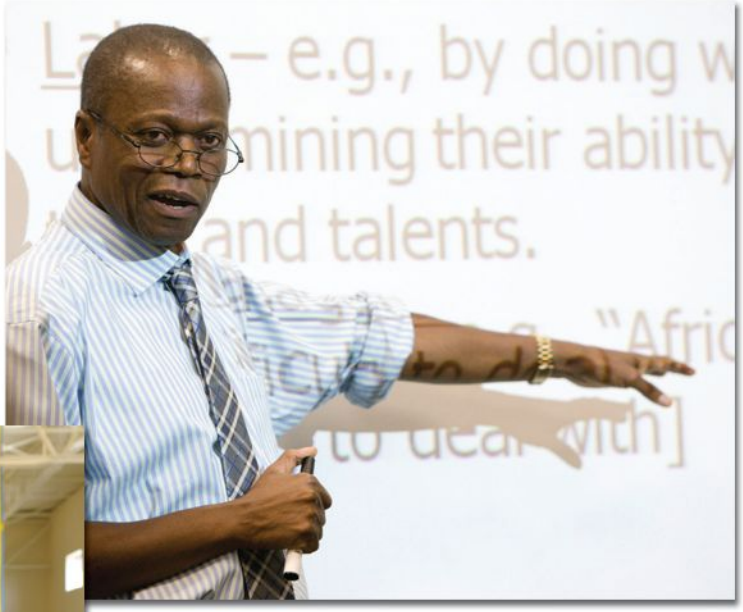
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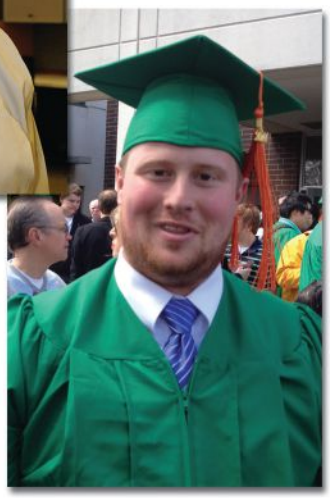
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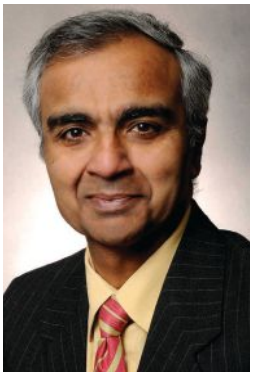


"At the Mic"

The Interview Issue

PUBLISHED BY AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS

The Global Potential of Ag and Bio Engineering



Our profession is gaining recognition. Case in point: ASABE has been named 2015 co-chair of DiscoverE (formerly known as Engineers Week), which we will lead with corporate partner Shell Oil. Related to that distinction, the theme selected for next year's Future City Competition will be "urban agriculture"—which is all about ag and bio engineering! To learn more about what lies ahead with DiscoverE, be sure to read this month's Last Word by ASABE Fellow and Past President Sonia Maassel Jacobsen and Dolores Landeck, ASABE Director of Public Affairs, who are leading our efforts. And for more information on DiscoverE, visit www.discovere.org.

In addition, the global appetite for affiliation with ASABE is creating further recognition of our profession. We can capitalize on this interest by reaching out to our sister organizations in other countries for hosting technical conferences at their locations and recognizing their unique needs and abilities. The grand challenges that we face call for collaborative solutions, and ASABE can best provide the vision, direction, and goals for the journey ahead. This effort will lead to membership growth, and it will ensure sustained recognition of our profession.

Meanwhile, the quest to provide value to our current and potential members is continuing. So far, our efforts to retain a greater percentage of student members have achieved mixed results. However, the growing recognition of our vital role in addressing the grand challenges should help in this task. Change is always difficult, but the rewards of capitalizing on our global potential far outweigh the disruptions of moving outside our comfort zone. The commitment of your Board of Trustees to enhance the marketing of ag and bio engineering, and of ASABE, is a great example of the kind of change we need.

Thank you all for the work that you've done and that you continue to do. It has been an honor to serve as your President. This past year has made me more confident than ever that the future of ASABE is bright, and that our profession will continue to feed and clothe a large and growing world.

Lalit R. Verma, P.E.
lverma@uark.edu

events calendar

ASABE CONFERENCES AND INTERNATIONAL MEETINGS
To receive more information about ASABE conferences and meetings, call ASABE at (800) 371-2723 or e-mail mtgs@asabe.org.

2014

July 12-13	**2014 Applications of Computer Image Analysis and Spectroscopy in Agriculture**. Montreal, Québec, Canada.
July 13-16	**ASABE and CSBE/SCGAB Annual International Meeting.** Montreal, Québec, Canada.

2015

Feb. 9-11	**Agricultural Equipment Technology Conference.** Louisville, Kentucky, USA.
May 3-5	**ASABE 1st Climate Change Symposium - Adaptation and Mitigation.** Chicago, Illinois, USA.
July 26-29	**ASABE Annual International Meeting.** New Orleans, Louisiana, USA.

2016

July 17-20	**ASABE Annual International Meeting.** Orlando, Florida, USA.

ASABE ENDORSED EVENTS

2014

July 16-18	**4th International Symposium on Soil Water Measurement, Using Capacitance, Impedance, and Time Domain Transmission.** Macdonald Campus of McGill University, Ste-Anne-de-Bellevue, Québec, Canada.
Sept. 16-19	**CIGR 2014.** Beijing, China.
Nov. 1-7	**2014 21st Century Watershed Technology Conference and Workshop.** University of Waikato, Hamilton, New Zealand.

July/August 2014
Vol. 21 No. 4

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Resource: Engineering & Technology for a Sustainable World (ISSN 1076-3333) (USPS 009-560) is published six times per year—January/February, March/April, May/June, July/August, September/October, November/December—by the American Society of Agricultural and Biological Engineers (ASABE), 2950 Niles Road, St. Joseph, MI 49085-9659, USA.

POSTMASTER: Send address changes to *Resource,* 2950 Niles Road, St. Joseph, MI 49085-9659, USA. Periodical postage is paid at St. Joseph, MI, USA, and additional post offices.

SUBSCRIPTIONS: Contact ASABE order department, 269-932-7004.

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ON THE COVER

Clockwise from upper left corner: Temple Grandin, William Kisaalita, Carey Smith, Kirk Gowen, and Brock Faulkner. *Microphone photo © jamesbin | Fotolia.com.*

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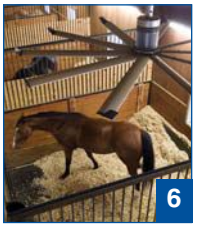
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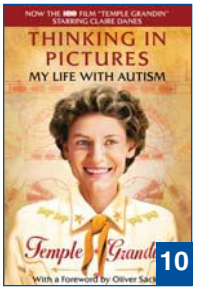
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engineering and technology for a sustainable world

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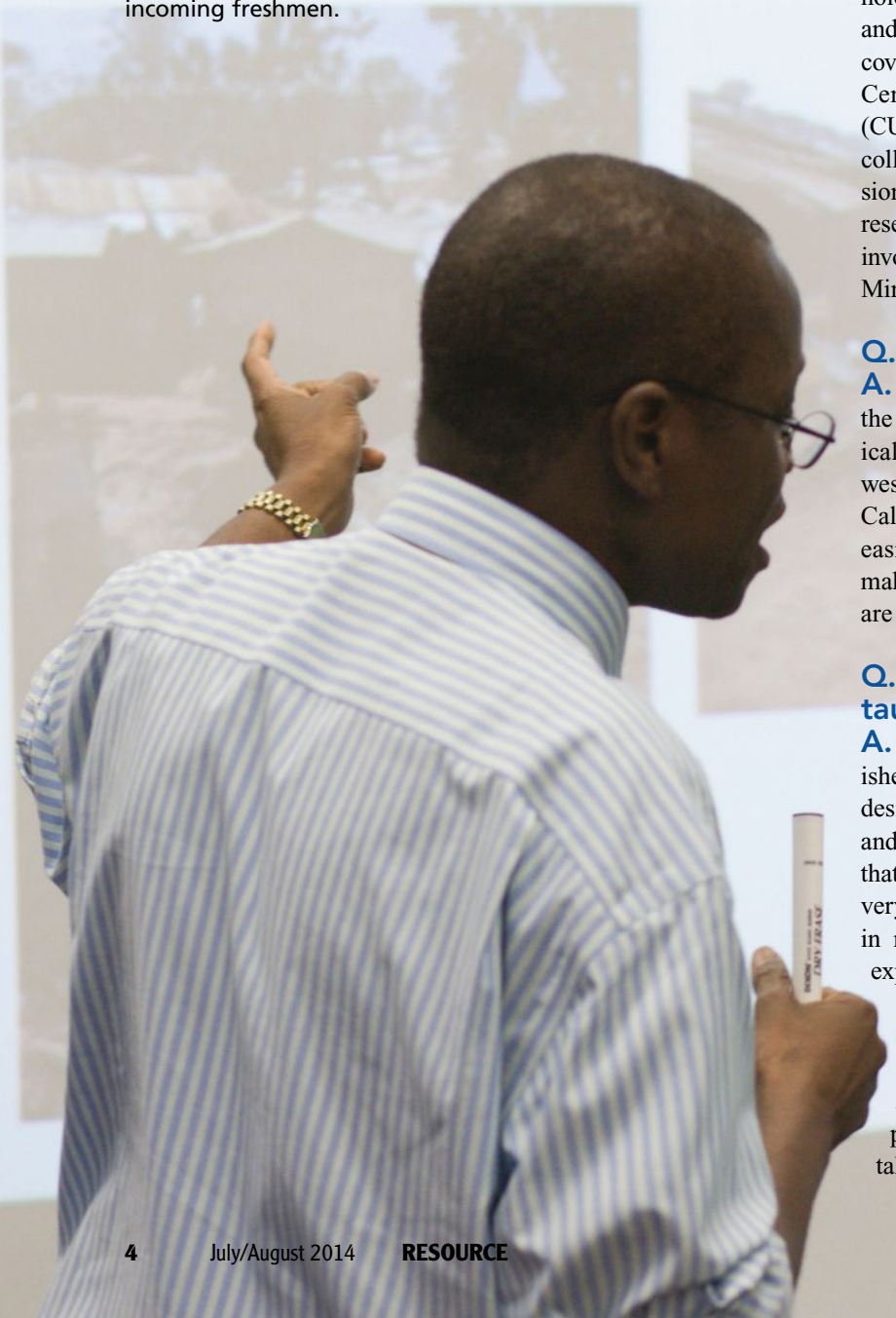
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A professor's broad perspective

William Kissalita

ASABE member William S. Kisaalita, professor and graduate coordinator at the University of Georgia (UGA), has developed research activities and international service-learning projects that have engaged students in helping to solve real-world problems. As noted in the previous issue of *Resource*, he recently received a $1 million grant to continue work on an evaporative milk cooler designed to help dairy farmers who lack access to refrigeration, particularly those in sub-Saharan Africa. Recently, Kisaalita was named UGA's Instructor of the Year and received a teaching award for his "First-Year Odyssey" class for incoming freshmen.



Q. Where did you earn your degrees?

A. I earned a PhD in chemical engineering from the University of British Columbia in Vancouver and a BS in mechanical engineering from Makerere University in Kampala, Uganda.

Q. What are your current responsibilities at UGA?

A. I am a professor of engineering with research responsibilities in two areas: Base of the Pyramid (BoP) technology development done with undergraduate students, and cell-based biosensors with applications in drug discovery. I was recently appointed associate director of the Center for Undergraduate Research Opportunities (CURO), with responsibilities for working directly with colleges, departments, and faculty to promote the expansion of CURO to all students interested in undergraduate research. I also work as a faculty mentor for students involved in the Peach State Louis Stokes Alliance for Minority Participation.

Q. What brought you to UGA?

A. I came to UGA in 1991 to do research, help develop the biological engineering curriculum, and teach biological engineering courses. We had an option to go out west, but the starter housing prices at the time in California made the decision to come to Georgia a bit easier. I thought I would get my career started here and make a move after five years or so, but 20 years later we are still here and enjoying our stay!

Q. What are your favorite courses taught, and why?

A. I have taught many courses at UGA. My most cherished experiences with students have been in engineering design project courses involving global service-learning and the companion summer research programs overseas that I developed. I get to know the students I travel with very well, and they get to know me very well. Watching in real-time and being part of these transformational experiences with the students is priceless.

Q. What interests you about your field?

A. For the work I do with undergraduates, I am most pleased with its "two-way street" nature. While it takes the students out of their comfort zone, it provides

real-world solutions to the problems of people at the bottom of the economic pyramid and enhances their earnings in a sustainable way. This approach—involving the development and deployment of simple technologies that are profitable for all those involved in the distribution chain—has been referred to by some as "social entrepreneurship." The profitable nature of entities built around the technology makes it easily scalable to other countries, reaching a wider population base. I am drawn to such activities.

For the bioengineering work, I am particularly drawn to answering fundamental questions that may lead to a practical value. For example, we are investigating how to create microenvironments in vitro that support cells to grow and mature like they do in the human body, so we can use them to lower the cost of discovering new drugs.



Q. How does your research or scholarship inspire your teaching? And can you describe your ideal student?

A. These two questions go well together for me. Research in its simplest form is like putting together a complex picture puzzle. You can try different pieces to see if they fit, and if you get enough put together, the true picture begins to emerge. I find this mindset very helpful in my teaching. The students and I "try different pieces" until they get it.

It is difficult to answer the ideal student question. It is like beauty—you know it when you see it. If I am forced to think about it, my ideal student is one who is not afraid to ask a "stupid" question that may turn out to be the "puzzle piece" that unlocks the class's trajectory to the "picture." One who is not afraid to fail—failure is an integral part of success. One who does not hesitate to engage in meaningful out-of-the-classroom activities locally or globally.

Q. What do you hope students gain from their classroom experience with you?

A. I have four goals. First, I want the students to learn as much as they possibly can in my class. Second, I want to foster an appreciation for the relationship between theory and solutions to real-world problems. Third, I want students to learn to make connections across disciplinary, national, and cultural borders—today's graduates are occupying workplaces and communities that have been transformed. Fourth, I want to prepare the students for life-long learning.

Q. Your favorite place to be or thing to do on campus is…?

A. Going to the Chapel to listen to the interesting speakers who come to this campus. Beyond the UGA campus, I like to go to the mountains with my family, especially in the fall.

Q. What does your community or civic involvement include?

A. When my children were young, we used to referee soccer games together in Athens and surrounding counties when they were not playing. Also, as an elder, I have previously led my church's outreach activities for the Athens area.

Q. What's your favorite book?

A. *The Contrarian's Guide to Leadership* by Steven B. Sample.

Q. What's your proudest moment at UGA?

A. My proudest moment at UGA was in 2004 when I was the first faculty member to receive the Mentor of the Year for Undergraduate Research Award.

Q. Finally, what are your plans for the future?

A. As a little boy, I was fascinated by my father's World War II medals. As I grew older, I learned that he fought in Burma (renamed Myanmar) under the British Command in one of the African Rifles Regiments. I have always wanted to know what it was like for him and his fellow Africans. He was reluctant to talk, and I learned not to press. I have read all the important books written about the China Burma India Theater, and there is no account from the perspective of the Africans. Fortunately, I have managed to talk to a few of his friends who are still with us, and I hope I will be able in the future to make their collective experience accessible in their own voices.

Q developed and administered by the Office of the Senior Vice-President for Academic Affairs and Provost, University of Georgia, Athens, USA. *Photos supplied by Mickey Y. Montevideo, Public Relations Coordinator, UGA College of Engineering.*

A successful business with a memorable name

Carey Smith



Carey Smith is the CEO of Big Ass Solutions, an AE-50 award-winning manufacturer of high-volume, low-speed fans and lights for agricultural, industrial, commercial, and residential use. Based in Lexington, Kentucky, his company's innovations and business sense extend around the world. In this interview, he takes a break from his busy schedule to answer a few questions for *Resource*.

Q. Big Ass Fans was founded in 1999 as the HVLS Fan Co. The company's name was changed in 2002 and caused a little stir. Can you tell us about that?

A. Our ceiling fans first hit the market in 1999 with the unremarkable brand name "HVLS Fan Company," as a nod to the concept of moving high volumes of air at low speeds. After years of hearing our customers refer to our industrial models as "big ass fans," we adopted the name and our mascot, Fanny the donkey.

When we announced our new name—Big Ass Fans—in 2002, postmasters in several states refused to mail our postcard campaign. Now, though, it's rare to hear any real criticism, outside of a handful of phone calls from the most straight-laced people who make it onto our mailing list.

One drawback of our name is that it leads people to think we're not serious about anything, so we work twice as hard at engineering the absolute best products and providing top-notch service to let them know that's not the case.

Q. Your company's fans use airfoils instead of flat blades to produce aerodynamic force, as well as onboard variable-frequency drives. Can you briefly explain why this was a breakthrough in agricultural settings?

A. Our fans use aerodynamic airfoils, inspired by airplane wings, to provide optimum airflow at the lowest possible operating cost. The fans can have as many as ten airfoils that slowly revolve to create a massive, gentle current of air in all directions. Because they move vast volumes of air, the fans create a cooling effect over large areas. This consistent air circulation helps move the air around common obstructions that are found in agricultural settings. Ensuring an even distribution of area eliminates "hot spots" and allows all occupants of a facility to feel cool.

The onboard variable-frequency drive (VFD) controls are prewired to the motor, requiring only a single electrical run from the breaker panel to the fan. This allows a minimal distance between the motor and the VFD controller, which eliminates the electromagnetic and radio frequency interference that is prevalent in older technology. Eliminating this noise reduces the chance of the fans interfering with other systems commonly found in agricultural settings, including electronic identification and robotic milking systems. Additionally, the onboard VFD provides simple integration into building automation systems, allowing owners and operators to easily control the fans.

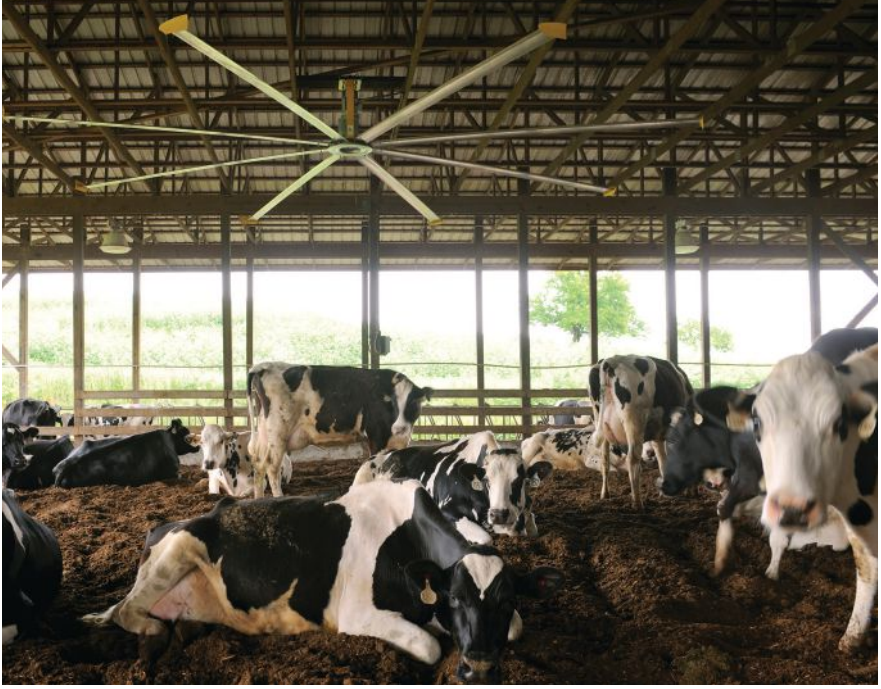
Q. *Forbes* added Big Ass Solutions to its list of "America's most promising companies," and *Inc.* added the company to its "Inc. 5000" list of the fastest-growing private companies in the United States and cited it as one of America's top job creators. And Big Ass Solutions has been named one of Kentucky's "best places to work." What makes your company's day-to-day so good?

A. We feel strongly about offering employees excellent pay and a challenging and rewarding work environment. The average wage for all employees exceeds the national average by nearly 30% and exceeds the average in Kentucky, where we are based, by 50%.

While our labor costs might be higher, we have much lower turnover and training expenses. When employees get the itch to try something new, they often do it here at the company. I encourage employees to rotate into different jobs because that gives them a broader perspective of the company, plus it keeps them happy and motivated. I describe the employees here as a tribe, and I am passionate about ensuring that everyone is well-cared for by the company.

Q. Last year, your company received an Innovation Award from *Green Manufacturer* magazine. Elaborate on your dedication to sustainability efforts.

A. Sustainability is crucial to our success, and we promote the concept in our products, facilities, and practices. Big Ass



Fans represent a major opportunity for energy savings—a core principle of sustainability. In recent decades, people have turned to air conditioning and heating for comfort, ignoring that our ancestors used fans for centuries. The breezes produced by Big Ass Fans make you feel up to ten degrees cooler, so you can raise your thermostat and feel just as comfortable while using far less electricity. People typically save up to 30% on their energy bills. In winter, Big Ass Fans push heat down from ceilings, creating uniform temperatures so your heater runs less. Interior designers use them to reduce unsightly ductwork. Less air conditioning tonnage is also required.

We walk the walk on sustainability, too. Our testing lab, which achieved LEED Gold certification, uses 35% less energy and 58% less water than a building meeting minimum code requirements. By employing an innovative design practice during construction, 9% less construction materials were used and 51% less landfill waste was generated compared to typical construction projects. At our new headquarters, an array of Big Ass Fans allowed us to install 10% less air conditioning capacity and save approximately $200,000 in construction materials by eliminating ductwork. We reduce water consumption by 17,000 gallons per year and reuse 15,000 pounds of scrap materials annually. In addition, more than 20 of our employees are LEED certified to provide customers with expertise on sustainable building.

Q. From donations to Iowa flood victims, families on "Extreme Makeover: Home Edition," and Haiti relief efforts to Christmas toy drives, SPCA, and non-profits like Art Start and homeless sheltering, your company does its part. What drives you to pay it forward?

A. When you have the means and resources to serve the larger community, it's a natural drive to want to do so. We have many unique outreaches. Recently, we've partnered with student groups to educate them about the ease and effectiveness of conservation through air movement. We're working with DesignBuildBLUFF, a program run through the University of Utah that gives students the chance to design and build a new home for a deserving Navajo family in Bluff, Utah. Native Americans living on or near tribal land face some of the worst housing conditions in the country.

Q. In addition to being named the 2011 Entrepreneur of the Year by Ernst & Young, *Inc.* named you an Economy Hero. Despite the downturn, your company continued to grow. Tell us about your constant investment in engineering that keeps you ahead of the pack.

A. During the recession, we refused to lay anyone off. As a result, we've grown from $34 million in annual revenue to $122 million in 2013. During that same period, our workforce nearly quadrupled, from 130 to 480 people.

When other businesses were scrambling to rehire employees once the economy picked up, we were ready to hit the ground running. We didn't have to spend time and resources training new employees, which allowed us to focus on research and development of new products. In our 44,000 square foot testing lab, we conduct complete fan performance testing, including air velocity profiles, fatigue testing of fan components, and prototype builds of the newest and most cutting-edge fan innovations.

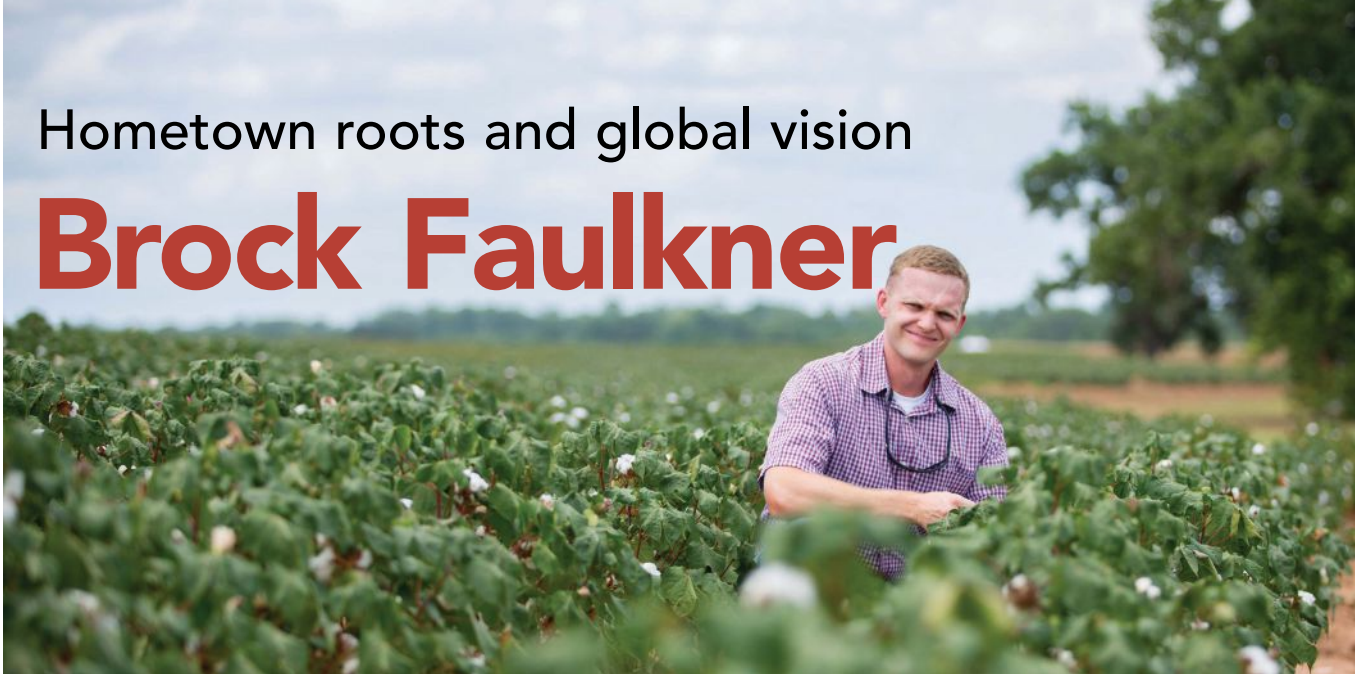
Q. How do you hire? What questions do you ask?

A. The main qualifications you need to succeed here are intelligence and a willingness to work hard. From there, we'll find the role that fits you best. And we recognize that can change over time. We encourage our employees to change roles to avoid burnout in any one area, often noting how you don't have to leave the company to change jobs. We're a company where everyone knows they can shape our future. In fact, I always tell each employee that Big Ass Solutions is the closest you'll ever get to running your own business without the capital, because everyone here is their own entrepreneur.

Q. What advice do you have for graduating agricultural and bioengineering students?

A. Look for the niches that are underserved, regardless of the field. These spaces are full of opportunity to improve efficiency, and in turn create better working environments and practices. Instead of looking at traditional models and methods of doing things, it is important to take a contrarian approach. Outstanding work often comes by way of not fitting into the mold.

Q supplied by *Resource* and administered by Megan Browning, Public Relations Associate, Big Ass Solutions. *Photos supplied by the company.*



Hometown roots and global vision

Brock Faulkner

Staying in your hometown can help build a national reputation in your professional field—at least if you're **ASABE member W. Brock Faulkner, P.E.,** a fifth-generation resident of Brazos County, Texas, and an agricultural engineer. In this interview, Faulkner discusses his deep roots in cattle ranching, global demand for ag and bio engineers, and opportunities in developing countries.

Faulkner received his BS, MS, and PhD degrees from the Department of Biological and Agricultural Engineering at Texas A&M University. Immediately after he completed his doctorate in 2008, the department hired him as a faculty member. Faulkner's research deals with two overlapping topics: cotton processing and air quality. Texas cotton farmers have used his results to make critical choices about harvesting methods. Another of his projects helped change emissions guidelines for almond harvesting operations in California.

In 2009, Faulkner was named Young Engineer of the Year by the Texas Section of ASABE. In 2012, he received the Dean's Early Career Research Award from Texas A&M's College of Agriculture and Life Sciences. Since becoming a faculty member, Faulkner has secured over $3.1 million in research funding.

Q. How did you end up in biological and agricultural engineering?

A. My family ranched, so I was always interested in agriculture. And I was pretty good at math and science in high school. I took the introductory course to agricultural engineering, and a couple of things happened. One, I realized the breadth of issues that agricultural engineers deal with, and two, by the time I finished that course, there were three professors in my department who knew my name, knew where I was from, and that definitely made me feel at home. And when I got into our processing course that I now teach, I loved it. I started looking at processing and at air quality and got really excited about that, and that's what I do now.

Q. What exactly is "processing"?

A. We produce a lot of agricultural commodities in this country. How do you harvest it, how do you transport it, how do you store it, how do you use it—everything from ginning cotton more efficiently to storing grain so it maintains its quality for milling or oil extraction—that's processing. How do we take our raw commodities and get them to our end products with the quality and quantity that is profitable for everybody along the supply chain.

Q. Any major questions in your field you'd like to tackle?

A. We have to bring good science to bear on policy. That's an evolving set of issues where I think there will always be exciting things for us to address. I think we can make great inroads into ensuring a safe and healthy environment and still allow inventive folks to pursue profitable enterprises. The other thing—I think there's tremendous opportunity to take the things we've learned in this country and put them to work in developing areas. We've got a growing global population, and we're going to have to feed and clothe it. I'll make no bones about it—I'm going to support American agriculture first. But there are things we can do to help developing countries that will not put us at a competitive disadvantage in the United States.

Q. What are ways we can help developing countries?

A. ASABE member Sergio Capareda [associate professor of biological and agricultural engineering at Texas A&M] is from the Philippines. He's done some great work helping to develop rural energy sources for the Philippines. I did some work to help folks in Central Asia figure out what they can do to get better-looking cattle. Kazakhstan is never going to compete with the United States for milk production, so I think we can help them with that development work.

Q. You are involved in ongoing studies attempting to pinpoint precisely how much ag and other industries are affecting nitrogen levels in Colorado near a national park. It's a warning-system endeavor. Tell us about the data you are collecting to commence a "pilot program" and what you hope to determine.

A. I'm not really involved in the nitrogen deposition measurement efforts at Rocky Mountain National Park, but I've worked for the Colorado Livestock Association as a consultant since 2006, and we've developed an "early warning system" to try to reduce agriculture's impacts on the park. In short, nitrogen deposition in the park is leading to undesirable ecosystem changes, and about half the nitrogen that is deposited is ammonia/ammonium, much of which comes from agricultural sources.

Even though the wind usually blows from the west in Colorado, most of the nitrogen is deposited during strong weather events that move air from the east up into the mountains. In our pilot project, we're sending out "meteorological-based warnings"—generated by my partners at Colorado State University—by email or text to participants that warn of an upslope weather event and ask them to refrain from certain "high emission" practices during days when those emissions are likely to move into the park, practices like scraping pens, turning compost piles, spreading manure, etc.

For the pilot project, producers are asked to respond to warnings by indicating whether they're changing their practices or not. If they aren't, we ask them why not, and we give them options ranging from "labor availability" to "other weather concerns" to "you send too many of these warnings, and I don't believe you anymore." During the pilot project, we're trying to build the infrastructure for a warning system and assess whether such a system has a reasonable chance of reducing nitrogen deposition in the park if it were adopted regionally. We launched the pilot on April 1 of this year, and we're excited to see how it goes. [More information can be found at www.rmwarningsystem.com.]

Q. What do you tell students interested in agricultural and biological engineering?

A. It's a fun place to be. *Forbes* magazine has said that ag engineering is going to be one of the most in-demand professions as we go forward. We're trying to feed a growing population with limited resources. We're trying to provide clothing. We're trying to provide fuel. There are tons of opportunities out there. Our Agricultural Systems Management curriculum is a phenomenal program for students who enjoy agriculture and enjoy business and want to put those together. Several of our ag systems management grads are part of the Aggie 100, the 100 fastest-growing Aggie-owned businesses. They get the foundation for business and management and for building good relationships at Texas A&M.

Q. You have a long history with Texas A&M. What's so special about the university?

A. On my dad's side, we're third-generation Aggies. On my mom's side, the earliest graduate that we can find graduated from A&M in 1895. My brother and I always wanted to come here. I managed to stay around. When I got my PhD, I interviewed at other places. But I loved doing air quality stuff and loved working with the cotton industry, and this was the only place I could do both. I was very fortunate to have support from people I had worked with, wanting me to stay. The other side was that my grandfather, who ran our ranch, was not doing well and we wanted to stay around. I love working with students and I love the research we are doing, so there's every reason to stay.

Q. Tell us about the ranch.

A. I run our place. We raise pasture-fed beef and sell it directly to consumers. Our place is about 12 miles outside of town in Brazos County. We raise Limousin and Beefmaster cattle and finish them on grass, get them custom-processed down in Navasota, and deliver meat to folks. I run a cow-calf operation all the way through to when ready to be eaten.

Q. How do you find the time?

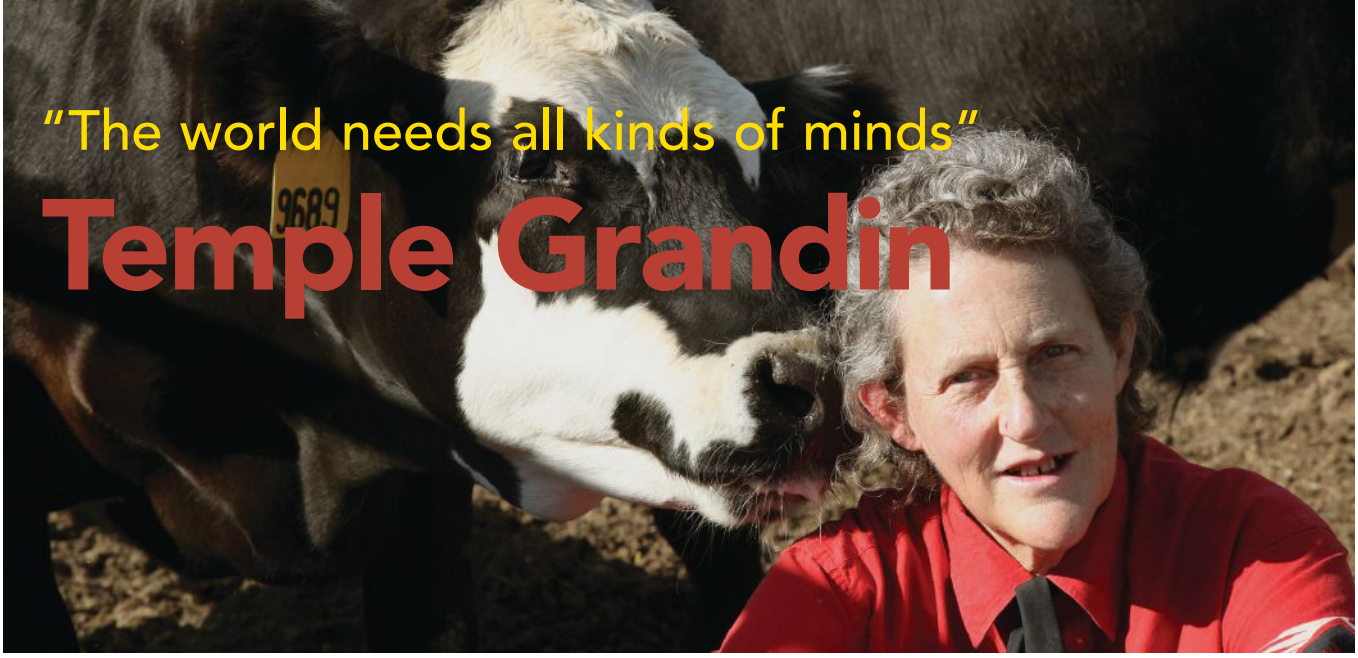
A. I'm a very busy person and very disciplined at time management. But my kids love it out at the ranch. My wife and I are trying to build a house out there. It's something that our family enjoys doing together. It's work, but it's fun, too.

Q developed and administered by Olga Kuchment, Texas A&M AgriLife Communications. *Photos provided by Texas A&M University, College Station, USA.*

Dr. Faulkner was diagnosed with leukemia in February and, at press time, is undergoing treatment in Houston at the University of Texas MD Anderson Cancer Center. Both Brock and his wife Brittney are grateful for prayers and encouragement from family and friends.

www.caringbridge.org/visit/brockfaulkner
http://www.kbtx.com/news/local/headlines/Aggies-Support-Sick-Professor-251838511.html





"The world needs all kinds of minds"

Temple Grandin

ASABE member Temple Grandin is a professor at Colorado State University, a best-selling author, and a consultant to the livestock industry on animal behavior. The subject of an award-winning 2010 biographical film, she also was listed in the "Time 100" list of the most influential people in the world in the "Heroes" category. Diagnosed with autism as a child, Grandin talks about how her mind works—sharing her ability to "think in pictures," which helps her solve problems that neurotypical brains might miss. She makes the case that the world needs people on the autism spectrum: visual thinkers, pattern thinkers, verbal thinkers, and all kinds of smart geeky kids.

I think I'll start out and just talk a little bit about what exactly autism is.

Autism is a very big continuum that goes from very severe—the child remains non-verbal—all the way up to brilliant scientists and engineers.

It's a continuum of traits. When does a nerd turn into Asperger, which is just mild autism? I mean, Einstein and Mozart and Tesla would all be probably diagnosed as autistic spectrum today. And one of the things that is really going to concern me is getting these kids to be the ones that are going to invent the next energy things.

OK. Now, if you want to understand autism: animals. And I want to talk about different ways of thinking. You have to get away from verbal language. I think in pictures, I don't think in language. Now, the thing about the autistic mind is it attends to details. There is a test where you either have to pick out the big letters, or pick out the little letters, and the autistic mind picks out the little letters more quickly.

And the thing is, the normal brain ignores the details. Well, if you're building a bridge, details are pretty important because it will fall down if you ignore the details. And one of my big concerns with a lot of policy things today is things are getting too abstract. People are getting away from doing hands-on stuff. I'm really concerned that a lot of the schools have taken out the hands-on classes, because art and classes like that—those are the classes where I excelled.

In my work with cattle ...

I noticed a lot of little things that most people don't notice would make the cattle balk. Like, for example—flag waving, right in front of the veterinary facility. This feed yard was going to tear down their whole veterinary facility; all they needed to do was move the flag. Rapid movement, contrast. In the early '70s when I started, I got right down in the chutes to see what cattle were seeing. People thought that was crazy. A coat on a fence would make them balk, shadows would make them balk, a hose on the floor ... people weren't noticing these things—a chain hanging down—and that's shown very, very nicely in the movie. In fact, I loved the movie, how they duplicated all my projects. That's the geek side. My drawings got to star in the movie, too. And actually it's called "Temple Grandin," not "Thinking In Pictures."

So, what is thinking in pictures?

It's literally movies in your head. My mind works like Google for images. Now, when I was a young kid, I didn't know my thinking was different. I thought everybody thought in pictures. And then when I did my book, *Thinking In Pictures*, I started interviewing people about how they think. And I was shocked to find out that my thinking was quite different. Like if I say, "Think about a church steeple," most people get this sort of generalized generic one. Now, maybe that's not true, but it's going to be true in a lot of different places. I see only specific pictures. They flash up into my memory, just like Google for pictures. And in the movie, they've got a great scene in there where the word "shoe" is said, and a whole bunch of '50s and '60s shoes pop into my imagination.

OK, there is my childhood church, that's specific. There's some more, Fort Collins. OK, how about famous ones? And they just kind of come up. Just really quickly, like Google for pictures. And they come up one at a time, and then I think, "OK, well maybe we can have it snow, or we can have a thunderstorm," and I can hold it there and turn them into videos.

Now, visual thinking was a tremendous asset in my work designing cattle-handling facilities. And I've worked really hard on improving how cattle are treated at the slaughter plant. I'm not going to go into any gucky stuff. I've got that stuff up on YouTube if you want to look at it. But, one of the things that I was able to do in my design work is I could actually test-run a piece of equipment in my mind, just like a virtual reality computer system. There is an aerial view of a recreation of one of my projects that was used in the movie. That was like just so super cool. And there were a lot of kind of Asperger types and autism types working out there on the movie set, too. But one of the things that really worries me is: Where's the younger version of those kids going today? They're not ending up in Silicon Valley, where they belong.

Now, one of the things I learned very early on because I wasn't that social, is I had to sell my work, and not myself. And the way I sold livestock jobs is I showed off my drawings, I showed off pictures of things. Another thing that helped me as a little kid is, boy, in the '50s, you were taught manners. You were taught you can't pull the merchandise off the shelves in the store and throw it around.

Now, when kids get to be in third or fourth grade, you might see that this kid's going to be a visual thinker, drawing in perspective. Now, I want to emphasize that not every autistic kid is going to be a visual thinker. Now, I had a brain scan done several years ago, and I used to joke around about having a gigantic internet trunk line going deep into my visual cortex. In tensor imaging, my great big internet trunk line is twice as big as the control's.

And some of the research now is showing is that people on the spectrum actually think with primary visual cortex. Now, the thing is, the visual thinker's just one kind of mind. You see, the autistic mind tends to be a specialist mind—good at one thing, bad at something else. I was bad at algebra. And I was never allowed to take geometry or trig. Gigantic mistake: I'm finding a lot of kids who need to skip algebra, go right to geometry and trig.



Now, another kind of mind is the pattern thinker.

More abstract. These are your engineers, your computer programmers. Pattern thinking. Here are the types of thinking: photo-realistic visual thinkers, like me; pattern thinkers, music and math minds. Some of these often times have problems with reading. You also will see these kind of problems with kids that are dyslexic. You'll see these different kinds of minds. And then there's a verbal mind; they know every fact about everything.

Now, another thing is the sensory issues. Some kids are bothered by fluorescent lights; others have problems with sound sensitivity. You know, it's going to be variable.

Now, visual thinking gave me a whole lot of insight into the animal mind. Because think about it: An animal is a sensory-based thinker, not verbal—thinks in pictures, thinks in sounds, thinks in smells. Think about how much information there is there on the local fire hydrant. He knows who's been there, when they were there. Are they friend or foe? Is there anybody he can go mate with? There's a ton of information on that fire hydrant. It's all very detailed information, and, looking at these kind of details gave me a lot of insight into animals.

Now, the animal mind, and also my mind, puts sensory-based information into categories. Man on a horse and a man on the ground—that is viewed as two totally different things. You could have a horse that's been abused by a rider. They'll be absolutely fine with the veterinarian and with the horseshoer, but you can't ride him. You have another horse, where maybe the horseshoer beat him up and he'll be terrible for anything on the ground, with the veterinarian, but a person can ride him. Cattle are the same way. Man on a horse, a man on foot—they're two different things. You see, it's a different picture. I want you to think about just how specific this is.

Now, this ability to put information into categories: I find a lot of people are not very good at this. When I'm out troubleshooting equipment or problems with something in a plant, they don't seem to be able to figure out, "Do I have a training people issue? Or do I have something wrong with the equipment?" In other words, categorize equipment problem from a people problem. I find a lot of people have difficulty doing that. Now, let's say I figure out it's an equipment problem. Is it a minor problem, with something simple I can fix? Or is the whole design of the system wrong? People have a hard time figuring that out.

Let's just look at something like, you know, solving problems with making airlines safer.

Yeah, I'm a million-mile flier. I do lots and lots of flying, and if I was at the FAA, what would I be doing a lot of direct obser-



vation of? It would be their airplane tails. You know, five fatal wrecks in the last 20 years, the tail either came off or steering stuff inside the tail broke in some way. It's tails, pure and simple. And when the pilots walk around the plane, guess what? They can't see that stuff inside the tail. You know, now as I think about that, I'm pulling up all of that specific information. It's specific. See, my thinking's bottom-up. I take all the little pieces, and I put the pieces together like a puzzle.

Now, there is a horse that was deathly afraid of black cowboy hats. He'd been abused by somebody with a black cowboy hat. White cowboy hats, that was absolutely fine. Now, the thing is, the world is going to need all of the different kinds of minds to work together. We've got to work on developing all these different kinds of minds. And one of the things that is driving me really crazy, as I travel around and I do autism meetings, is I'm seeing a lot of smart, geeky, nerdy kids, and they just aren't very social, and nobody's working on developing their interest in something like science.

And this brings up the whole thing of my science teacher.

My science teacher is shown absolutely beautifully in the movie. I was a goofball student. When I was in high school, I just didn't care at all about studying, until I had Mr. Carlock's science class. And he got me challenged to figure out an optical illusion room. This brings up the whole thing of you've got to show kids interesting stuff. Because I'm seeing a lot of these geeky nerdy kids, and the teachers out in the Midwest, and the other parts of the country, when you get away from these tech areas, they don't know what to do with these kids. And they're not going down the right path.

The thing is, you can make a mind to be more of a thinking and cognitive mind, or your mind can be wired to be more social. And what some of the research now has shown in autism is there may by extra wiring back here, in the really brilliant mind, and we lose a few social circuits here. It's kind of a tradeoff between thinking and social. And then you can get into the point where it's so severe you're going to have a person that's going to be non-verbal. In the normal human mind, language covers up the visual thinking we share with animals.

We've got to show these kids interesting stuff. And they've taken out the auto shop class and the drafting class and the art class. I mean art was my best subject in school.

We've got to think about all these different kinds of minds, and we've got to absolutely work with these kind of minds, because we absolutely are going to need these kind of people in the future. And let's talk about jobs. OK, my science teacher got me studying because I was a goofball that didn't want to study. But you know what? I was getting work experience. I'm seeing too many of these smart kids who haven't learned basic things, like how to be on time. I was taught that when I was eight years old. You know, how to have table manners at granny's Sunday party. I was taught that when I was very, very young. And when I was 13, I had a job at a dressmaker's shop sewing clothes. I did internships in college. I was building things, and I also had to learn how to do assignments.

You know, all I wanted to do was draw pictures of horses when I was little. My mother said, "Well, let's do a picture of something else." They've got to learn how to do something else. Let's say the kid is fixated on Legos. Let's get him working on building different things. The thing about the autistic mind is it tends to be fixated. Like if a kid loves racecars, let's use racecars for math. Let's figure out how long it takes a racecar to go a certain distance. In other words, use that fixation in order to motivate that kid, that's one of the things we need to do. I really get fed up when they, you know, the teachers, especially when you get away from this part of the country, they don't know what to do with these smart kids. It just drives me crazy.

What can visual thinkers do when they grow up? They can do graphic design, all kinds of stuff with computers, photography, industrial design. The pattern thinkers, they're the ones that are going to be your mathematicians, your software engineers, your computer programmers, all of those kinds of jobs. And then you've got the word minds. They make great journalists, and they also make really, really good stage actors. Because the thing about being autistic is, I had to learn social skills like being in a play. It's just kind of—you just have to learn it. And we need to be working with these students.

And this brings up mentors.

You know, my science teacher was not an accredited teacher. He was a NASA space scientist. Now, some states are getting it to where if you have a degree in biology, or a degree in chemistry, you can come into the school and teach biology or chemistry. We need to be doing that. Because what I'm observing is the good teachers, for a lot of these kids, are out in the community colleges, but we need to be getting some of these good teachers into the high schools.

Another thing that can be very, very, very successful is there is a lot of people that may have retired from working in the software industry, and they can teach your kid. And it doesn't matter if what they teach them is old, because what you're doing is you're lighting the spark. You're getting that kid turned on. And you get him turned on, then he'll learn all

the new stuff. Mentors are just essential. I cannot emphasize enough what my science teacher did for me. And we've got to mentor them, hire them.

And if you bring them in for internships in your companies, the thing about the autism, Asperger-y kind of mind, you've got to give them a specific task. Don't just say, "Design new software." You've got to tell them something a lot more specific: "Well, we're designing a software for a phone and it has to do some specific thing. And it can only use so much memory." That's the kind of specificity you need.

Oh, you've got a question for me? OK.

Q. You know, you once wrote, and I like this quote, "If by some magic, autism had been eradicated from the face of the Earth, then men would still be socializing in front of a wood fire at the entrance to a cave."

A. Because who do you think made the first stone spears? The Asperger guy. And if you were to get rid of all the autism genetics, there would be no more Silicon Valley, and the energy crisis would not be solved.

Q. So, I want to ask you a couple other questions, and if any of these feel inappropriate, it's okay just to say, "Next question." But if someone who has an autistic child or knows an autistic child and feels kind of cut off from them, what advice would you give them?

A. Well, first of all, you've got to look at age. If you have a two, three, or four year old, you know, no speech, no social interaction, I can't emphasize enough: Don't wait, you need at least 20 hours a week of one-to-one teaching. You know, the thing is, autism comes in different degrees. There's going to be about half the people on the spectrum that are not going to learn to talk, and they're not going to be working in Silicon Valley; that would not be a reasonable thing for them to do.

But then you get the smart, geeky kids that have a touch of autism, and that's where you've got to get them turned on with doing interesting things. I got social interaction through shared interest. I rode horses with other kids, I made model rockets with other kids, did electronics lab with other kids, and in the '60s, it was gluing mirrors onto a rubber membrane on a speaker to make a light show. That was like ... we considered that super cool.

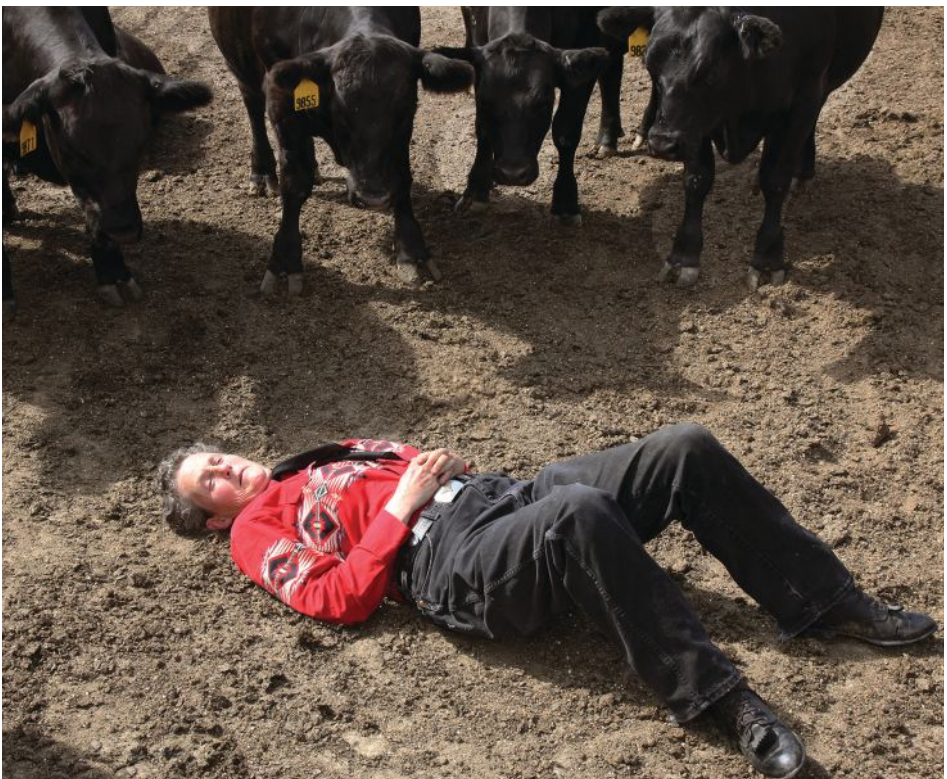
Q. Is it unrealistic for them to hope or think that that child loves them, as some might, as most, wish?

A. Well let me tell you, that child will be loyal, and if your house is burning down, they're going to get you out of it.

Q. Wow. So, most people, if you ask them what are they most passionate about, they'd say things like, "My kids" or "My lover." What are you most passionate about?

A. I'm passionate about the things I do that are going to make the world a better place. When I have a mother of an autistic child say, "My kid went to college because of your book, or one of your lectures," that makes me happy.

You know, the slaughter plants, I worked with them in the '80s; they were absolutely awful. I developed a really simple scoring system for slaughter plants where you just measure outcomes: How many cattle fell down? How many cattle got poked with the prodder? How many cattle are mooing their heads off? And it's very, very simple. You directly observe a few simple things. It's worked really well. I get satisfaction out of seeing stuff that makes real change in the real world. We need a lot more of that, and a lot less abstract stuff.



Q. When we were talking on the phone, one of the things you said that really astonished me was you said one thing you were passionate about was server farms. Tell me about that.

A. Well, the reason why I got really excited when I read about that, it contains knowledge. It's libraries. And to me, knowledge is something that is extremely valuable. So, maybe, over ten years ago now our library got flooded. And this is before the Internet got really big. And I was really upset about all the books being wrecked, because it was knowledge being destroyed. And server farms, or data centers, are great libraries of knowledge.

Q by Chris Anderson, content courtesy of TED.com.
Photos by Rosalie Winard, Colorado State University.

Meeting the future head on

Kirk Gowen



Pursuing a degree in agricultural and biological engineering is an exciting path, filled with problem solving, shoulder-to-shoulder teamwork, and skill-building experiences. **ASABE member Kirk Gowen** is a great example of what graduates in ag and bio engineering can accomplish. Originally from Grosse Pointe Woods, Michigan, a leafy suburb of Detroit, Gowen received his BS in biosystems engineering, with a concentration in food engineering, from Michigan State University last May. During his college career, he served as president of MSU's Biosystems Engineering Club and worked at the MSU Dairy Plant. In this interview, Gowen answers *Resource*'s questions as he prepares for his first job out of college—with Nestlé in Bakersfield, California.

Q. What important work experiences throughout your undergrad years were the best learning experiences? Tell us about your internships.

A. During the summer of 2012, I was an engineering intern at Coloma Frozen Foods in Coloma, Michigan. Coloma Frozen Foods provides the food industry with high-quality frozen fruits, vegetables, juices, and juice concentrates. For over 30 years, they have provided flexible solutions for frozen food and juice concentrate sourcing, and they handle "private label" needs as well. They also market food products with their own label—Nature Blessed—a wholly owned subsidiary. The concentrate made from tart Montmorency cherries, which are named for a valley in France, is a big seller in their online store.

The company is located in southwestern Michigan, the heart of America's Fruit Belt. The local growers are the source of premium crops for the baking industry, food service providers, retail grocery chains, and other parts of the food industry. The company's close proximity to Chicago and major interstate highways allows them to distribute products easily and cost-effectively across the country.

My experience there was a stepping stone to post-graduation employment. During my internship, I worked on several continuous improvement projects related to preventive maintenance and sanitary equipment design standards. These projects allowed me to gain a multidisciplinary understanding of the equipment used in post-harvest processing systems. While developing a framework for preventive maintenance in the juicing and freezing operations, I was able to gain valuable knowledge about performance indicators for centrifugal pumps, electric motors, compressors, heat exchangers, transslicing units, and many more unit operations.

The following summer, in 2013, I had an internship at Dreyer's Grand Ice Cream, a division of Nestlé USA in Ft. Wayne, Indiana. Nestlé has been named one of "the world's most admired food companies" by *Fortune* magazine for nearly 20 straight years, and true to that accomplishment, Nestlé brands, like Lean Cuisine and Toll House, have become household words. Nestlé USA, with annual sales of around $10 billion, is part of Nestlé S.A., which is based in Vevey, Switzerland. It's the world's largest food company, with annual sales of $98 billion.

Nestlé is a big company compared to Coloma Frozen Foods. But, as with Coloma Frozen Foods, I worked on several operations improvement projects in the engineering department, and there were many similarities. At Dreyer's, my internship project was focused on process improvements for spare parts storage. By combining my experience with optimizing logistics for preventive maintenance along with executing preventive maintenance tasks, I was able to grasp how important maintenance systems are to the overall productivity of any processing facility.

Long story short, I wouldn't trade my internship experiences for anything!

Q. What led you to ag and bioengineering? High school interests? Family? Friends? What's the story behind your choice of this field?

A. After a visit to Michigan State University, I fell in love with the campus and the biosystems engineering program that MSU offered. What really convinced me that I made the right decision to pursue biosystems engineering was the first class, BE 101, taught by **ASABE member Brad Marks**. During this introductory course, several industry representatives came to speak to us about potential internship and co-op opportunities. Those talks showed me a great path for gaining experience in my chosen field prior to graduation.

Later on, in a heat and mass transfer and thermodynamics class, I learned how valuable it is for food engineers to understand the principles of heating and cooling and how those principles relate to producing and maintaining a safe food supply. That is now my passion.

On a personal level, my cousin, Heath Calhoun, is a former U.S. Army staff sergeant who lost his legs after a rocket-propelled grenade hit his Humvee in Iraq in 2003. Heath is a double-leg amputee and has various prosthetic legs that help him be more mobile than I could ever have imagined. He won a silver medal in the Paralympics Alpine super-combined event last March—and he was featured on the Kellogg's Corn Flakes box, wearing his special skis! His perseverance in accomplishing his dreams, despite his condition, has inspired me to pursue my own goals just as relentlessly.



Fellow BAE graduate Patrick Sheridan, MSU Assistant Professor Gail Bornhorst, and Gowen at the 2014 MSU Biosystems Engineering Showcase.

Q. In your mind, what's the value of an ag and bio engineering degree? How does this degree make sense in today's world?

A. Over the next few decades, grads with BAE degrees will be facing some of the most difficult challenges that the world has to offer. How do we establish, sustain, and localize a reliable, safe, food supply for an additional two billion people? Problems of similar magnitude will be facing the biomedical, bioenergy, and environmental sectors.

Q. What should students who are considering this field look for while school shopping?

A. Explore the curriculum before making a decision. Most schools publish a curriculum guideline that explains what classes you have to take. Many will likely be similar, but they let you see exactly what classes you need to get your bachelor's degree. After finding out what classes are required, do some preliminary research on what those classes actually cover. And talk to the faculty. Professors, counselors, and industry advisors are there to help you! Find out what companies the graduates typically get hired by, and decide if they align with your goals for after graduation. And after you're in, stay organized! Use a calendar to keep track of important exam dates, homework due dates, and other necessary information. And find time to take some industry-related field trips.

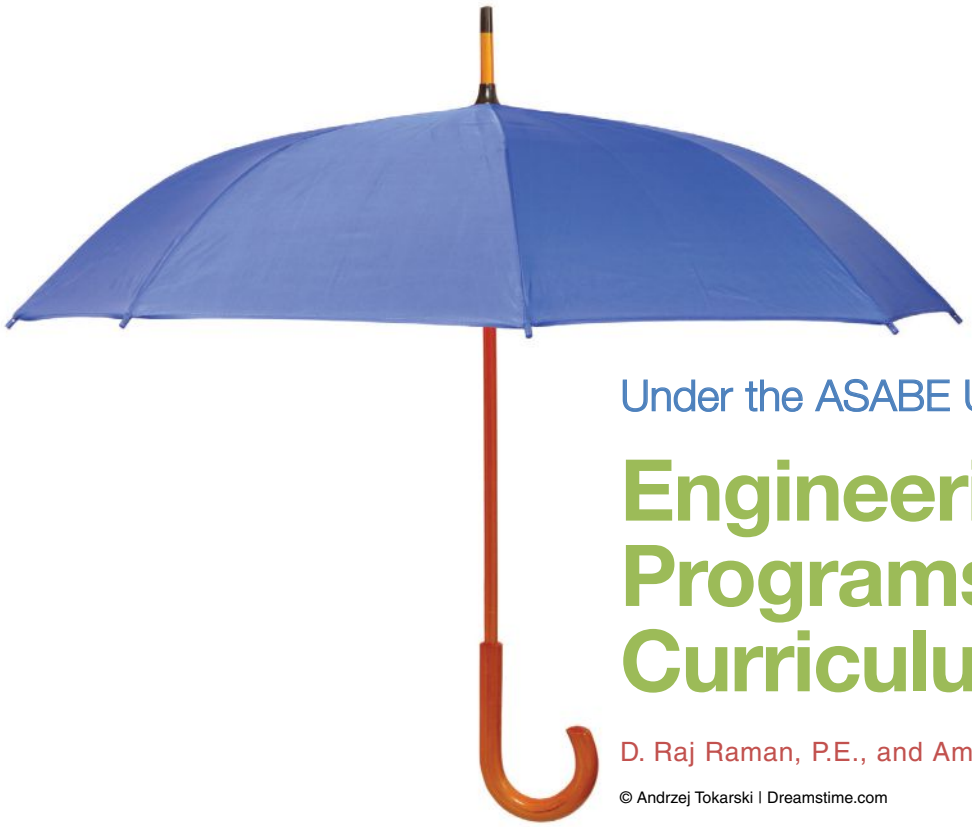
Q. What's the best part of being an active member of an ASABE student organization?

A. At meetings, students have the ability to network with guest speakers from industry, learn more about biosystems engineering opportunities on campus, and get to know other students within the major. It's invaluable on all three fronts.

Q. So what lies ahead?

A. After getting married in July, I look forward to making the move from Michigan to California, where I'll be starting as an operations management trainee at Nestlé USA. After my five-year rotation in that position, I'd like to work as a business unit manager within the company. Ultimately, I aspire to being a quality systems manager, division quality manager, or plant manager. In the meantime, my favorite TV show is "Diners, Drive-Ins, and Dives." I'm a sucker for good barbecue, and I intend to find some good places to try in California.

Q supplied and administered by *Resource*.
Photos courtesy of Gary and Donna Gowen.



Under the ASABE Umbrella

Engineering Degree Programs Need Curriculum Reform

D. Raj Raman, P.E., and Amy L. Kaleita

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The first-ever issue of *Transactions of the ASAE*, published in 1907, opens with a talk given by Howard W. Riley (after whom Riley-Robb Hall at Cornell University would later be named) that's modestly titled "The Courses in Agricultural Engineering that Should be Offered." Responses from several other luminaries, including J. B. Davidson (after whom Davidson Hall at Iowa State University would later be named), are included and make for fascinating reading for any student or practitioner of our discipline.

Riley describes the fundamental curricular challenge for our discipline thusly: "Our field is a broad one, our subjects cover work that ordinarily is divided between a number of colleges." He gives a nod to the need for local conditions to inform courses, noting in particular that drainage and irrigation coursework should be "more or less extended according to the requirements prevailing in the state." He also expresses the value of hands-on learning, saying: "[the student] will himself take a few simple examples of practical work right thru the different stages of their design and manufacture, thereby getting much clearer ideas of the different steps than he would get if he drew things that he never made and made things that he never drew."

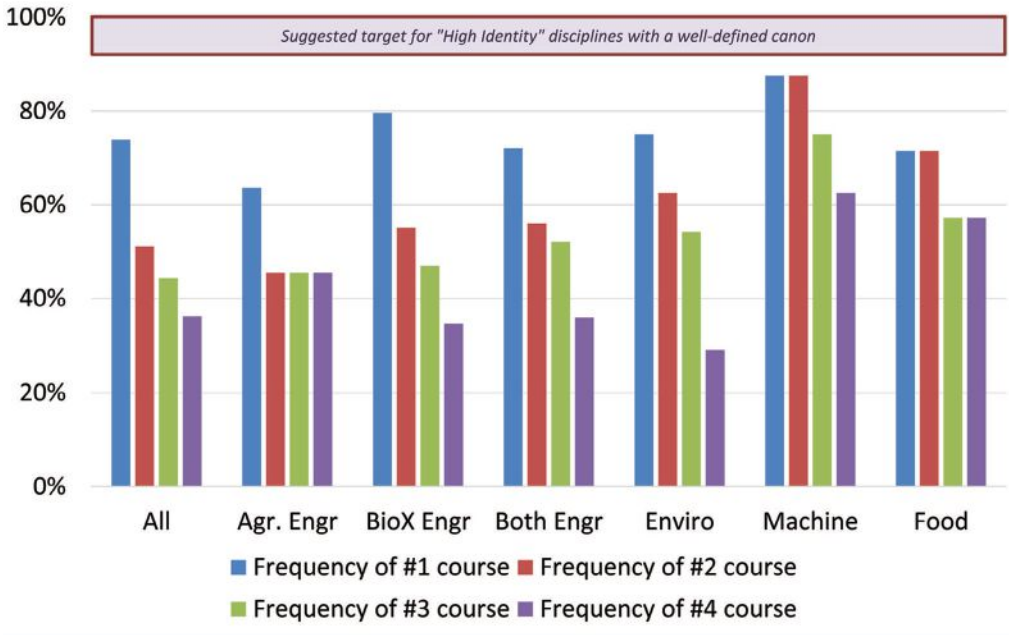
Riley goes on to explain that we should strive to provide our students with equal parts of self-reliance, common sense, ingenuity, and technical information so that they might be "provided with the best possible equipment for meeting the great variety of special problems" that they will eventually face. According to Riley, our core knowledge base should be built on courses in drawing, shop work, farm machinery, farm motors, field engineering, and rural architecture. In response, several commentators noted the similarities between Riley's vision and the curricula that they were offering at their own schools, although Professor John Evans (of Ontario Agricultural College) dissented slightly, saying: "Conditions vary and … no hard and fast course can be formulated."

Leading the discussion, Davidson agreed that there were many similarities, and concluded his comments with a recommendation: "A committee should be appointed at some future time to canvass the various institutions offering instruction in any of the branches of Agricultural Engineering and make a report to the Society covering the courses taught and the hours of class room and laboratory work allotted to each course."

One hundred years later

In the December 2012 issue of *Transactions of the ASABE*, we reported on the variation in the curricula of agricultural engineering, biological engineering, and similar academic programs. We undertook that work unaware of the conversations that took place long ago at the first meeting of our Society, but we were motivated by the same goals set forth by J. B. Davidson, namely, to attempt to canvas and summarize the state of the curricula in the academic programs that serve our broad discipline. For simplicity, we called these various programs "ASABE-umbrella programs" because they're all represented by the diverse membership of our Society.

What we found was not surprising. Although the academic programs that we evaluated share many core math, science, and basic engineering courses, the commonality drops off rapidly at the discipline-specific level. Furthermore, our analysis showed that the program names do not map clearly to the contents of their curricula. Since that earlier article appeared, we've received many thoughtful comments from colleagues in academic departments across the country. Several of them encouraged us to extend our analysis to



Frequency of the top four discipline-specific courses by academic program name: "All" represents all ASABE-umbrella curricula, "Agr Engr" represents curricula within programs called agricultural engineering, "BioX Engr" represents curricula within programs called biological engineering (or biological systems engineering, etc.), and "Both Engr" represents curricula within programs called agricultural and biosystems engineering (or biological and agricultural engineering, etc.). The last three groupings (environment, machine, and food) are common options within many degree programs, regardless of the program name.

describe the degree of commonality in discipline-specific coursework (that is, outside of core math, science, and engineering courses) when programs are grouped by name.

In our earlier article and here, we defined an academic program as any unique set of required courses. Depending on the institution and degree, it may be a degree program or a defined option with unique course requirements within a major.

The above graph shows our analysis broken down by academic program name. For reference, the top four courses in each program type are defined in the table on the next page. The results of this additional analysis confirm that the lack of commonality across the entire discipline (i.e., the first grouping in the graph) is more than just a symptom of the multitude of options offered. Even within specific options, we have significant diversity in course offerings. Bluntly put, other than general engineering topics, our discipline lacks a canon.

The path forward

The path that led to this collection of eclectic curricula has been complex. The agricultural crises of the 1980s made it challenging for many programs to maintain viable student numbers. Shifting demographics and agricultural practices, as well as differing visions regarding the mission and scope of the discipline, also played a role. However, the 21st century has brought enrollment growth to many of our programs. A multitude of factors can be credited for this growth, including recognition of the importance of renewable energy and materials for sustainable human development, a realization that global population trends will increase the demand for food, clean water, and perhaps bio-based transportation fuels, and a job market that values the systems perspective that our graduates can apply to engineering projects.

Some of this growth may also have been driven by the quality of education provided by typical ASABE-umbrella programs. For reasons about which we can only speculate (e.g., maybe Howard Riley's valuing of hands-on problem solving has become part of our curricular DNA), ASABE-umbrella programs are often a locus of outstanding engineering education on their campuses. As a result, just over a century since its founding, our discipline finds itself in the slightly paradoxical situation of strong student enrollment in highly disparate curricula.

This curricular diversity may contribute to a lack of identity that is not in the best long-term interest of the discipline. We believe it is time for a discipline-wide conversation about the costs and benefits of these disparate curricula, and about the potential value of defining and teaching an agreed-upon common core of courses. As we noted in our earlier article, diverse curricula have many advantages: they reflect the needs of regional stakeholders including employers and graduate programs, they fit the capabilities of the teaching faculty, and they mesh with the academic environment at a specific university. But this disparity in curricula also makes it hard to know exactly what a graduate of one of our programs can do, and this creates confusion in the minds of prospective employers, recent graduates, and even the faculty themselves. Therefore, to improve the long-term health of our discipline, we propose the following three-pronged approach:

1. Request that ASABE Committee ED-210 (Academic Program Administrators) promulgate a series of specific curricular proposals that broadly define our discipline. This will start the discipline-wide conversation that we need.

2. Provide an undergraduate engineering education that emphasizes the synergism between theoretical knowledge

Program Name	No. of Programs	Top Four Discipline-Specific Courses in Order of Frequency			
		First Course	Second Course	Third Course	Fourth Course
All Programs	88	Instrumentation and controls	Engineering properties of biological materials	Applications of mass and envery balances in ag and bio systems	Natural resource engineering
"Ag" Programs	11	Instrumentation and controls	Applications of mass and energy balances in ag and bio systems; Machiner systems; Natural resource engineering		
"Bio" Programs	49	Instrumentation and controls	Engineering properties of biological materials	Applications of mass and energy balances in ag and bio systems	Natural resource engineering
"Ag and Bio" Programs	25	Instrumentation and controls	Engineering properties of biological materials	Process engineering	Applications of mass and energy balances in ag and bio systems; Natural resource engineering
Environment (soil and water)	24	Natural resource engineering	Instrumentation and controls	Engineering properties of biological materials	Applications of mass and energy balances in ag and bio systems engineering analysis of biological systems; Nonpoint-source pollution
Machine	8	Instrumentation and controls; Machine systems		Engineering properties of biological materials	Natural resource engineering
Food	7	Instrumentation and controls; Engineering properties of biological materials		Food Engineering Biological reactors	

and practical application. This will translate into a virtuous cycle of increasing enrollment and strengthening placement opportunities for graduates.

3. Continue to hire faculty members from a wide range of disciplines—we are unusual in engineering academia in this regard—and be more effective at integrating them into our discipline and into ASABE. This will build on our current strengths.

In regard to proposal item 1, let's define a concise, but broadly acceptable, core knowledge base for the discipline. There should be at least one full semester (e.g., 12 to 15 semester hours equivalent) of discipline-specific coursework taken by students in all ASABE-umbrella programs. This represents a significant increase over the status quo, in which only two discipline-specific topics, equivalent to maybe six semester hours, are required in more than half the programs. This is not to argue that every graduate of an ASABE-umbrella program should be a power and machinery expert, or a soil and water expert, or a bioprocessing expert. Instead, it's intended to achieve a degree of commonality in undergraduate training across the discipline. We regularly require a similar amount of common coursework for minors at our institutions. Why not do the same for majors?

Our discipline is characterized by its unique embrace of biology and engineering in the context of natural resources production and protection. Our graduates should have experience with engineering approaches to biological systems ranging in size from microscopic to field scale, and they should be trained to make linkages across those scales. They should be familiar with instrumentation because our discipline relies on instrumentation in systems ranging from compost piles to UAVs, and because our instrumentation courses offer a unique opportunity to integrate multiple engineering concepts. With this in mind, here are four courses that might serve as a core for our discipline:

- Mass and energy balances in biological systems.
- Engineering properties of biological systems.
- Instrumentation and control applications in biological systems engineering.
- Ecological applications of soil and water engineering.

Our degree programs at Iowa State University do not include all of these courses, so it is not our intent to suggest that the common core is simply whatever we are currently doing at our campus. Instead, we propose these courses based on the results of our curricular analysis (many departments already offer similar courses) and because we believe that these courses provide a knowledge base that can be used in virtually all of the programs within our discipline.

Once ED-210 has developed its proposals, a consortium of stakeholders could review the proposals and make recommendations to the Society. The consortium could comprise key educational committees and employers across a range of industries. If ratified, each proposal could be codified into the ABET programmatic requirements for both "agricultural" and "biological" engineering degrees—although it seems

unlikely that the multiple societies that inform biological systems engineering degree requirements would be amenable to such a change. It might be more realistic to offer an ASABE-ratified recommendation for a core curriculum, which would serve as a target to which programs would aspire, rather than a requirement for accreditation.

In regard to proposal item 2, although we didn't collect data on hours of lab exposure for each curriculum, we believe that many ASABE-umbrella programs emphasize hands-on problem solving, and we also believe (based on our experience at Iowa State) that this trait is highly valued by employers. In fact, we believe that our discipline is uniquely positioned to provide clear linkages between theory and practice, and we should harness this strength in the service of the discipline, and of engineering education in general.

In regard to proposal item 3, executing proposal 1 will greatly facilitate this effort. We believe that it's crucial that the majority of faculty members in ASABE-umbrella programs consider themselves part of our discipline, and part of our Society, whatever their individual area of specialization.

This effort to "normalize" our academic curricula will take deliberation, time, and compromise—and it could make for some hurt feelings. It is certainly easier to live with the status quo and leave things as they are. However, this is not a discipline whose practitioners turn away from challenges. And given the grand challenges that the world is facing, the status quo just won't do. Our discipline has crucial contributions to make in the coming century, and educating the next generation of capable, practical, versatile engineers could be the greatest contribution of all. Let's get on with it.

ASABE members D. Raj Raman, P.E., Professor and Associate Chair for Teaching, and **Amy L. Kaleita, P.E.,** Associate Professor, Department of Agricultural and Biosystems Engineering, Iowa State University, Ames, USA; rajraman@istate.edu and kaleita@istate.edu.

*The authors thank **ASABE members Larry P. Walker, Alvin R. Womac, P.E., Stuart J. Birrell,** and **Mark R. Riley** for their thoughtful comments on preliminary versions of this article. They are particularly indebted to **ASABE Executive Director Darrin Drollinger** for pointing out H.W. Riley's work to them.*

The authors—along with other faculty members from across the United States and Canada interested in curricular issues—will be presenting on related topics at the AIM, Advancing the Core Curriculum in Biological Engineering special session, Monday, July 14, organized by Professor Ashim Datta of Cornell University. Check the AIM agenda for place and time.

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Examples from other engineering disciplines

As examples of how other wide-ranging, industry-oriented, engineering disciplines organize themselves, here are the 2013-2014 ABET program criteria for aeronautical engineering and architectural engineering and for two degrees that are within ASABE-umbrella programs.

Aeronautical Engineering

Aeronautical engineering programs must prepare graduates to have knowledge of aerodynamics, aerospace materials, structures, propulsion, flight mechanics, and stability and control. Astronautical engineering programs must prepare graduates to have knowledge of orbital mechanics, space environment, attitude determination and control, telecommunications, space structures, and rocket propulsion. Aerospace engineering programs or other engineering programs combining aeronautical and astronautical engineering must prepare graduates to have knowledge of aeronautical engineering or astronautical engineering, as described above, as well as knowledge of some topics from the area not emphasized. Programs must also prepare graduates to have design competence that includes integration of aeronautical or astronautical topics.

Architectural Engineering

The program must demonstrate that graduates can apply mathematics through differential equations, calculus-based physics, and chemistry. The four basic architectural engineering curriculum areas are building structures, building mechanical systems, building electrical systems, and construction and construction management. Graduates are expected to reach the synthesis (design) level in one of these areas, the application level in a second area, and the comprehension level in the remaining two areas. The engineering topics required by the general criteria must support the engineering fundamentals of each of these four areas at the specified level. Graduates are expected to discuss the basic concepts of architecture in the context of architectural design and history.

Agricultural Engineering (and similarly named programs)

The curriculum must include mathematics through differential equations and biological and engineering sciences consistent with the program educational objectives. The curriculum must prepare graduates to apply engineering to agriculture, aquaculture, forestry, human, or natural resources.

Biological Engineering (and similarly named programs)

The curriculum must include mathematics through differential equations, a thorough grounding in chemistry and biology, and a working knowledge of advanced biological sciences consistent with the program educational objectives. The curriculum must prepare graduates to apply engineering to biological systems.

For nursery and fruit tree crops

An Intelligent Sprayer

Heping Zhu



Conventional spray application in floral, nursery, and other specialty crop production requires excessive amounts of pesticide to achieve effective pest control. This excessive pesticide use has economic as well as environmental consequences. To address this problem, our research at the USDA-ARS Application Technology Research Unit has demonstrated that optimizing the spray coverage, rather than the spray volume, can reduce pesticide use by more than 50% and result in significant production cost savings. Until recently, to achieve the optimum spray coverage required for effective pest and disease control, spray applicators had to follow complex operational guidelines, which could vary for each situation.

This onerous procedure is now simplified by our new automated variable-rate, air-assisted precision sprayer, which minimizes human involvement in determining the amount of spray needed for pesticide applications. The spraying system determines the presence, size, shape, and foliage density of target trees and then applies the optimum amount of pesticide in real time. It integrates a high-speed laser scanning sensor (270° radial scan and 30 m range) with a non-contact Doppler radar travel speed sensor, a sophisticated nozzle flow rate controller, an embedded computer, touch screen control for the operator, and four independent five-nozzle manifolds on each side of the sprayer. Each nozzle is operated by its own PWM (pulse width modulation) controlled solenoid valve.



Embedded computer and touch screen.

Automatic control of the sprayer is achieved by the sensors and the embedded computer. To acquire the ground travel speed in real time, the travel speed sensor is mounted at the bottom of the sprayer. The laser scanning sensor, which is mounted between the tractor and the sprayer, detects the return signals from the tree canopies on both sides of the sprayer. An algorithm, written in C++, uses these signals to determine the presence of a tree canopy and calculate the canopy height, width, foliage density, and volume. It then determines the amount of spray for each vertical tree section and each sprayer travel speed.





Pest control and reliability tests for the new sprayers shown at Sunleaf Nursery LLP, Avon, Ohio (above) and Hans Nelson and Sons Nursery, Boring, Oregon (below).

Consequently, the application rate of each nozzle is optimized for each designated section of the canopy structure.

During spray applications, a diaphragm pump delivers spray solution from a 400 L onboard tank to the five flat-fan nozzles in each of the eight manifolds and into the airstream from an axial turbine fan. The nozzle flow rates are controlled by the flow rate controller, which is connected to the embedded computer by a wiring harness with pluggable connectors. Its two microprocessors generate flow rate commands to independently modulate the 10 Hz pulse width duty cycles of the solenoid valves for each nozzle. All 40 nozzles in the eight manifolds on both sides of the sprayer can thus independently discharge variable flow rates to their designated canopy sections. The entire sprayer unit mounts on a tractor with a three-point hitch, and the tractor's PTO system powers the spray pump and fan.

The embedded computer, touch screen, and switch box are mounted in the tractor cab. The touch screen displays the sprayer travel speed, total discharged spray volume, spray width, and active nozzles. The operator can use the touch screen to modify the spray parameters as needed. The toggle switches on the switch box allow the operator to activate the sprayer output on one or both sides in manual or automatic mode.

All the electronic devices are powered by the 12 VDC tractor battery. In addition, a small (10 × 6 × 2 cm) rechargeable battery provides backup power in case of a power failure or a power surge when starting the tractor. Another precaution includes a flat jet mounted on the top of the laser sensor that provides an air stream from the sprayer fan to prevent dust and droplets from landing on the sensor surface.

The USDA-ARS Application Technology Research Unit has built several prototype sprayers at a cost of $21,000 per unit, and we are currently testing them for their pest control efficacy, reliability, and durability in commercial nurseries in Ohio, Oregon, and Tennessee. So far, these field experiments have shown that the precision sprayer reduces the variation in spray deposition due to changes in tree structure and species, and it increases the uniformity of spray deposition on targets at different growth stages, as compared to conventional sprayers with best pest management practices. The pest control efficacies of the new sprayer are comparable to those of conventional sprayers, while the new sprayer reduces average pesticide use by 46% to 68%, for an average cost savings of $230 per acre. Additional tests in an apple orchard have shown that the new sprayer reduces spray loss beyond the tree canopy by 40% to 87%, reduces airborne spray drift by up to 87%, and reduces spray loss on the ground by 68% to 93%.

In this global economy, efficiency and sustainability are key attributes of a competitive advantage. Nursery and orchard growers have been waiting for technology that can increase their spray application efficiency, ensure worker safety, and improve profitability. This new precision spraying system has significantly advanced the technology for efficient variable-rate pesticide applications, and it offers an environmentally responsible approach to controlling insects and diseases. The next step is to make this new technology commercially feasible.

ASABE Member Heping Zhu, Agricultural Engineer and Lead Scientist, USDA-ARS Application Technology Research Unit at OARDC/The Ohio State University, Wooster, Ohio, USA, heping.zhu@ars.usda.gov.

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Thousands of honey bees in Australia are being fitted with tiny sensors as part of a "swarm sensing" program.

Mapping honey bees using tiny backpack sensors

In Brief: Thousands of honeybees in Australia are being fitted with tiny sensors as part of a world-first research program to monitor the insects and their environment using a technique known as "swarm sensing."

New research is underway by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia's national science agency and one of the largest and most diverse research agencies in the world. CSIRO aims to improve honey bee pollination and productivity on farms as well as help understand the drivers of colony collapse disorder (CCD), a condition that is devastating honey bee populations worldwide.

Australia's bees don't yet have a problem with CCD or other major threats, such as the Varroa destructor, a parasitic mite that has killed honey bees in every country except Australia. Nevertheless, the CSIRO researchers are keen to learn more about what affects bees' productivity before they're faced with these problems. The sensors could also give them insight into which conditions best suit pollination, leading to crops that are quite literally more fruitful.

"Honeybees play a vital role in the landscape through a free pollination service for agriculture, which various crops rely on to increase yields. One of our recent studies showed that bee pollination of faba beans can lead to a productivity increase of 17%," said CSIRO science leader Paulo de Souza, who leads the swarm sensing project, "Around one-third of the food we eat relies on pollination, but honey bee populations around the world are crashing because of the Varroa mite and colony collapse disorder. Thankfully, Australia is currently free of both those threats."

The research will also look at the impacts of agricultural pesticides on honey bees by monitoring insects that feed at sites with trace amounts of commonly used chemicals. "Using this technology, we aim to understand the bee's relationship with its environment. This should help us understand the optimal productivity conditions," de Souza said. Some pesticides have been shown in past studies to wreak havoc on pollinators, even when they were thought to be safe. Because some of the sensor-carrying bees in this new study will be feeding at sites where trace levels of pesticide chemicals are present, the researchers will be able to see if, and how, their behavior is affected.

Up to 5,000 sensors, each measuring just 2.5 mm × 2.5 mm (0.1 in. × 0.1 in.), are being fitted to the backs of bees in Hobart, Tasmania, before they are released into the wild. This is the first time that such a large number of insects has been used for environmental monitoring. The tiny radio frequency identification (RFID) sensors indicate when the insects pass particular checkpoints. This information is then sent to a central location where researchers will use the signals from the 5,000 sensors to build a comprehensive three-dimensional model and visualize how the insects move through the landscape.

"Bees are social insects that return to the same point and operate on a very predictable schedule," de Souza commented. "Any change in their behavior indicates a change in their environment. If we can model their movements, we'll be able to recognize very quickly when their activity shows variation and identify the cause. This will help us understand how to maximize their productivity as well as monitor for any biosecurity risks."



A honey bee with a sensor glued to its back. ***Photos courtesy of CSIRO.***

Understanding bee behavior will give farmers and fruit growers improved management knowledge, enabling them to increase the benefit they receive from this free pollination service. It will also help them improve the way they monitor for pests. "We're working with the University of Tasmania, the Tasmanian Beekeepers Association, local beekeepers in Hobart, and fruit growers around the state to test this technology. Many growers rely on wild bees or on beekeepers to provide them with pollinators so they can improve their crops each year. Understanding the optimal conditions for these insects will improve this process," de Souza said.

To attach the tiny 2.5 mm square sensors to the bees, the researchers first refrigerated the insects, which essentially puts them to sleep, and then attached the RFID backpacks to them using tweezers and adhesive. Some young bees, which tend to be hairier than older bees, need to be shaved before the sensor can be glued on.

After a few minutes, the bees awaken and are ready to return to their hive and start gathering valuable information. "This is a non-destructive process, and the sensors appear to have no effect on the bee's ability to fly and carry out its normal duties," explained de Souza.

While the plight of bees is of great importance to anyone who wants to eat in the future, the sensor technology could also be adapted to other applications. "We could use it to observe, say, pest movement, such as codling moths in orchards, or disease vectors, such as malaria-carrying mosquitoes," said Stephen Quarrell of the University of Tasmania, which is working with CSIRO on the project. "If it moves, we can tag it."

The next stage of the project is to reduce the size of the sensors to only 1 mm square, so they can be attached to even smaller insects such as mosquitoes and fruit flies. One size does not fit all when it comes to wearable tech for bugs.

For more information, contact Adam Harper, Sustainable Agriculture Flagship Communication Manager, Adam.Harper@csiro.au, or Paulo de Souza, OCE Science Leader, CSIRO Computational Informatics, paulo.desouza@csiro.au.

What is a varroa mite?

Varroa mites are external parasites of bees. The mites, which are about the size of a pinhead, use specialized mouthparts to attack developing bee larvae or adult bees, resulting in deformed bees, reduced lifespan, and ultimately the destruction of the colony or hive. These mites are the most important pests of honey bees around the world.



Visible as a dark, oval shape, an adult female varroa mite feeds on the midsection of a developing worker bee. ***Photo by Scott Bauer, courtesy of USDA.***

What is colony collapse disorder?

Colony collapse disorder (CCD) is a phenomenon in which the worker bees from a beehive or European honey bee colony abruptly disappear. CCD is economically significant because European honey bees pollinate many agricultural crops worldwide.



A honey bee being inoculated with Nosema to determine bee infection rates and immune responses. ***Photo by Stephen Ausmus, courtesy of USDA.***



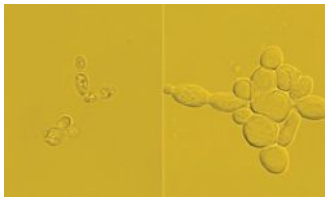
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UT Austin team converts yeast cells into "sweet crude" biofuel

In Brief: Researchers at The University of Texas at Austin's Cockrell School of Engineering have developed a new source of renewable energy, a biofuel, from genetically engineered yeast cells and ordinary table sugar. This yeast produces oils and fats, known as lipids, that can be used in place of petroleum-derived products. Harnessing *Yarrowia lipolytica* lipogenesis creates a platform for lipid and biofuel production

Assistant professor Hal Alper along with his team of students created the new cell-based platform. Given that the yeast cells grow on sugar, Alper calls the biofuel produced by this process "a renewable version of sweet crude."

The researchers' platform produces the highest reported concentration of oils and fats through fermentation, the process of culturing cells to convert sugar into products such as alcohol, gases, or acids. The UT Austin team was able to modify the yeast cells to enable up to 90% of the cell mass to become lipids, which can then be used to produce biodiesel. "To put this in perspective, this lipid value is approaching the concentration seen in many industrial biochemical processes," Alper said. "You can take the lipids formed and theoretically use it to power a car."



Under the microscope: genetically engineered yeast cells (left) and ordinary table sugar (right).

The biofuel that the researchers formulated is similar in composition to biodiesel made from soybean oil. The advantages of using the yeast cells to produce commercial-grade biodiesel are that yeast cells can be grown anywhere, do not compete with land resources, and are easier to genetically alter than other sources of biofuel. "We took a starting yeast strain of *Yarrowia lipolytica*, and we've been able to convert it into a factory for producing oil directly from sugar," Alper said. "This opens up a new source for renewable energy and biochemicals." Biofuels and chemicals produced from living organisms represent a promising portion of the renewable energy market. Overall, the global biofuels market is expected to double during the next several years, from $82.7 billion in 2011 to $185.3 billion in 2021.

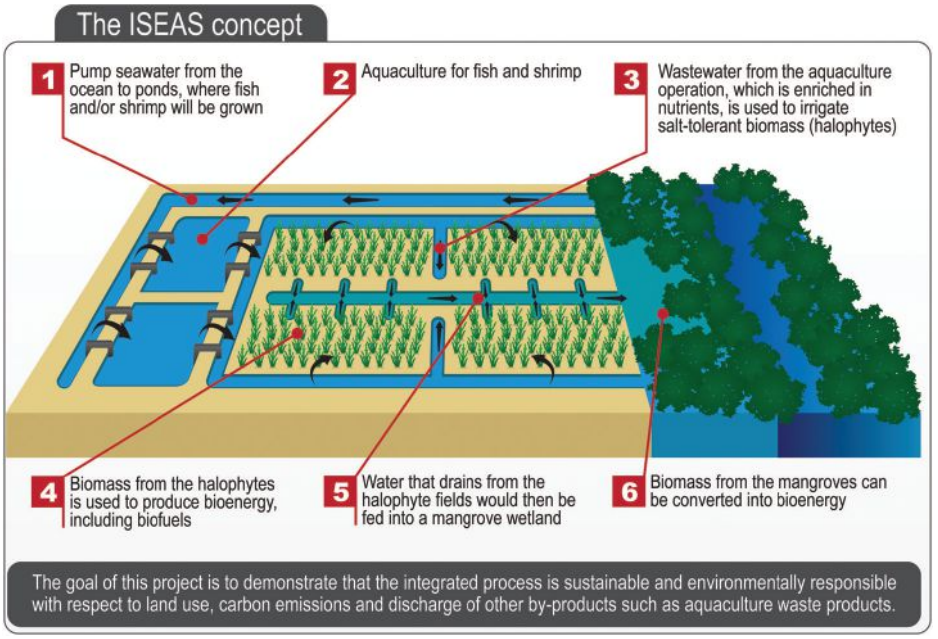
"By genetically modifying *Yarrowia lipolytica*, Dr. Alper and his research group have created a near-commercial biocatalyst that produces high levels of bio-oils during carbohydrate fermentation," said Lonnie Ingram, director of the Florida Center for Renewable Chemicals and Fuels at the University of Florida. "This is a remarkable demonstration of the power of metabolic engineering." Since fatty materials are the building blocks of many household products, this process could be used to produce a variety of items currently made with petroleum: from plastics to nutritional supplements to fuels.

In a large-scale engineering effort spanning over four years, the researchers genetically modified *Yarrowia lipolytica* by both removing and overexpressing specific genes that influence lipid production. In addition, the team identified optimum culturing conditions that differ from standard conditions. Traditional methods rely on nitrogen starvation to trick yeast cells into storing fat and materials. Alper's research provides a mechanism for growing lipids without nitrogen starvation. The team increased lipid levels by nearly 60-fold from the starting point.

So far, high-level production of biofuels and renewable oils has been an elusive goal, but the researchers believe that industry-scale production is possible with their platform. "Our cells do not require nitrogen starvation," Alper said. "That makes this process extremely attractive from an industry production standpoint." At 90% lipid levels, the platform produces the highest levels of lipid content created so far using a genetically engineered yeast cell. To compare, other yeast-based platforms produce lipid content in the 50% to 80% range, and these alternative platforms do not always produce lipids directly from sugar.

The research has resulted in a technology for which UT Austin has applied for a patent. In the meantime, Alper and his team are continuing to find ways to further enhance the lipid production levels and develop new products using the engineered yeast.

For more information, contact Sandra Zaragoza, zaragoza@utexas.edu.



This diagram explains the SBRC's test project, called the Integrated Seawater Energy and Agriculture System (ISEAS). ***Graphic courtesy of SBRC.***

Boeing and partners look to harvest biofuel from desert plants

In Brief: Boeing and research partners in the United Arab Emirates have made breakthroughs in sustainable aviation biofuel development, finding that desert plants fed by seawater can produce biofuel more efficiently than other well-known feedstocks.

The Sustainable Bioenergy Research Consortium (SBRC), affiliated with the Masdar Institute of Science and Technology in Abu Dhabi, will test the findings in a project that could support biofuel crop production in arid countries, such as the UAE.

"Plants called halophytes show even more promise than we expected as a source of renewable fuel for jets and other vehicles," said Dr. Alejandro Rios, Director of the SBRC. Halophyte seeds contain oil suitable for biofuel production. The SBRC research found that the entire shrublike plant could be turned into biofuel more effectively than many other feedstocks.

Funded by Boeing, Etihad Airways, and Honeywell UOP, the SBRC is dedicated to the development and commercialization of sustainable aviation biofuel, which emits 50% to 80% less carbon through its lifecycle compared to fossil fuel. "Etihad Airways is very pleased with the research results of these saltwater-tolerant plants," said Etihad Airways President and CEO James Hogan. "This is real progress in developing a truly sustainable aviation biofuel from a renewable plant source, appropriate to our environment."

In the coming year, SBRC scientists will create a test ecosystem by planting two crops of halophytes in Abu Dhabi's sandy soil. Waste seawater from a fish and shrimp farm will nourish the halophytes, which will clean the water as they grow. The water will then flow into a field of mangroves before returning to the ocean. Both plants would be converted into aviation biofuel using SBRC research findings. "This project can have a global impact, since 97% of the earth's water is ocean and 20% of the earth's land is desert," Rios said.

"Boeing is committed to finding ways to reduce aviation's carbon emissions, and sustainable aviation biofuels are a key component of our strategy," said Jeffrey Johnson, president of Boeing Middle East. "The Masdar Institute's biofuel research is showing tremendous potential, and we applaud Abu Dhabi's leadership and innovation in this critical area."

The SBRC's research success, announced at the 2014 World Future Energy Summit, continues the momentum for a sustainable aviation biofuel industry in Abu Dhabi. On January 18, 2014, Etihad Airways conducted a demonstration flight with a Boeing 777-300ER (Extended Range) powered in part with biofuel refined in the UAE. On January 19, Boeing, Etihad Airways, the Masdar Institute, and others launched BIOjet Abu Dhabi: Flight Path to Sustainability, an initiative to advance biofuel research, feedstock production, and refining capability.

These activities are aligned with the Abu Dhabi Economic Vision 2030, which seeks to develop sustainable energy sources to diversify the UAE economy and increase workforce opportunities for Emiratis. "The UAE has become a leader in researching the use of desert land and seawater to grow sustainable biofuel feedstocks, which has potential applications in other parts of the world," Rios said.

For more information, contact Jessica Kowal, jessica.m.kowal@boeing.com.



These halophytes show great promise in sustainable aviation biofuel research at the Masdar Institute of Science and Technology in Abu Dhabi. The plant genus is ***Salicornia. Photo courtesy of SBRC.***



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Potatoes could step up performance under climate change pressure

In Brief: Research at the USDA suggests that potatoes are still the go-to tuber when times get tough. Potato plants can produce more tubers when exposed to climate change conditions.

Agricultural engineer David Fleisher and his colleagues at the USDA-ARS Crop Systems and Global Change Laboratory in Beltsville, Maryland, conducted studies to measure how potato plants respond to elevated atmospheric carbon dioxide levels and the increasingly erratic rainfall patterns expected to result from global climate change.

The team conducted two studies to evaluate the effects of short-term drought cycles at current and elevated carbon dioxide levels. The studies used soil-plant-atmosphere research chambers that provide precise control of carbon dioxide level, air temperature, irrigation, and humidity. The chambers contained sensors that monitored air, soil, and canopy temperatures, relative humidity, and solar radiation above and below the canopy.

The quantity of solar radiation in the first study was about twice as much as in the second study. The two different study periods allowed the scientists to evaluate how variations in solar radiation during drought periods affected the plant response. In both studies, 11-day drought cycles were applied before tuber formation and again 10 days after tuber formation began.

The researchers observed significant differences in plant response that they attributed to the variation in solar radiation, which in turn affected plant water-use efficiency and dry matter production. With all other growth factors being equal, the plants in the first study had a 30% to 200% increase in total dry matter production, depending on carbon dioxide levels and water availability.

The team also noted that the cyclic droughts resulted in lower levels of dry matter and leaf area production. They concluded that drought stress before tuber formation probably enhanced the future delivery of carbon, water, and plant nutrients to tubers instead of to stems or leaves, and that this response increased under elevated carbon dioxide levels. Averaged across all drought treatments, tuber yield from plants growing under elevated carbon dioxide levels was as much as 60% greater than tuber yield from plants growing under current carbon dioxide levels.

For more information, contact Ann Perry, Ann.Perry@ars.usda.gov.



USDA-ARS agricultural engineer David Fleisher studies water-stressed potato plants in a soil-plant-atmosphere research chamber that controls carbon dioxide and irrigation levels. Potato plants produced more tubers when exposed to higher carbon dioxide levels and erratic drought conditions in studies that simulated potential climate changes. The results reveal how climate change will affect potato plant growth. *Photo by Stephen Ausmus, courtesy of USDA-ARS.*

Bright pulses of light could make space veggies more nutritious

In Brief: Exposing leafy vegetables grown during spaceflight to a few bright pulses of light daily could increase the amount of eye-protecting nutrients produced by the plants, according to a new study by researchers at the University of Colorado Boulder.



Former undergraduate researcher Elizabeth Lombardi talks with Barbara Demmig-Adams in a rooftop greenhouse at the University of Colorado Boulder.
Photo by Casey Cass, University of Colorado.

One of the concerns for astronauts during future extended spaceflights will be the onslaught of eye-damaging radiation they'll be exposed to. But astronauts should be able to mitigate radiation-induced harm to their eyes by eating plants that contain carotenoids, especially zeaxanthin, which is known to promote eye health. Zeaxanthin could be ingested as a supplement, but there is evidence that human bodies are better at absorbing carotenoids from whole foods, such as green leafy vegetables.

NASA has already been studying ways to grow fresh produce during deep space missions to maintain crew morale and improve overall nutrition. Current research into space gardening tends to focus on getting the plants to grow as large as possible as quickly as possible by providing optimal light, water, and fertilizer. But the conditions that are ideal for producing biomass are not necessarily ideal for the production of many nutrients, including zeaxanthin.

"There is a trade-off," said Barbara Demmig-Adams, professor of distinction in the Department of Ecology and Evolutionary Biology at CU-Boulder. "When we pamper plants in the field, they produce a lot of biomass, but they aren't very nutritious. However, if they have to fend for themselves—if they have to defend themselves against pathogens or if there's some stress in the environment—then plants make defense compounds that help them survive. And those are the antioxidants that we need."

Plants produce zeaxanthin when their leaves are absorbing more sunlight than they can use, which tends to happen when the plants are stressed. For example, a lack of water might limit a plant's ability to use all the sunlight it's getting for photosynthesis. To keep the excess sunlight from damaging its biochemical pathways, the plant produces zeaxanthin, a compound that helps safely remove the excess light.

Zeaxanthin, which the human body cannot produce on its own, plays a similar protective role in our eyes. "Our eyes are like a leaf—they are both about collecting light," Demmig-Adams said. "We need the same protection to keep us safe from intense light." The CU-Boulder research team set out to determine if they could find a way to simultaneously maximize plant growth and zeaxanthin production. Using the model plant species *Arabidopsis*, the team demonstrated that a few pulses of bright light on a daily basis spurred the plants to begin making zeaxanthin in preparation for an expected excess of sunlight. The pulses were short enough that they didn't interfere with the otherwise optimal growing conditions, but long enough to cause accumulation of zeaxanthin.

Arabidopsis is not a crop, but past research has shown that its behavior is a good indicator of what many edible plant species will do under similar circumstances. "When they get poked a little bit with light that's really not a problem, they get the biomechanical machine ready, and I imagine them saying, 'Tomorrow there may be a huge blast and we don't want to be unprepared,' " Demmig-Adams said.

The idea for the study came from former undergraduate researcher Elizabeth Lombardi, who began thinking about the challenges of growing plants during long spaceflights while working with CU-Boulder's Exploration Habitat graduate project team in the Department of Aerospace Engineering Sciences, which built a robotic gardening system that could be used in space.

While the study is published in an astronautics journal, Lombardi says the findings are applicable on Earth as well and could be especially relevant for future research into plant-based human nutrition and urban food production, which must maximize plant growth in small areas. The findings also highlight the potential for investigating how to prod plants to express traits that are already written into their genetic code. "Learning more about what plants already know how to do and trying to manipulate them through changing their environment rather than their genes could be a really fruitful area of research," Lombardi said.

For more information, contact Barbara Demmig-Adams, Barbara.Demmig-Adams@colorado.edu; Elizabeth Lombardi, Lizzie.Lombardi@gmail.com; or Laura Snider, CU media relations, Laura.Snider@colorado.edu.







AGRICULTURAL AND BIOLOGICAL ENGINEERING

Visual Challenge 4

ENTRY DEADLINE: October 1, 2014

Engineers are proficient in science and technology, and have to be good communicators as well.
In fact, engineers have a unique responsibility to communicate technical concepts to a larger audience.
Traditionally, that is done that with words and numbers.
Increasingly, however, communication in images make statements without words.

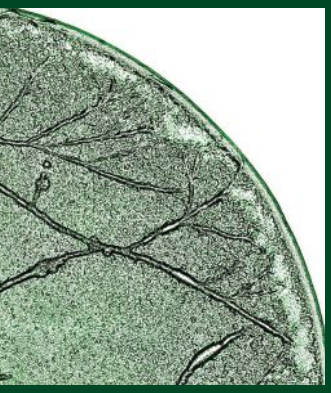
Visual imagination combined with technical skill can produce astonishing–and deeply informative–images.
To call attention to and celebrate the visual aspects of agricultural and biological engineering,
Resource announces the fourth Agricultural and Biological Engineering Visual Challenge.

The theme is visual communication of agricultural and biological engineering, and the Challenge is open to all–members, non-members, engineers, and non-engineeers. To participate, submit one or more entries in any/all of three categories: photographs/captured images, illustrations/drawings, and informational/explanatory graphics.

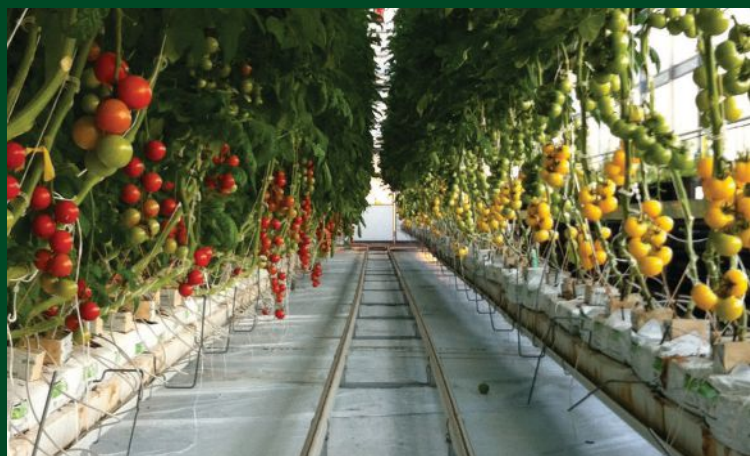
Entries will be judged on their visual appeal, clarity, or explanatory power (according to the entry category) as well as their relevance to the Challenge theme. Use your entry to convey the beauty and meaning of your work, your research developments, and your Society division. All entries should be original work.
The Challenge is an opportunity to be creative and to show those outside the ABE field: "This is what we do."
Submit your entry as an e-mail attachment in jpg format (300 dpi or higher) to Sue Mitrovich, *Resource* managing editor (mitro@asabe.org).
Enter "Visual Challenge" in the subject line, and include your full name, professional affiliation, contact information, and a title with a brief description of your entry in your message. If necessary, include a source credit and an assurance that permission has been granted to submit, and possibly reprint, the entry. Multiple entries are welcome.

The winning entries will be selected by *Resource* staff and published in the January/February 2015 issue of *Resource*.









IRRIGATION/WATER MANAGEMENT SPECIALIST—TWO POSITIONS

The Institute of Agriculture and Natural Resources (IANR) at the University of Nebraska-Lincoln (UNL) is seeking applicants for two tenure-leading positions to develop national and internationally recognized research and extension programs in irrigation and agricultural water resource management. One position is located at the Panhandle Research and Extension Center (PHREC) in Scottsbluff, NE and will focus on developing and conducting relevant and responsive water and soil resources management extension and research programs for the unique crops and cropping systems of the Central High Plains region and, in particular, the Nebraska Panhandle. Another position is located at the West Central Research and Extension Center (WCREC) in North Platte, NE and will develop and conduct relevant and responsive crops water extension and research programs for the crops and cropping systems of the Central High Plains region with a focus on how agricultural producers can manage irrigation applications to meet crop needs.

The tenure home for these positions will be the Department of Biological Systems Engineering (http://bse.unl.edu) with administrative assignment to PHREC (http://panhandle.unl.edu) in Scottsbluff for one position and WCREC (http://westcentral.unl.edu) in North Platte for the other position.

For both positions, a Ph.D. or equivalent degree in Agricultural Engineering, Biological Systems Engineering, or a similar field is required. The degree must be completed before employment begins. For requisition number F_140059 (the PHREC position), the successful candidate must have documented experience in irrigation. For requisition number F_140061 (the WCREC position), the successful candidate must have documented experience in water use in cropping systems and irrigation management. For the Associate Professor level, an externally supported, nationally recognized research and extension program in the area of water resources engineering is required.

Preferred qualifications for both positions include: excellent communication skills; practical experience with irrigation equipment operations and management; and experience in working in multidisciplinary teams.

To view the complete position details and to apply for these positions, go to the UNL Employment web site: http://employment.unl.edu. Search for requisition number F_140059 for PHREC-Scottsbluff and F_140061 for WCREC-North Platte. Click on "Apply to this job." Complete the application and attach a letter of interest, curriculum vitae, contact information for three professional references, and a statement of research and extension interests under "Other". To apply for both positions, please submit an application to each requisition number. Review of applications will begin on September 1, 2014 and continue until the position is filled or the search is closed.

The University of Nebraska has an active National Science Foundation ADVANCE gender equity program, and is committed to a pluralistic campus community through Affirmative Action, Equal Opportunity, work-life balance, and dual careers.

ASSISTANT PROFESSOR IN BIOPROCESS AND FOOD ENGINEERING IN THE BIOLOGICAL AND AGRICULTURAL SYSTEMS ENGINEERING (BASE) PROGRAM AT FLORIDA AGRICULTURAL AND MECHANICAL UNIVERSITY (FAMU)-POSITION #19337

The position is a 9-month, tenure track, teaching and research (approximately 60% teaching and 40% research) position with responsibilities in the area of bioprocess and food engineering. Candidates should have a strong working knowledge of engineering fundamentals, unit operations, fermentation, bio-separation isolation, and purification processes and equipment. The successful candidate must have a commitment to high quality undergraduate teaching and research. This position provides substantial collaborative and interdisciplinary opportunities with faculty in BASE, Food Science, as well as faculty in the Agricultural Biotechnology group in the College of Agriculture and Food Sciences' Center for Viticulture and Small Fruits Research.

The position requires an earned residential PhD in Biological, Agricultural, Chemical, Food or a closely related engineering discipline at the time of appointment. Preference will be given to candidates with an earned residential BS degree in the discipline. The successful candidate will be expected to:

1. teach courses in Bioprocess and Food Engineering including Biochemical Engineering and Heat and Mass Transfer in Biological and Food Engineering and co-teach Senior Design; and develop new courses: in Food Packaging, and Food Engineering for Food Science Majors and other non-engineering majors;
2. develop and implement an extramural funded research program in bioprocess and food engineering. Focus areas may include fermentation and value added products derived from grapes and small fruits; and
3. assist with student recruitment, advisement, internship placement, and participate in activities that enhance BASE's instructional program.

It is desirable that the candidate becomes licensed or is already licensed as a professional engineer. The appointment is expected to begin October 20, 2014.

Applicants should submit a cover letter, teaching and research statement, curriculum vitae, academic transcripts, FAMU employment application (http://www.famu.edu/index.cfm?hr&Employment), and names, addresses, telephone and fax numbers, and e-mail addresses of three references to: Mrs. Carrie M. Gavin, Director Equal Opportunity Programs, 674 Gamble Street, Florida A&M University Tallahassee, FL 32307.

The deadline for applications is July 31, 2014. Women and minorities are encouraged to apply.

Resource is published six times per year: January/February, March/April/, May/June, July/August, September/October, and November/December. The deadline for ad copy to be received at ASABE is four weeks before the issue's publishing date.

For more details on this service, contact Melissa Miller, ASABE Professional Opportunities, 2950 Niles Road, St. Joseph, MI 49085-9659, USA; 269-932-7017, fax 269-429-3852, miller@asabe.org, or visit www.asabe.org/resource/persads.html.

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ASABE to Co-Chair Engineers Week 2015

Sonia Maassel Jacobsen and Dolores Landeck

Here's an exciting new opportunity to highlight our profession: ASABE will serve as organizational co-chair of DiscoverE's Engineers Week 2015. ASABE Past President Sonia Maassel Jacobsen is leading ASABE's efforts, with support from E-05/1, chaired by Alicia Modenbach, and staff liaison Dolores Landeck. Our industry co-chair is Shell Oil, with spokesperson Marvin Odum.

DiscoverE's mission is to promote all engineering professions. Our leading role gives us a chance to shine a special light on agricultural and biological engineering—and you can help us leverage this effort by getting involved in DiscoverE programs. A few opportunities are listed below. For more information, visit www.discovere.org or contact Dolores Landeck (landeck@asabe.org). And plan to attend the E-05/1 committee meeting at the Annual International Meeting in Montreal!

DISCOVER
LET'S MAKE A DIFFERENCE

Future City Competition

Open to middle school students, the Future City Competition begins with regional contests across the U.S. The regional winners compete in the national finals in Washington, D.C., during Engineers Week. Each year's competition has a theme, and for 2015 the theme is urban agriculture—which calls for ASABE's unique expertise! Mentor a team from your local school. In particular, judges are needed for the final presentations.

Introduce a Girl to Engineering Day

Girl Day proves how creative and collaborative engineering is and how women engineers are changing our world. Hundreds of events take place—both local and virtual. Get involved by joining a Girl Day event, and make a difference with the girls in your community.

The Global Marathon (for Women in Engineering)

The only free, virtual event uniting women in engineering and technology, the Global Marathon coincides with International Women's Day. ASABE members can participate through webcasts and locally organized satellite events. Each day has a new theme. Examples from 2014 include "Advice from the top," "Gaining momentum," and "Inspire yourself, inspire others." ASABE will be looking for women to participate in the webcasts.

New Faces of Engineering - Professional

This program recognizes young engineers, up to age 30, who are making a difference in the world. Winning nominees from each society, agency, or company are featured in *USA Today* during Engineers Week. Recent winners from ASABE include Grace Richardson, John Andruch, and Michael Sama. ASABE conducts its own "New Faces" program as a way of recognizing talent. Watch for the call for nominations, which will be coming out in late summer.

New Faces of Engineering - College Edition

Similar to New Faces - Professional, this program recognizes undergraduate engineering students for their excellent work. Recent winners from ASABE include Max Wallace (University of Florida) and Rebecca Chin (McGill University). Sections and communities submit nominations within ASABE. Watch for the call for nominations in late September.

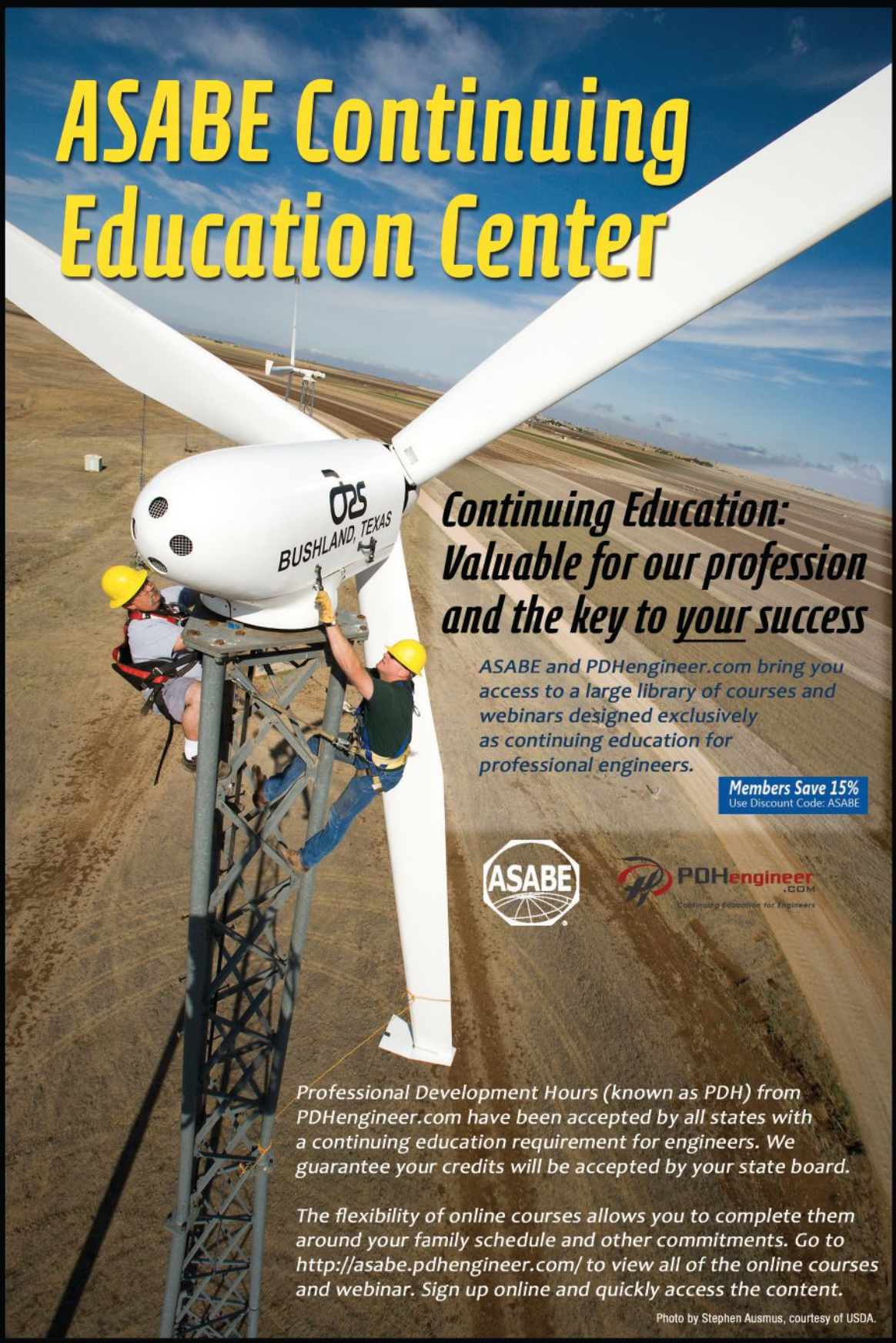
Family Day at the National Building Museum

ASABE has a popular exhibit at this event, thanks to Gary Siebel from the University of Maryland, demonstrating why popcorn pops—and producing lots of free popcorn in the process! Many other engineering societies and employers also have family-friendly exhibits. The activities are focused on ages 4 to 12, but all ages enjoy the tasty learning. Volunteers are enthusiastically encouraged.

Local Outreach

Many communities have local Engineers Week events. Information on these events is available through the DiscoverE website and from ASABE headquarters. Join a local effort to celebrate Engineers Week. DiscoverE is fun, it inspires young people, and now it promotes your Society!

ASABE Fellow and Past President Sonia Maassel Jacobsen, P.E., Adjunct Professor, Bioproducts and Biosystems Engineering, University of Minnesota; smmjacobsen@asabe.org. **Dolores Landeck,** ASABE Director of Public Affairs; landeck@asabe.org.


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Photo by Stephen Ausmus, courtesy of USDA.