Grape harvesting at its best

Also inside:

- Boosting Grain Preservation
- What's an Iron Goat? ePortfolios and Learning
- Robotic Wonders 1/4 Scale Excitement

PUBLISHED BY AMERICAN SOCIETY OF AGRICULTURAL AND BIOLOGICAL ENGINEERS
Global Partnerships for Global Solutions” is the theme of ASABE’s vision to be among the leaders that provide engineering and technological solutions for a sustainable world with abundant food, water, and energy, and a healthy environment. Agricultural and biological engineers (ABEs) are critical players in addressing the grand challenges that the world is facing with respect to food, energy, and water systems, but we cannot meet these challenges alone. We must form partnerships that can address the complex dimensions of the challenges. Because of their importance in achieving our vision, I have identified Partnerships as a special focus of ASABE for 2015-2016.

One of my specific goals for my presidential year is to increase ASABE’s ties with the bio-based products industry, making that industry a partner in pursuing our mutual interests. Many ABEs, including a significant number of recent graduates, are working in the bio-based products industry. While ASABE has a good relationship with some sectors of that industry, the leadership of many bio-based product companies is not engaged with, or even familiar with, ASABE. With your help, we can build Partnerships with the bio-based products industry.

A second goal under the Partnerships theme is advancing our Global Initiative. As part of that effort, ASABE will host the “Engineering and Technology Innovation for Global Food Security” conference in South Africa in 2016. To make this first-ever conference a success, we must engage a wide range of partners, and those partnerships must continue beyond the conference to address the challenges of feeding the growing world population.

For ASABE to be effective in these wide-ranging partnerships, many members must be involved. Many of you are already active in ASABE partnerships. I encourage each of you to be a partner. Be an active member of a committee or community related to your interests or expertise. Serve on a team that develops or continues a partnership between ASABE and other organizations. To learn more about our existing partnerships, to volunteer for a new partnership team, or to suggest new partners, get involved at www.asabe.org/get-involved.

I am honored and excited to serve as your President for 2015-2016. Let’s work together to strengthen our existing partnerships, build new partnerships, and make this another great year for ASABE!

As always, I look forward to hearing from you,

Mary Leigh Wolfe
mlwolfe@vt.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.

**2016**

- **Feb. 8-10** 2016 Agricultural Equipment Technology Conference. Louisville, Ky., USA.
- **April 8-9** Young Professional Development Workshop. Lexington, Ky., USA.
- **July 17-20** ASABE Annual International Meeting. Orlando, Fla., USA.

**2017**

- **July 16-19** ASABE Annual International Meeting. Spokane, Wash., USA.
November/December 2015
Vol. 22 No. 6

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As summer grows shorter, vineyard owners and the engineering staff at Ag Industrial Manufacturing (AIM) in Lodi, Calif., keep watch on thousands of acres in the state’s northern San Joaquin County. AIM faces a tight deadline to complete its 85th grape harvester and bring in a client’s crop without delay or disaster. The pace picks up as the grape leaves turn brown at the edges, a sign that harvest time is approaching.

For the local agricultural economy, no machine is more important than the grape harvester. With 100-plus growers cultivating more than 100,000 acres worth roughly $400 million, most of the region’s grapes are harvested using machines created at AIM’s sprawling manufacturing complex. Without the speed, capacity, and efficiency of these modern harvesters, growers would lose money, and grapes would rot on the ground.

Grape harvesters have to be rugged enough to work long hours in the vineyard, yet precise enough to remove ripe fruit from the vines without crushing it or damaging the vines. Each custom-made harvester costs more than a Lamborghini and must be delivered on time. Making the delivery date represents the difference between a smooth harvest and major losses for the grower.

The key players
AIM’s founders, ASABE Fellow Paul Burkner, his partner ASABE Fellow Claude Brown, and Burkner’s brother Charlie, have spent more than three decades perfecting machines that can do the day’s work of a dozen men in just a few hours. AIM has a dedicated staff of more than 30, and most are long-time employees, with widely varied skills, who operate and maintain the company’s machines. And every year there is more innovation, more fine-tuning, and
more pressure to produce the machines that have become the international leader in grape harvesting.

AIM began in 1979, when Burkner and Brown set up a business to repair parts, build custom parts, and sell out-the-door steel. After scraping together enough money to purchase two grape harvesters—machines that were so unusual at the time that few growers could afford them—Burkner and Brown began harvesting grapes for hire. Their first employee was Tommy Homer, who had moved to California from Arkansas right after high school. Homer has now been AIM’s foreman for 35 years. In the early days of the company, Homer worked double shifts while Burkner and Brown slept in their trucks at clients’ vineyards to troubleshoot the third-party harvesters. There were always problems with those machines. They didn’t hold up over time, and they needed constant in-field modifications. Burkner and Brown knew they could do better. They decided to build their own grape harvester.

Brown had graduated from San Joaquin Delta College and took courses at UC Davis. As a youngster, he worked on machines—building, fixing, and improving. As a teen, he supervised a crew doing commercial electrical work, once running wire and conduit up a soaring TV tower in the San Francisco Bay area. He later worked for Randtron—a conglomerate of manufacturing companies based in Menlo Park, Calif.—and his mechanical skills led him to Randtron’s Holtz Rubber Co., in Lodi, Calif., where he worked his way up to vice president for manufacturing.

When Randtron was sold, Brown and Burkner set up their new business, focused on designing and building grape harvesting machines. Their reputations for ingenuity, innovation, and determination preceded them.

Burkner had an ag engineering degree from Cal Poly-San Luis Obispo, did graduate work at the University of Hawaii, and worked with the USDA building date, onion, and citrus harvesters. But grapes were another story. “Back then, grape harvesting machines were designed by people who didn’t use them,” Burkner says. “It wasn’t a big market, but it was a tough, very specialized market that was not being satisfied.”

Equipment manufacturer Food Machinery Corporation (FMC) developed a prototype for a fruit shaker for automated grape harvesting in the 1970s, and AIM helped with the design. Burkner attached the new picking head to a commer-
cial harvester and began pitching mechanical grape harvesting to area growers. A collaboration was born, but it didn’t last. FMC left the ag equipment market in the mid-1980s.

“We were trying to make a buck and survive,” Burkner says of AIM’s early days. Before mechanical harvesting became an industry standard, area growers viewed it with skepticism. “Let me put it to you this way,” he says, “The machines were pretty crude. Not too many growers were willing to risk having a machine destroy their vines.”

Finally, in 1990, Brown and Burkner unveiled AIM’s own prototype—their first grape harvester. It had a voracious appetite for grapes, and it worked reliably. Burkner credits several local growers for being forward thinking at the time, and for being willing to try mechanical harvesting—even though harvesting just 80 acres of grapes took nearly two months. By comparison, today’s machines harvest 80 acres in less than four days of eight-hour shifts.

85 and counting

AIM’s 85th grape harvester (shown on the cover) is a direct descendant of that first machine. Harvester No. 85 has a large square frame with the driver’s seat on top. The machine straddles a row of grapevines and holds the vines with its two long Soft-Touch arms—a unique feature of AIM harvesters. The arms oscillate at 350 rpm until the fruit is “rigorously but gently” shaken loose. Two conveyor belts, on either side of the vines, move the grapes toward the rear of the machine, where a vertical belt carries the fruit upward. The grapes travel through a blower, which removes leaves, bits of vine, and insects. On top of the machine, the grapes enter a cross conveyor and pass through a sorting station, where two workers pick out damaged grapes and any debris missed by the blower.

Perfect grapes pour into a gondola, towed at the side of the harvester, which holds about six tons of fruit. That’s the equivalent of about 5,000 bottles of wine.

Ready to roll

The vineyard owner calls to say that the grapes cannot wait: “We have to pick tonight.” Harvesting happens at night to protect the grapes from the daytime heat. Looking pristine and eager, AIM harvester No. 85 rolls down the highway and into the vineyard.

As the sun goes down, No. 85 roars into action. Tractors tow gondolas back and forth and follow the harvester up and down the rows. After the harvester passes, only bare stems—called rachis—are left on the vines. Dust and debris fly while grapes swirl along the conveyor belts and then settle into the gondolas.

The harvester is automated, but it’s still tricky work. “There’s always something,” says Brown, as he and Burkner watch in the darkness. For now, all is well. Their new baby is bringing the harvest in on time.

One good idea leads to another

Burkner is credited with developing the grape gondolas, which transport the grapes from the harvester to trucks parked at the vineyard edges. A hydraulic extension lifts the gondola’s payload into the truck’s tank. “The big dump,” says Burkner with a chuckle. AIM’s grape gondola continues to be one of the industry’s largest sellers, mostly in California and Oregon.

Continuous R&D has led to constant innovations, such as the gondola’s hydraulic system, as well as the Soft Touch system, for which Burkner holds a U.S. patent, that shakes grapes onto the conveyor belts with a continuous, fluid motion for minimal crop damage.

As lucrative as grape harvesters proved to be, Burkner realized that harvesting was only two months of the year. “So we looked at other products,” he says. One idea naturally led to another.

In addition to grape harvesters, AIM has produced harvesters for radishes, chrysanthemums, coffee, guayule,
patchouli, and Dichondra seed, as well as tomato vine diverters, vineyard pre-pruners, vine trimmers, brush rakes, tractor saddle tanks, chemical applicators, twin-bin picking trailers, hydraulic pruning shears, a highway barrier mover, a steam leaf removal machine, and pieces of custom equipment—some of which are “strictly confidential.”

But ideas take time. Brown and Burkner often sift through several solutions to an engineering problem. “Sometimes you have compelling ideas that don’t make good business sense,” says Burkner. “You have to make payroll and pay taxes, too.”

One thing doesn’t change: all AIM harvesters are painted green. Why green? E&J Gallo was AIM’s first customer and requested a specific shade of green to match the company’s truck fleet. AIM’s harvesters are still painted green to honor that first sale. Brown and Burkner will use another color at a client’s request, but only reluctantly. One harvester was painted white, and scoffingly dubbed “The Albino.” Another was painted blue. “Enough of that,” says Burkner.

Sue Mitrovich, Managing Editor, Resource, St. Joseph, Mich., USA; mitro@asabe.org; Sara Jane Pohlman, “Lodi Living” Editor, Lodi News-Sentinel, sarap@lodinews.com, contributed to this article.

Mitrovich and Pohlman have both taken a night ride on a grape harvester and highly recommend it. To climb aboard visit https://www.youtube.com/watch?v=eRV_Lsp-LeA&feature=youtu.be and https://www.youtube.com/watch?v=WVzNqj8Tafk.

Before: Grapes ripe for the harvester’s picking.

After: No fruit left on the vines, and grapes safely in the gondola.
Every year, California’s San Joaquin County Ag Commissioner, in partnership with the local Farm Bureau, area schools, and local ag community, organizes AgVenture events in several locations in the county. This ag-based field trip is attended by third grade students and is intended to increase their understanding and knowledge of agriculture.

For the past several years, I have accompanied an AIM model GH9000 grape harvester at the Lodi AgVenture. One of our customers, Kautz Farms, brings an entire grape harvesting setup—the harvester, a tractor pulling a gondola, and a semi-truck. I get to explain what the harvester is and how it works. I had to come up with an explanation that third graders would understand. Here’s a peek at how it goes.

When talking to third graders about a grape harvester, it’s very effective to (1) wear grape earrings, (2) wear purple, (3) apply purple eyeliner, and (4) use a portable headset microphone and speaker!

Before the kids arrive, I put up some large photos of the machine in action and an overhead view of the machine at the kids’ eye level. After the kids arrive, I begin by asking if anyone knows what this machine is and what it does. “Corn harvester!” “Cherry picker!” “Monster truck!” “Apple harvester!” “Car wash?” I usually get the right answer eventually—“Grape harvester!”—because many local kids have parents who work in the grape industry.

My goal is to get the children thinking about the grape harvest in our area: “What time of day is harvesting done?” “Why are grapes an important crop?” I give a simple explanation of how the machine works. I tell them that the grape harvest season is the end of summer and early fall, when they return to school, and that harvesting happens at night, when they are in bed, because that keeps the fruit cool and protects it from the sun, and that there are 100,000 acres, or the equivalent of 100,000 football fields, of grapevines in the Lodi area.

To explain how the grape harvester works, I hold my arms up to look like the letter “T” and say, “If I were a grape vine, I would look like a ‘T,’ and I would be holding hands with other grape vines all in a row. Grapes would be growing on the undersides of our arms, and when the machine passes over us, it shakes our bellies, and all the ripe grapes fall onto a conveyor belt. The conveyor belt is similar to the ones that you see in the grocery store, and it carries the grapes to the big rolling bin—the gondola. When the gondola is full, it dumps the grapes into a big semi-truck, and when the semi-truck is full, it takes all the grapes to the processor where the grapes are used make grape juice and adult beverages.”

These kids are savvy, because someone will always say, “You mean like wine? My mom and dad drink wine!” I also tell them that fresh whole grapes, called table grapes, like the ones in their lunch boxes, are not picked by a machine like this one. Those are all picked by hand, and it’s a lot of work.”

Then come the questions: “How do you drive it?” I point to the ladder and then to the driver’s seat and explain that it has a steering wheel and controls just like a car.

“How much does it weigh?” 22,000 pounds, which is 11 tons, or the equivalent of about 12 elephants.

“How much does it cost?” $350,000 or about as much as a nice house!

Other third grade relatable factoids are:

• The machine harvests about one acre, or the equivalent of a football field, every hour.
• The harvester needs just 30 minutes to fill a gondola.
• Each gondola holds about 12,000 pounds, or the equivalent weight of 240 third graders or six elephants!
• The grapes in one gondola load can make 5,000 bottles of wine, or enough juice to fill 1,000 one-gallon milk jugs.

Monica Burkner is the daughter of ASABE Fellow Paul Burkner, co-founder of Ag Industrial Manufacturing (AIM). She is actively involved in AIM and in the local agricultural community in Lodi, Calif., USA, mburkner@icloud.com.
URGED in recent years by members who want to see
the Society do more to promote the profession,
ASABE has expanded its efforts in pre-college
STEM (science, technology, engineering, and
math) outreach. As a small organization, ASABE is particularly
thoughtful about spending resources for STEM outreach. We look for opportunities that provide the most impact.

Time and again, we’ve found that our best investment is in activities that take advantage of the enthusiasm that staff and members have for the profession. At the top of the list are opportunities that allow one-on-one engagement with students and their “influencers”—educators, advisors, parents, and mentors. That’s why DiscoverE’s Future City Competition has become a favorite.

Future City is a cross-cultural program that lets students in the 6th, 7th, and 8th grades do the things engineers do: identify problems, brainstorm ideas, design solutions, test, retest, build, and then share the results. Each year’s event begins with a theme. Last year’s was urban agriculture; this year’s is waste management. Students then research, design, and build their future city. They use SimCity to model their design. They also write a 1,500-word city description and produce a scale model, project plan, and oral presentation. Each team has an academic advisor and an engineer mentor.

Future City’s focus is strictly engineering, an aspect that distinguishes it from an array of other international STEM competitions, such as FIRST robotics.

Its impact is significant. The program, which celebrated its 20th anniversary in 2015, annually serves more 40,000 students throughout the U.S. and abroad, many of them in underserved communities. It also draws a high number of girls—46% of participants in 2013 and 2014 were girls—another mark of distinction over similar programs.

Students repeatedly report that Future City increases their motivation and excitement about STEM. In addition, students and teachers alike report a marked improvement in students’ public speaking, project management, and problem-solving skills and in their ability to apply math and science concepts to real-world issues.

Enlightened by their Future City experience, 65% of students say they can envision becoming an engineer. More important, all participants emerge better informed about the value of engineering in improving quality of life.

What does it mean for you as an ASABE member?

It means you have an excellent one-on-one opportunity to inform a new generation about engineering—specifically, agricultural and biological engineering. Future City is fun and rewarding for all involved, so check out the sidebar to see how you can volunteer.

Dolores Landeck, ASABE Director of Public Affairs, St. Joseph, Mich., USA, landeck@asabe.org.

Nurture a New Generation—
Get Involved in Future City!

Regional Competitions

ASABE is sponsoring a special award at all Future City regional competitions for the team that demonstrates the Most Sustainable Food Production System. Who better than ASABE members to serve as judges for this special award?

The regional competitions are typically held on a Saturday in January. To volunteer your services as an ASABE special award judge, contact Dolores Landeck by December 15 (landeck@asabe.org; 269-757-6094).

 Judges are also needed beforehand to review the essays, and on the day of the competition to evaluate the presentations. Contact your Regional Coordinator to volunteer (www.futurecity.org/regions).

National Finals

Come to Washington, D.C., on President’s Day (Feb. 15, 2016) to judge the team presentations. Or consider reviewing essays onsite, ahead of time. Visit www.futurecity.org/register to sign up.
The process of job hunting for a student typically starts with preparation of a résumé that contains the student’s degree and major, courses taken, and work-related experience. The résumé encapsulates the education that was defined by the institution and delivered to the student, but it does not always explain what the student actually learned from the courses. Neither does the résumé demonstrate the skill level of the student, nor the relationship between courses taken and other college experiences, such as study abroad programs, co-ops, internships, research experience, and community service. These intangibles can represent the student’s most desirable qualities to a potential employer, but they are also the most difficult to express within the confines of a résumé.

Unlike other engineering programs, students in biosystems engineering (and similarly named programs) have the additional challenge of name recognition by employers of engineering graduates who are not familiar with the discipline. In fact, the most common question that BE students face during career fairs is: “I’m not familiar with your degree, so can you tell me more about biosystems engineering?” Embedded in this question—often to the students’ dismay—is the expectation that students can effectively articulate their preparation for a specific career in biosystems engineering. The students are most persuasive when they have reflected on their learning experiences, can connect the courses in the curriculum, and can provide evidence of acquired skill sets. This personal reflection and the collection of supporting material are two of the major elements of the ePortfolio, which facilitates students’ ability to express the professional growth they experienced in college and explain why they are interested in a particular position with a particular employer.

**What’s an ePortfolio?**

An ePortfolio (short for electronic portfolio) is an organized collection of documents and media (called artifacts) in digitized format that are contextualized with the student’s reflection on professional goals. An ePortfolio demonstrates a student’s growth over time in skills, knowledge, and achievements. A well-designed ePortfolio gives prospective employers a complete sense of what the student is capable of. Personal reflection is the hardest part of developing an effective ePortfolio because it requires that students:

- Connect concepts from different courses and make connections between courses and extracurricular activities.
- Integrate, synthesize, and organize ideas from various sources.
- Think about and articulate significant experiences, both in and out of the classroom.
- Ask critical questions about their professional goals, progress towards these goals, and if need be develop new goals.

This personal reflection is also the most important part of developing an effective ePortfolio because it improves the
Students Sarah Ashworth, Zac Lee, and Anna Breland (left to right) participated in the ePortfolio Project in Auburn University’s Department of Biosystems Engineering.

Auburn University and ePortfolios

In 2013, Auburn’s Department of Biosystems Engineering received an ePortfolio grant from Auburn’s Office of University Writing as part of the campuswide ePortfolio Project and the university’s Quality Enhancement Project. The goal of the ePortfolio grant is to embed reflection practices into the department’s three curriculum options (i.e., biosystems engineering, ecological engineering, and forest engineering). The ePortfolio Project will also complement our efforts (through a USDA Higher Education Challenge grant awarded in 2012) to improve student learning and the employment prospects of BE students after graduation. The USDA grant is aimed at improving students’ ability to integrate the concepts needed to solve complex, real-world, biology-based engineering problems while improving student learning, recruitment, and retention by using a hybrid pedagogical approach that combines a spiral curriculum with innovative hands-on investigation and multimedia case studies. Apart from the obvious benefits of using ePortfolios to promote reflective thinking and writing, we hope that ePortfolios will significantly improve the ability of BE students to articulate their technical competence, especially during a job search.

Three BE students were initially selected in fall of 2013 to work with Auburn’s ePortfolio Project, through the Office of University Writing, to create ePortfolios that could be showcased to other BE students. Here are their comments on the experience (and links to their ePortfolios):

students’ critical thinking, which is a useful skill for lifelong learning in any field.

A well prepared ePortfolio combines all the attributes of a social networking site (such as LinkedIn), a traditional paper-based portfolio, and a blog. Artifacts such as completed assignments, essays, project reports, videos, graphics, audio files, PowerPoint presentations, résumés, and professional and personal achievements can all be part of an ePortfolio. These artifacts enable students to document their professional development with metrics that are more informative, and more comprehensive, than course grades.

Historically, other academic programs, such as English, visual arts, and architecture, have used paper portfolios to demonstrate skill sets. However, traditional paper portfolios cannot be shared easily with remote audiences, they are difficult to duplicate, and they are limited in scope because they can’t be easily modified for different purposes and diverse audiences.

In addition to overcoming the disadvantages of paper portfolios, ePortfolios can be used to assess student learning. They can also be used by faculty to share teaching philosophies and practices, to present department and program self-studies, and to satisfy institutional and program accreditation requirements. Because of their benefits, ePortfolios are becoming a common practice in professional programs such as nursing, pharmacy, medical school, and engineering.

The engineering programs at Virginia Tech, Montana State, Clemson, and the University of Texas-Austin, among others, have already introduced ePortfolios as part of the student learning experience. However, there is still a lack of sustained adoption of ePortfolios in these engineering programs, partly because ePortfolios have mostly been used for assessing program outcomes. It has therefore been difficult to manage the creation and evaluation of student ePortfolios, especially in large engineering programs. These challenges can be easily overcome in smaller engineering programs, such as biosystems engineering (and other engineering programs that may not be familiar to potential employers). As a result, ePortfolios can provide an effective means for students in these small programs to gain credibility with employers of engineering graduates.

Attributes of ePortfolios. Courtesy of Wende Garrison and Auburn University’s Office of University Writing.
Sarah Ashworth: “The process of creating an ePortfolio helped me figure out who I am as a person and who I want to be as a professional. I now have a unique way to show people what makes me me and what I have learned in school” (http://skashworth.weebly.com).

Zac Lee: “The Auburn ePortfolio Project allowed me to use a new form of media to learn more about myself, better explain who I am, and share my experiences as a biosystems engineer” (http://zacharyscottlee.weebly.com).

Anna Breland: “The ePortfolio experience allowed me the opportunity to look back at my college courses and identify tangible skills that I have to offer employers” (http://annabreland.weebly.com).

Based on this initial success, we have extended the incorporation of ePortfolios in several of the courses (asterisks in the table above, representing ~60% of the student population) in Auburn’s Department of Biosystems Engineering. Our long-term goal is to incorporate ePortfolios in all of the courses listed in the table. In each of these courses, ePortfolio-related assignments have been developed that at the minimum require students to collect artifacts related to the course and reflect on their collected artifacts by incorporating (1) the new competencies that they acquired in the course, (2) competencies that they learned in previous courses and then related to the current course, (3) competencies that they think they lack, and should acquire before graduation, in relation to a particular assignment, and (4) an overall reflection on their learning experience at this stage in the curriculum.

We also anticipate that by the time students are in the capstone design course, which is when they typically attend the career fair, they will have collected sufficient artifacts and reflections on their learning, through their ePortfolios, to be able to articulate their learning experience and their overall competence. Ultimately, we expect that ePortfolios will lead to a better learning experience for undergraduate BE students, including improvements in their communication skills, critical reflection, visual literacy, and technical competency. Most important, the students will learn how to provide evidence of their abilities to potential employers—because it’s not enough to know something; you have to be able to show it. Initial evidence from the 2014-2015 graduating class indeed shows that this is the case. A higher percentage of the graduating students were invited for employer interviews before graduation, and their ePortfolios were part of the reason these students were interviewed.

ASABE member Oladiran Fasina, P.E., Alumni Professor; ASABE member Puneet Srivastava, P.E., Professor; ASABE member Mark Dougherty, P.E., Associate Professor; ASABE member Sushil Adhikari, P.E., Alumni Associate Professor; ASABE member Timothy McDonald, Professor; ASABE member Steven Taylor, P.E., Professor and Head, Department of Biosystems Engineering; and Margaret Marshall, Office of University Writing, Auburn University, Auburn, Alabama, USA. Contact e-mail: fasinoo@auburn.edu.

Further reading

In addition, software platforms for designing ePortfolios are freely available from Auburn University’s Office of University Writing: http://wp.auburn.edu/writing/eportfolio-project/.

Courses in Auburn’s Department of Biosystems Engineering that will use ePortfolios

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*ePortfolios currently implemented
Let’s Help Smallholders Spray Safely

John Morrison, Jr., Amar Dhere, and Robin Bellinder

Editor’s note: A quick reaction we received to the cover image of the July/August issue of Resource created a learning opportunity. To represent the theme of global agriculture, we selected a stock photo of a young woman working in a field. The issue went to print, and the woman’s handheld sprayer wand escaped our notice. To more experienced eyes, this pastoral image represents potentially toxic pesticide exposure. We are grateful to the authors of this article for explaining this serious, and all too common, hazard.

Around the world, in more regions than we can imagine, farmers apply pesticides using methods that are dangerous to their short-term and long-term health. While there are many other health and safety issues involved in pesticide handling and application, the widespread use of knapsack sprayers with single-nozzle spray wands, especially on smallholder farms, requires workers to apply pesticides directly in front of themselves as they walk through the field or between crop rows. The workers are typically unprotected from the fumes, the airborne spray droplets, and the pesticide-wetted foliage. Safety boots, wet suits, goggles, and respirators are unknown, and typical worker attire may be short pants and sandals.

The research literature from India is full of horrific data on the results of repeated pesticide exposures from using knapsack sprayers and single-nozzle wands. Skin disorders are most common, with reports of skin rashes and cancers, but the list of disorders is long and includes poisoning, loss of fingernails, dizziness, brain and nervous system damage, birth defects, miscarriages, muscle cramps, difficulty breathing, abdominal pains, body tremors, coughing, death—and the list goes on. It appears that most of these reported symptoms are the result of direct contact with pesticides.

The knapsack sprayer is a useful and economical tool for smallholders; consequently, these portable sprayers are used by millions of farmers. The horror of the current situation is that many action-agency advisors are training farmers in the use of knapsack sprayers using single-nozzle wand attachments. In the extreme, at least one NGO is teaching the “new and improved” method of using a multi-nozzle spray boom carried ahead of the worker to cover a wider swath, while the worker walks closely behind, through the cloud of sprayed pesticide.

Let’s assume that the knapsack sprayer tank and pumping unit are here to stay. What can we do to make them safer to use?

As an agricultural engineer, with a knapsack sprayer on your back, where would you want the spray nozzles to be located relative to your position? It’s simple—you would want the nozzles to be as far behind you as possible for the particular field operation at hand. The criteria for such technology might be:

- Position the spray nozzle or multiple nozzles on a lightweight boom that workers can easily pull behind them across the field or between crop rows.
- Use regulated low spraying pressure to minimize pesticide atomization and drift.
- Use spray nozzles that develop their full spray pattern at low pressures, again to minimize atomization and drift.
- Use a dripless quick disconnect on the pressure line between the knapsack sprayer and the trailing boom for convenient separation of the worker from the boom to facilitate rest breaks and refilling operations.

The above criteria are not rocket science, nor are they intended to guarantee complete protection from pesticide exposure, but they seem to be worth field-testing against the current methods. Models of safer sprayer attachments have been developed and have been demonstrated occasionally, but they have not been adopted. We would be interested to learn about any innovations in handheld sprayer design or training that can protect people from the hazards of pesticide exposure. Together, this is a problem that we can solve.

ASABE member John Morrison, Jr., Adjunct Professor, University of Tennessee, Knoxville, Tenn., USA, morrison@mounet.com; Amar Dhere, Assistant Professor, Department of Science, SVT College of Home Science (Autonomous), SNDT Women’s University, Mumbai, India, prof.amardhere@gmail.com; and Robin Bellinder, Professor, Department of Horticulture, Cornell University, Ithaca, N.Y., USA, rrb3@cornell.edu.

Sled (left) and buggy-type wheeled carrier (right) for single or multiple spray nozzles.
Before I joined the 1/4 Scale team during my sophomore year at the University of Wisconsin-Madison, my experiences with fabrication in a shop were mostly with a hammer, grinder, and stick welder. Don’t get me wrong, I could fix anything on the farm, but I never built anything from scratch. On the 1/4 Scale team, I got hands-on experience running a milling machine, lathe, press, cut-off tools, press-brake, shear, MIG and TIG welders, tube benders, and much more. The 1/4 Scale project also gave me experience in practical engineering skills, like modeling parts, finite element analysis, cost and project management, and fund raising. In my current job at John Deere, I still rely on what I learned in 1/4 Scale to help me understand the complete picture and design things that will work in real life.

Learning by doing

To stay on schedule leading up to the 1/4 Scale competition, my team had to make decisions fast and frequently. There were often three or four “right” answers, but time and cost constraints required us to build consensus among the team and then move on. This ability to weigh options, make a decision, and stay on schedule is valuable in the workplace, and it’s needed throughout the 1/4 Scale design process. The competition won’t be delayed if your team isn’t ready; you have to meet the deadline.

When we presented our tractor at the competition, I thought I understood the judging process as well as the judges did. I didn’t appreciate it the time, but they were a lot nicer in their critique than I realized. Nevertheless, it can hurt to hear...
someone declare that the product of your hard work, pride, and joy is not up to their full expectations. That was a great lesson in humility!

Looking back, it’s easy to see opportunities for improvement, but in the heat of the battle, they aren’t always so clear. That’s where a network of knowledgeable people is valuable. You learn to rely on trusted mentors and other experts who can provide candid feedback on your ideas.

**Building a network as well as a tractor**

In fact, participation in 1/4 Scale is as much about building those relationships as it is about hands-on learning. For me, 1/4 Scale was a springboard for my involvement in ASABE—volunteering for whatever I could, attending meetings, and trying to soak up all the tech sessions. My first trip to the Agricultural Equipment Technology Conference (AETC) in Louisville was to display UW-Madison’s 1/4 Scale tractor. That was all it took to get me hooked on the Society, its members, and AETC specifically. Since then, I’ve only missed only a couple of AETCs.

I also have fond memories of carpooling to other ASABE meetings over the years. My team took our 1/4 Scale tractor to the 1999 Annual International Meeting (AIM) in Toronto. We traveled with an unassuming PhD student and now former **ASABE president Terry Howell**, who never expected the experience our team provided! When I lived in Iowa, I traveled to Iowa Section meetings with a group of John Deere colleagues—and former **ASABE president Tony Kajewski**’s seemingly limitless supply of homemade beef jerky!

At the 2000 AIM in Milwaukee, I volunteered to work in the book room (yes, back when there were books and meeting papers that needed to be distributed). My plan was to save some money on the registration fee, but I ended up with much more. I was assigned to work with Jill Grodecki, who was also a student at UW Madison, although we hadn’t met before. Jill and I hit it off, we started dating when we returned to Madison, and three years later she became Jill Huenink!

**Enduring value**

Student design competitions give you a place to test your ideas, exercise your classroom knowledge, and learn in a safe environment. It’s okay to fail, and fail often, as long as you pick up the pieces, understand where you went wrong, and plan how you can improve.

If you’re on the fence about participating in 1/4 Scale, my advice is to dive in and stick with it. It will be difficult, and you will want to give up. But stay the course, because the reward is always great—even if your team doesn’t take home the trophy.

From time to time, I interview candidates for hire at John Deere. One of the first things I look for is experience with 1/4 Scale or an equivalent competition in the candi-
About the Author

For the last 12 years, Brian Huenink has been a design engineer at the John Deere Product Engineering Center in Waterloo, Iowa, working on the 5000 to 9000 Series tractors. He served on the team that redesigned the 7R tractor for the 2011 model year and received a John Deere Innovation Award for his work on that program. He continued working on the 7R and 9R programs to provide new exhaust systems to meet Final Tier 4 emissions requirements. He is currently on the team responsible for future updates to the 8R program.

Huenink graduated from the University of Wisconsin-Madison with an agricultural engineering BS in 2000 and MS in 2003. Four years ago, he began a new adventure by becoming a full partner on his family’s dairy and certified seed farm in Wisconsin. He continues his work for John Deere as a telecommuter.

He has been involved with ASABE’s 1/4 Scale Tractor Design Competition since it started in 1998, first as a student and later as student member of the organizing committee. Upon graduation, he volunteered as a full committee member, having progressed through most of the officer positions.

Huenink notes that 1/4 Scale is unique among student engineering competitions because it provides a realistic design and manufacturing experience. Each student team is provided with a 31 hp Briggs & Stratton engine and a set of Titan tires. After that, the design is up to them.

At the competition site, industry experts judge each design for its innovation, manufacturability, serviceability, maneuverability, safety, sound level, and ergonomics. The teams also submit a written report in advance of the competition and they must sell their design in a live presentation to industry experts who play the role of a corporate management team. Finally, the machines are put to the test in three tractor pulls and a maneuverability course.

As Huenink explains, through involvement in the competition, students gain practical experience in design and manufacturing processes, as well as analysis of tractive forces, weight transfer, strength of materials, and other engineering concepts. They also develop skills in communication, leadership, teamwork, and fund raising. For more information about the 1/4 Scale Tractor Design Competition, contact Mark Crossley (crossley@asabe.org) or visit the ASABE website (www.asabe.org/membership/preprofessionalstudents/14-scale-comp.aspx).
Editor's note: ASABE member Tony Grift initiated the ASABE Student Robotics Competition in 2007. Since then, he has provided steady leadership as chair of the competition committee.

Time flies when you’re having fun. That’s a cliché, but it’s true for those involved in the ASABE Student Robotics Competition. For nine years running, it’s been a crowd-pleaser at ASABE’s Annual International Meeting (AIM).

I remember exactly why we started this competition. For years, I’d been spreading the gospel of need for agricultural automation and robotics. My alma mater, Wageningen Agricultural University in The Netherlands, had hosted a similar competition, although the Wageningen event took place outdoors. In 2006, I officially proposed the idea of a student robotic design competition as a recurring event at the AIM, and the ASABE Foundation generously provided seed money to get the first robots up and running. It took off from there!

Challenges along the way

When we started the competition, and every year since, our goal was to be an exciting part of the AIM. Therefore, to be close to the AIM attendees, we were constrained to a relatively small indoor space. In addition, the robots had to be small enough to allow the teams to transport them as checked baggage.

To set our event apart from other robotics competitions—of which there are many—we developed a defining factor: the competition must be related to agriculture. Over the years, we’ve refined that aspect of the event based on the local agricultural practices where each AIM was held, such as feeding cattle in Texas (Dallas 2012), harvesting round hay bales in Kansas (Kansas City 2013), and collecting sap for maple syrup in Canada (Montreal 2014). Next year’s AIM in Orlando may inspire a competition related to citrus fruit.

Furthermore, the competition must be achievable—but challenging—for a two-person team with a limited budget, and it must offer a spectacle for the AIM attendees. For instance, we once received a suggestion about building an instrumented potato (which in real life travels through harvesting and processing machines to study the forces exerted on potatoes), but we had to decide against it. It’s useful technology, but it’s not much to look at. The same goes for controller area network (CAN) plug fests, where students write software according to a standard and see if two separately developed systems can talk to each other. It would make for a high-tech competition, but there’s not a lot of excitement in staring at computer screens.

ASABE’s Student Robotics Competition is Thriving

Tony Grift

Kansas State University takes the prize.

Clemson paws tackle the track.

Washington State University zips along.

University of Illinois stares down the competition.

McGill maneuvers a forest of obstacles.
We’ve also considered robotic sheep shearing, but so far ASABE has been hesitant about that idea—to say nothing of the sheep.

We initially worried that finding impartial and attentive judges would be a problem, but every year we’ve had excellent judges. They volunteer their valuable time at the AIM to support our students and our Society. We’re fortunate that, as engineers, we can build stuff that works and cheer each other on—and not every profession gets to do that!

Lessons from previous events

At the first competition in 2007 in Minneapolis, we had five teams: Kansas State, Iowa State, McGill, Oklahoma State, and the University of Illinois. That first challenge involved robotic grain harvesters and unloaders. The grain was represented by BBs (4.5 mm metal balls). At the time, the robots were typically constructed using LEGO® Mindstorms components, and the controllers used line-of-sight communication. The harvesters and unloaders communicated with each other, the teams learned how to define communication protocols, and for a first attempt, it was a very good experience. We also learned that materials handling can be hilarious when things go awry, as thousands of BBs spilled onto the floor while students frantically tried to contain them.

In 2008, the challenge was to selectively harvest randomly placed “trees” (represented by painted dowels of two sizes). We assumed that the teams would build harvesters that roamed through the forest, randomly finding the right trees to harvest. Instead, Kansas State surprised everyone with a huge gantry system that did a beautiful job of grabbing only the thicker trees. The judges looked at this behemoth and wondered if it was legal, but the rules did not prevent it. It didn’t represent the way such things work in reality, but nowhere did the rules say that the solution had to mimic reality! The Kansas State team had found a loophole and then capitalized on it, and there was nothing wrong with that. However, to prevent this kind of thing from happening again, we now require that the robot must fit within a cubic foot at the start and end of its run.

The 2011 competition in Louisville required robot harvesters to follow a row of wheat made from broom bristles—which took a long time to construct! The goal was to travel the longest distance while maintaining a constant distance relative to the wheat. To trace the machine’s path, we required each robot to drop a trail of coffee particles, which had to be removed after every run. It was quite a sight: the robots running, the students sweeping up the coffee trails, and the judges right behind them. It was like a carefully choreographed performance. And it was one of the best competitions: speed, pandemonium, and students and judges trying to stay out of each other’s way.

Zhejiang University sent two teams from China to compete in the competition.
You'd think that, with so many constraints, it must be nearly impossible to come up with a new challenge each year. That hasn't been a problem. However, one of the most difficult constraints for the teams is the limit imposed on resources. If there were no limits, a two-person team with a $500 robot would have to compete against a ten-person powerhouse with a $30,000 budget. Of course, it's impossible to police how many people are involved and how much money they spend, but we want to give every team the same opportunity.

That brings me to Kansas State's controversial winning streak. Because KSU has won first place nine years in a row, some people have wondered if the competition is fair. Yes, it's fair. The KSU teams have come up creative ideas and amazing machines. To beat KSU, other teams must work at KSU's level, rather than force KSU to descend to the realm of mere mortals. The goal of the competition is to achieve the highest possible level of technical sophistication, presentation, and reporting—and KSU consistently does that. Kudos to them!

Looking ahead

At the 2014 AIM, ASABE Fellow Naiqian Zhang and ASABE member Alex Thomasson explained how they use the ASABE robotics competition in their coursework at KSU and Texas A&M, respectively. I'm in favor of that, and I hope other university instructors will do the same.

We once feared that some technologies were too advanced for an undergraduate team, but experience shows otherwise. At the 2015 competition in New Orleans, the teams did not shy away from coupling image-processing to client-server computing, communicating in five different programming languages, twittering results in real time, and generating 3D printed parts. We have also grown from a low of three teams in 2008 to eleven teams in 2015, which has required us to extend the competition to Monday afternoons and Tuesday mornings.

The future of the robotics competition looks good. As we eventually get into drones, perhaps underwater challenges, and linking up with the 1/4 Scale Tractor competition and even Fountain Wars, there's no possibility of it becoming stale. Most important, as long as we provide a competition where our young engineers can apply their energy, creativity, and resourcefulness, it will be an entertaining and educational event for years to come. And I want to see that sheep get sheared before I retire!

ASABE member Tony Grift, Associate Professor, Department of Agricultural and Biological Engineering, University of Illinois at Urbana-Champaign, Urbana, Ill., USA, grift@illinois.edu; ASABE member Jodie Wehrspann, Senior Editor, Farm Industry News, Minneapolis, Minn., USA, jodie.wehrspann@penton.com, contributed photos for this feature and served as a 2015 competition judge.

To learn more about the ASABE Student Robotics Competition, visit the ASABE website: www.asabe.org/awards-landmarks/student-awards,-competitions-scholarships/robotics-competition.aspx
Indoor farming was once only available to research laboratories and NASA. Cubic Farming™, generally referred to as vertical farming, is now becoming a commercial reality in Canada. For over a year, Urban Barns Foods has been producing high-quality lettuce, herbs, and microgreens in a fully controlled space in Mirabel, Quebec. Reclaimed warehouse space is ideal for the installation of the proprietary modular Cubic Farming™ technology that allows production of leafy greens using state-of-the-art LED grow lights. The company has an ongoing collaboration with ASABE member Mark Lefsrud, associate professor and William Dawson Scholar at McGill University. His team of researchers and students develop and optimize the technology and methods used by the company.

In the past century, in order to meet the demands of an increasing global population, agriculture has undergone intensification, concentration, and specialization. Modern agriculture has evolved into a resource-intensive process. The standard methods for commercial field production of fruits and vegetables involve rigorous use of herbicides, pesticides, irrigation, and heavy machinery, which results in rapid exhaustion of soil fertility, widespread damage to ecological habitats and water supplies, and negative effects on human health. In combination with improvements in transportation logistics, intensive agriculture has flourished and is now part of a worldwide market in which consumers have constant access to imported fresh produce, regardless of the season or availability of local produce.

What is Cubic Farming™?

Although fruits and vegetables can be easily shipped around the world, intensive agriculture and the global transportation of these agricultural goods contribute to high CO₂ emissions. In addition, there is a growing awareness of agricultural sustainability, as well as food safety, security, and traceability. Reduced dependence on foreign food and increased availability of local food will also continue to grow. To address these concerns, Cubic Farming™ is a form of controlled environment agriculture that allows growth of fresh produce year round in locations that are challenging for conventional forms of agriculture, including arid urban areas and harsh northern climates.
A fully indoor controlled environment for crop production requires control of all the environmental factors involved in plant growth, from the temperature and relative humidity of the ambient air, to the lighting and nutrients delivered to the plants. The result is an efficient and fully traceable operation that is less resource intensive (using roughly 6% of the water that would be required to irrigate an equivalent field); that does not require fungicides, pesticides, or herbicides; and that has unparalleled consistency. The environment in which the plants grow is optimized for growth, reducing the time to harvest to as little as two or three weeks for some lettuce varieties, roughly half the time required in most commercial greenhouse operations.

The latest Cubic Farming™ growth unit developed by Urban Barns Foods and the McGill team has a capacity of 300 heads of lettuce per square foot. By comparison, a conventional lettuce operation typically produces two heads per square foot. The process begins with certified organic and non-GMO seeds placed in a standard hydroponic substrate such as rockwool. After germination and a short maturation period, the seedlings are relocated into stacked stainless steel trays that rotate through the growth unit on a system of cables to provide the crop with uniform light and a regular supply of recycled water. The water, which contains essential plant nutrients, is carefully injected into the trays and is recovered, rebalanced, and reused. The McGill team is currently testing several promising biological and fully biodegradable alternatives to rockwool, a non-renewable material that currently has limited organic alternatives.

**Lighting for living color**

One of the cutting-edge technologies used in the growth units is the intercanopy lighting method. Because current plant lighting technologies are intended for overhead use, the obstruction of light at the lower levels creates a limitation to stacking layers of plants. Intercanopy lighting brings the light source in close proximity to the plants and allows intense and uniform distribution of the light. The McGill team has developed high-intensity LED strips that are designed for use as intercanopy grow lights. Two essential conditions must be met to obtain effective intercanopy lighting. First, the surface of the LED strip must remain relatively cool to avoid scorching the plant leaves, which is an issue with high-intensity LEDs. Thermal management is important when designing grow lights in general, but it’s imperative when designing intercanopy lights.

Second, the McGill team has optimized the colors of the LEDs. In a natural environment, plants use most of the spectrum of sunlight as an energy source to make the sugars and carbohydrates needed for growth. Published research has shown that plants can grow efficiently and can even be stimulated to increase in nutritional value when subjected to a precise blend of different wavelengths of light. LEDs are wavelength-specific, which means they emit only the exact wavelength they were designed for. The McGill team has developed a specific mix of red, blue, and amber LEDs for use in the growth units.

**Leafy greens now, fruit-bearing plants next**

Cubic Farming™ is not limited to leafy greens. To broaden the company’s product line, the McGill team is selecting new varieties of plants that can thrive in the Urban Barns Foods growth unit. Dwarf varieties of bell pepper and tomato are examples of fruit-bearing crops that the team is currently testing. Edible flowers are also being tested. Locally sourced strawberries during Montreal’s cold winter months may become a reality in the near future thanks to Urban Barns Foods and the team of researchers at McGill University.

This technology might seem far out for some consumers, but it’s an insight into the future of fresh food production. Sustainable, traceable, and local fresh food is a growing movement, and the Cubic Farming™ method, developed by Urban Barns Foods and McGill University, is providing just what consumers want at a never-before-seen quality and production rate.

**ASABE member Lucas McCartney, Doctoral Student, Department of Bioresource Engineering, McGill University, Macdonald Campus, Ste-Anne-de-Bellevue, Quebec, Canada, lucas.mccartney@mail.mcgill.ca.**

Cubic Farming™ is a trademark of Urban Barns Foods, Mirabel, Quebec, Canada; www.urbanbarns.com.
So, What’s an Iron Goat?

S
o, what is an iron goat? In many respects, it’s similar to a regular goat, the hardy domesticated animal noted for its frisky behavior and hearty appetite. Similarly, the iron goat roams, eating plants and producing “pellets.” It has a digestive system that derives energy from the plants it consumes, so it will eat as long as there is something to eat. It’s voracious, too, consuming 360 kg (800 lb) an hour. Sound great? But why would someone want one of these?

This goat is a harvesting machine—a computer-guided, self-powered pelleting harvester. It produces dry pelleted agricultural products directly from standing plants without human labor or fossil fuels.

While the initial market is forage for livestock fodder, this technology has applications in a variety of industries. The iron goat creates opportunities for commercial agricultural processes to coexist with the natural environment, reducing the need for segmented land management. Policy rules can be implemented in the software: “Eat this, not that,” “Don’t disturb the nesting birds,” “Only harvest 10% of this area this year.”

Its stereo hyperspectral machine vision system allows the iron goat to be species-selective, so it can target invasive species like Bromus tectorum (a noxious weed that invades grassland communities and displaces native plants), which often thrive in disturbed areas. Also known as drooping brome or cheatgrass, Bromus tectorum is responsible for significant wildfires in the U.S. Midwest.

While there are other interesting technical innovations in the iron goat, for any new technology to be sustainable, the biggest impact is in the business model. Removing the cost of labor and fuel makes big a difference, and that makes the iron goat a game changer in agricultural feed production. In addition, pelleted products are easier to transport, handle, and store compared to the conventional methods used for producing livestock feed, and the iron goat eliminates the need for a separate pelleting process.

Putting the goat out to nibble

In North America, the primary uses of the iron goat are in feed production and ecological engineering. In impoverished areas of the world, a self-powered feed and fuel producing machine could bring great changes. A low entry barrier to producing local fuel and livestock feed could serve as a catalyst for local economies and drive improvements in the local infrastructure. The process is designed primarily for grassy sources, so it can also reduce deforestation for fuel use.

The energy technology and biomass gasification process is simple: remove the water from harvested biomass, pelletize, and gasify. The output fuel is compatible with most engines designed for gasoline operation. In terms of performance, the process produces 8.5 kg kWh⁻¹ (14 lb hp-h⁻¹) of dry pellets and consumes about 1.3 kg kWh⁻¹ (2.2 lb hp-h⁻¹). For example, with a ~15 kW (20 hp) engine, production would be 128 kg h⁻¹ (280 lb h⁻¹) and consumption would be 20 kg h⁻¹ (44 lb h⁻¹). These figures include energy for cutting, moisture removal, biomass processing, mobility, and sensors. Co-generated heat from the engine is used for drying, and there is significant excess.

Gasification is not new

The production of energy through gasification has been around for nearly 200 years. Coal and peat, which were used to produce town gas for lighting and cooking in the 1800s, have since been replaced by electricity and natural gas. They were also used in blast furnaces, but they played a larger role...
in the production of synthetic chemicals, for which they have been used since the 1920s.

During both world wars, especially WWII, the need for gasification-produced fuel re-emerged due to petroleum shortages, especially in occupied territories. Wood gas, also called gasogene or gazogene, was used to power motor vehicles in Europe. By 1945, there were trucks, buses, and agricultural machines powered by gasification. It is estimated that close to nine million vehicles were running on producer gas all over the world.

**From the past to today’s pellets**

The iron goat converts biomass directly to pellet form in a single pass without human labor. The pellets, for use as fuel or fodder, are periodically off-loaded from the mobile harvester to fixed or mobile storage. The iron goat is guided by machine vision and GPS, and it can operate around the clock in most weather. The harvested crop also fuels the engine through the onboard gasification process, significantly reducing emissions and cost.

Future plans include micro-grid power generation and licensing the technology for use in vehicles, heating, and electrical power generation. We are also establishing partnerships on both the supply and demand sides of agricultural feed, power generation, and agricultural equipment manufacturing. The impact will be financial, social, and environmental. In emerging economies, where the capital equipment cost is a significant barrier to establishing power utilities, the iron goat can be a revolutionary micro-grid solution. A single 600 lb harvester can produce enough fuel to provide 100 kW of continuous power. Environmentally, each harvester will offset about 600 tons (1.2 million lb) of CO₂ per season. We project 1000 harvesters running by 2017, with an aggregate offset of 600 ktons (1.2 billion lb) of CO₂.

**So, where did this idea come from?**

Spurred by the continual dread of lawn mowing, I created a mower that not only drives itself around the yard but also runs on fuel made from its own grass clippings. Based on a tractor-type mower with a conventional rotary cutter deck, the design stores the leftover fuel for quick startups, as well as for use in heating and, on a much larger scale, supplying power plants and prime movers with clean, sustainable energy. As always, one thing leads to another.

**ASABE member Jason Force, CEO, Iron Goat Technologies, Clifton, Va., USA, jforce@irongoattech.com, www.irongoattech.com.**
n early 2015, the ASABE Foundation kicked off the KEYS campaign, a targeted program focused on student development and humanitarian outreach. During the Annual International Meeting in New Orleans, the Foundation sponsored several fundraising activities with proceeds going to the KEYS campaign. Thanks to your generous support, nearly $8,000 was raised, bringing the YTD total to $62,000—steady and encouraging progress toward our five-year goal of $500,000.

The KEYS campaign is every member’s opportunity to ensure that agricultural and biological engineers continue to make a difference for years to come. KEYS funds will be made available to Society projects that educate youth about careers in agricultural and biological engineering and technology, to projects that motivate and build leadership among students while encouraging innovation, and to projects that help ensure that the expertise of our profession reaches those most in need of its benefits.

A contribution to the KEYS campaign is an important way to support our profession and its future. Ag and bio engineers can have great impact on a growing world that needs more food, energy, and renewable resources. Increased financial support will sustain and enhance our professional future, enabling the influence that we can have. The Foundation will use KEYS funds to support KEYS-based programs of the Society.

Like all contributions to the Foundation, your support for the KEYS campaign is fully tax-deductible. Please consider contributing to this important campaign before year end. Your membership invoice will contain a donation allocation line where you can specify a donation to KEYS or other Foundation funds, or consider sending a contribution directly to:

ASABE Foundation KEYS Campaign
2950 Niles Road
St Joseph, MI 49085-9659 USA

Contact Darrin Drollinger (drollinger@asabe.org; phone 269-932-7007) or visit www.asabe.org/foundation.

ASABE member and Foundation Development Committee Chair Sylvia Schonauer, P.E., Principal Engineer, Advanced Innovation, W. K. Kellogg Institute, Battle Creek, Mich., USA, sylvia.schonauer@kellogg.com.

Special awards sponsored by ASABE at Future City regional and national competitions raise awareness of engineering for food, agriculture, and biological systems.

K-12 outreach: ASABE sponsors awards at Future City competitions for food and renewable energy—a great way to introduce the next generation to our profession!
The Pharos of Alexandria Global Learning Award is one of several that honor student excellence.

Student competitions, like Robotics (above) and Fountain Wars (directly above), enrich academic experience and cultivate hard and soft skills for workplace success.

John Lumkes (front row, far right) of Purdue University was the first recipient of a Giving Back Fund grant, for the Purdue Utility Project.

Encourage humanitarian missions:
The Giving Back Fund provides financial support to projects that showcase the knowledge and skills of our profession through projects that benefit underserved individuals or groups.

Youth career development:
The Young Professionals Community has encouraged many new graduates to become active in ASABE.

Student chapter support:
The Foundation supports many of the student competitions and events that student chapters are involved in. With your support of the KEYS campaign, more students can participate in expanded opportunities and ASABE meetings and programs.

The Pharos of Alexandria Global Learning Award is one of several that honor student excellence.

The Young Professionals Community leads efforts to address the unique needs of early-career ASABE members.
Helping Texas sorghum growers reduce water use

In Brief: ASABE member Susan O’Shaughnessy is providing much needed guidance to sorghum farmers in the Texas High Plains who are trying to save water by using less-than-optimal amounts of it.

Farmers in the High Plains area are turning to sorghum because many of them suffered major losses raising corn during recent droughts and water shortages. Sorghum is more drought tolerant than corn, but growers need to know if they will get sufficient yields using less water. They also must decide whether to raise early-maturing sorghum varieties (which are planted later and are less vulnerable to drought) or late-maturing varieties (which produce higher yields if given enough water).

O’Shaughnessy, an agricultural engineer with the USDA-ARS in Bushland, Texas, evaluated yields and water use efficiency of early- and late-maturing sorghum varieties produced under four levels of deficit irrigation. She and her colleagues planted late-maturing and early-maturing varieties at optimal times and harvested both types at about the same time in the fall. They grew the crops for three seasons, tracked weather data and rainfall levels, and measured evapotranspiration rates—an indicator of the plant’s overall water needs. Above-average rainfall occurred in 2009 and 2010, and much lower than average rainfall occurred in 2011.

They found that on average over the three growing seasons, crop water use efficiency (the water used by the crop in relation to the crop yield) was typically greatest at the 55% replenishment level, but even 30% replenishment at least doubled the yields when compared with no irrigation. At 80% replenishment, the late-maturing variety consistently produced higher yields than the early-maturing variety, but the early-maturing variety produced sufficient yields to make it a viable alternative. Growers risk severe or total losses if they practice even moderate deficit irrigation during droughts. In fact, total crop failure is likely without at least some irrigation in drought years like 2011.

The results from this research should help farmers in regions with a growing season that has erratic rainfall, widely varying temperatures, and extreme weather, such as hail, flooding, and lightning.

For more information, contact Dennis O’Brien, Public Affairs Specialist, USDA-ARS, dennis.obrien@ars.usda.gov.

In Bushland, Texas, an early-maturing hybrid of grain sorghum irrigated at a mild deficit level shows little water stress. Photo by Susan O’Shaughnessy.
Taking the temperature of water-thirsty plants

In Brief: When crops get thirsty, they get hot. Farmers can use canopy temperatures to determine if crops are water stressed, but the process can be complicated. ASABE member Kendall DeJonge, a USDA-ARS agricultural engineer in Fort Collins, Colorado, has found a way to simplify the process. The goal is to manage irrigation water more effectively in an area where saving water has become a top priority.

A key to DeJonge’s research is the use of infrared radiometric thermometers (IRTs), affordable sensors that can determine the crop canopy temperature and subsequently whether a crop is water-stressed. IRTs can be placed on fence posts or center-pivot irrigation systems to gather hourly or daily temperature readings on crops. Farmers and researchers can interpret the IRT data by using one of several indices, including the commonly used crop water stress index (CWSI). Developed by the USDA-ARS in the early 1980s, the CWSI involves using the air temperature and humidity to calculate a “vapor pressure deficit,” in addition to knowing the canopy temperature. The process is technical and requires additional measurements, so many farmers in Colorado just “guesstimate” when irrigation is needed. As a result, farmers may over-irrigate and waste water or under-irrigate and reduce yields. Providing farmers with a simple yet effective method of monitoring crop water needs is key.

Population growth and droughts have made water a critical issue in Colorado, and DeJonge says using IRTs to determine crop water needs just makes sense. “With water becoming more precious, we need to exploit the potential of every tool available,” he says.

DeJonge and his colleagues compared the CWSI with five other indices for interpreting IRT data to see how well they could detect crop water stress over two years in a corn-sunflower rotation. All of the indices used crop canopy temperatures to determine water stress levels. The CWSI, often considered the gold standard for quantifying water stress, also required air temperature and humidity data. Two of the indices developed for the study were simpler than the CWSI, including the “degrees above non-stressed” (DANS) index and the “degrees above critical temperature” (DACT) index.

DANS is calculated by comparing a stressed plant’s temperature to the temperature of a non-stressed plant in the same environment. DACT is based on an established crop temperature threshold, with plant water stress determined by how many degrees the plant temperature rises above that threshold. Crop canopy temperatures for DANS and DACT were taken each day at 2:00 p.m., when water stress levels were usually highest. The researchers monitored soil water levels and crop water use, and fully irrigated part of the field while intentionally stressing other areas, some moderately and some severely. All the while, the IRTs continually measured crop canopy temperature.

The findings showed that the DANS and DACT indices were just as effective as the CWSI at determining water stress even though they require much simpler measurements—a once-a-day reading of crop canopy temperatures.

DeJonge plans to develop “crop water coefficients” that establish water needs of specific crops for different scenarios. With that data, IRTs could be widely used by farmers. DeJonge foresees farmers using handheld IRTs in the near future, and eventually using IRTs with drones to calculate water needs over extensive areas.

For more information, contact Dennis O’Brien, Public Affairs Specialist, USDA-ARS, dennis.obrien@ars.usda.gov.

North Carolina’s AgrAbility project assists aging and disabled farmers

In Brief: All-terrain wheelchairs, truck lifts, and garden scooters are among the solutions that the North Carolina AgrAbility partnership has designed to help disabled farmers remain productive. ASABE member Gary Roberson, associate professor and extension specialist in the Department of Biological and Agricultural Engineering at North Carolina State University, discusses the program and the impact of student design projects for these farmers.

I’m the engineering consultant for the North Carolina AgrAbility project,” said Roberson. “AgrAbility is a partnership between North Carolina State University, North Carolina A&T State University, East Carolina University, and the Agromedicine Institute, where we assist farmers who have suffered some form of disabling injury or disabling illness maintain a level of productivity.

“We design or help design and develop assistive technology or adaptive technology that we can apply to tractors, combines—you name it. The garden scooter was one of our earlier projects. It’s designed to allow someone to move through a garden and harvest produce, vegetables, or whatever they want to do. It lets you get down close to the ground so you don’t have to bend or stoop or crawl. The original design was developed by ASABE member Mike Boyette here at NC State. We’ve been making some modifications and improvements all along. We have student groups working on enhanced versions of it.

“We also have an all-terrain wheelchair. There are some commercial units out there, but this one is a standard power wheelchair that our students modified to make it all-terrain. They’ve been able to demonstrate it climbing hills, climbing steps, going through streams—so again if someone needs to go out, maybe go around the fence line checking the status of livestock or maybe just go hunting or fishing, this is a device that will help them do that.

“We’ve got a truck lift. There are commercial lifts available that you can put on the back of a truck so you can lift things like coolers or produce baskets into the truck to take to the farmers market. This one is much, much less expensive. It’s also something that a farmer, if he’s got a good shop, can fabricate or can have fabricated locally. But again it’s designed to help make the task of lifting heavy objects into the back of the truck a lot easier.

“We’ve looked at other technologies, and in a lot of cases we’ve found a way to adapt things that are available off the shelf, to make things a little easier for farmers who have disabling or debilitating injuries or illnesses. “The senior design aspect of our AgrAbility project is unique to us, I think. We are one of the few programs—maybe the only one—that incorporates a senior design component into the AgrAbility program.

“Some of the projects are things that we have gleaned from dealing with clients. We work one-on-one with clients, so we get a lot of ideas. We will formulate the idea, write it up, and present it to the senior class. The seniors are free to choose the projects they are interested in. However, in the last couple of years, some of the first projects they chose were AgrAbility projects, because the students can see how useful it is for the person at the other end—the client.

“I think this work is important because we are trying to maintain agricultural productivity. Our farm population is steadily getting older. A lot of knowledge and experience is out there, and a lot of older farmers aren’t ready to quit. So, this is all about maintaining productivity, giving them the tools that they need so they can maintain that level of productivity, safely and comfortably.”

For more information, contact Carolyn Mitkowski, CALS News Center photographer, carolyn_mitkowski@ncsu.edu.

A video of Roberson’s interview, with clips of the projects he mentions, is available at www.cals.ncsu.edu/agcomm/news-center/media-releases/steward-of-the-future-gary-roberson/.
ASABE Fellow Singh receives World Agriculture Prize

In Brief: ASABE Fellow R. Paul Singh, a distinguished professor emeritus who has held dual appointments in the Department of Biological and Agricultural Engineering and the Department of Food Science and Technology at the University of California, Davis, has been named the 2015 Laureate of the World Agriculture Prize by the Global Confederation for Higher Education Associations for Agriculture and Life Sciences (GCHERA).

Singh’s award was announced at the annual GCHERA conference, held in June at the Holy Spirit University of Kaslik in Juniyah, Lebanon. Formal presentation of the award took place in September, during a ceremony at Nanjing Agricultural University in Nanjing, China.

“I was deeply humbled and honored upon receiving news of this award,” Singh said. “I’m proud of my students, post-doctoral fellows, and visiting scientists for their numerous contributions to our research program. I’m also indebted to my UC Davis colleagues for their consistent support, which has allowed me to pursue my research and teaching activities in food engineering.”

Singh earned a bachelor’s degree in agricultural engineering at India’s Punjab Agricultural University, and then a master’s degree and PhD at the University of Wisconsin-Madison and Michigan State University, respectively. He joined the UC Davis faculty one year later, in 1975.

“For over four decades, Professor Singh’s work as a pioneer in food engineering has been improving lives the world over,” said UC Davis Chancellor Linda P. B. Katehi. “This prestigious, and well-deserved, honor is a testament to the importance of his research, and UC Davis is tremendously honored to call him a member of our faculty.”

Singh became recognized for a body of research in areas such as energy conservation, freezing preservation, postharvest technology, and mass transfer in food processing. His research on airflow in complex systems helped in the design of innovative systems for rapid cooling of strawberries, and his studies on food freezing led to the development of software that improves the energy efficiency of industrial freezers. Under a NASA contract, his research group created food-processing equipment for a manned mission to Mars.

He has helped establish and evaluate food engineering programs at institutions throughout the world, including Brazil, India, Peru, Portugal, and Thailand. As of June 2015, individuals from 193 countries have viewed his 115 video tutorials more than 150,000 times.

In recent years, his research has focused on the physical mechanisms responsible for the digestion of foods in the human stomach, with an eye toward developing the next generation of foods for health.

The GCHERA World Agriculture Prize, a multidisciplinary, lifetime achievement award, was established in October 2012 on the occasion of Nanjing Agricultural University’s 110th anniversary. The prize is designed to encourage the global development of higher education institutions that focus on research and innovations in agricultural and life sciences by recognizing the distinguished contributions of individuals in these fields.

The previous GCHERA World Agriculture Prize laureates are Ronnie Coffman, an internationally acclaimed plant breeder at Cornell University, and Paul Vlek, a world-renowned soil scientist at Germany’s Bonn University.

For more information, contact Pat Bailey, UC Davis News Service, pjbailey@ucdavis.edu.
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Almost every morning when I check my email, there is another invitation to review a paper. I used to politely turn down review requests from journals that I’d never heard of, but now I just right-swipe these emails into the trash. I realize that finding qualified reviewers has become a problem, with so many new journals in print, and ASABE is not immune. I saw that problem first-hand when I co-authored a paper for *Transactions of the ASABE*. After 18 months, the Associate Editor told us that he couldn’t find any reviewers, sorry. At another journal, the editor went a step further. After two years, he told us that he couldn’t find reviewers and, based on that, implied that our paper was not worth publishing. Yikes! I also submitted a paper for which the editor could find only one reviewer, a statistician who hammered on the numbers and ignored the technical content. Clearly, the volunteer peer-review system is not working. So, let me offer a blunt engineering solution: pay me to review!

To test this innovative concept, I responded to review requests from a few obscure journals by saying that I now charge $10 per page. That did not stop the flood of invitations (they must have right-swiped my response), but one journal told me that they had taken me off their potential reviewer list. Pardon me? Are they really implying that my review of a ten-page paper is not worth 100 bucks? So it seems.

Why do journals expect us academic saps to do this work for free? Are they poor? No, they aren’t. Reed Elsevier recently reported a pre-tax profit of approximately 1.1 billion Euros (being aware of the tax brackets in the Netherlands, I recommend moving the headquarters to the Cayman Islands, but that’s another story). Seriously, what is left of the argument that poor Elsevier, or any other publisher, needs to rely on an army of volunteers to vet their manuscripts?

Some administrators might argue that reviewing papers is part of my job. It comes with being a professional, and I have to show some loyalty (I find that rather hypocritical, since loyalty is scant among the highest echelons of organizations, but that’s for another day). And sometimes the system actually works. I recently co-authored a paper on which the reviewers did a fantastic job. At the second revision, instead of calling us stubborn (or stupid), they stayed calm and even apologized for not being clear in the first revision. That paper was much stronger for their efforts. In particular, ASABE’s volunteer reviewers are wonderful people who care about the Society and our profession.

But that’s not the point. I’m also a loyal long-time ASABE member, and as a trained engineer, I need to optimize everything (and I’m writing this article for free, so there).

The point is that the current system is obsolete and ineffective, and there is an easy fix. Pay people small amounts for small jobs. An incentive of just $100 to review a ten-page paper will make me do it faster, much better, and by the deadline. The same goes for a weekend-long review of a proposal at, say, $750. If I get inundated with pay-based review requests, I will gradually raise my price until I reach a comfortable equilibrium (how American of me). Over time, this will create a market mechanism in which the best reviewers get paid the most, and I hope to be among them. We will no longer have these frustrating delays in the review process, the reviews will be much more thorough (and not handed off to an unsuspecting post-doc), and the quality of the literature will improve. This isn’t rocket science, friends: you get what you pay for.

I’m sure there are technical hurdles to the payment process, but these are the days of PayPal, Apple Pay, and bitcoin (don’t pay me with that one). The days of wiring funds through Wells Fargo are over. Maybe you can send me review invitations with a downloadable remittance already attached. I’m sure some bright IT person can make it happen. If you don’t trust that I’ll pay taxes on the income, then consider me an independent contractor. I’ll be waiting for my 1099 in the mail. Whatever you have to do, just pay me, pal! You’ll be glad you did.

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