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FEATURES

5 Energy Issues Series
From Field to Biorefinery
Gale A. Buchanan, Joseph A. Dunn, James R. Fischer, Stanley R. Johnson, and Janine A. Finnell
In the third feature of Resource’s ongoing Energy Series, the co-authors examine the current intriguing research on the feedstock interface.

COVER STORY

8 The Recycling King’s Workshop for Kids
James W. Garthe
“As part of our unwritten professional doctrine, I believe we have an obligation to perpetuate our engineering profession. One way of doing this is by becoming active in our communities and exposing others to our ways.”

10 Power Hop
Reed Turner
“… power hop is time consuming to deal with, often seems to slow down operations at the worst possible moment, and can be painful for the operator and hard on the equipment.” What can agricultural engineers do?

14 Addressing Water Issues in the Peach State
Georgia Irrigation in Review
Kerry Harrison
Drought, water wars, permit systems … Georgia has seen it all.

19 Global Opportunity – Tanzania
Modern-Day Marco Polo
Fred Bergsruud
Taking a chance: improving the living conditions of farmers by moving them from below-subsistence production to having sufficient surplus to market and realize profit.

22 Energy Performance of Homes and Households
Allen Zimmerman
C’mon, ASABE! Do some calculations, reduce energy consumption, and live “greener.”

DEPARTMENTS

4 From the President
4 Events Calendar
25 Update
29 Professional Opportunities
30 Professional Listings
31 Last Word

ON THE COVER
His Majesty James Garthe wears a crown fit for a Recycling King as he literally takes the wonders of his profession “to the streets,” teaching and demonstrating for school-age children and often their parents as well.
The world looks to ASABE members and others in allied professions for solutions to global demand for energy, food, potable water, and natural spaces to escape pressures of daily life. As we embark on our next century, ASABE’s historic mission is as valued today as ever; plus, skills in sustainable systems, biological engineering, appropriate technology, and bioproducts processing set the stage for our members and professions to meet the challenges ahead.

The context of how we organize and operate as a professional and technical society is affected by many factors, all for the good. Globalization of communication, technology, transport, and economies affect how we deliver knowledge, develop standards, and execute committee activities. The move to Web-based forums and teleconferencing enable members and clients to participate from anywhere worldwide. The shift to electronic communication is one of the most visible changes to how we do business and how we strive to serve members in more than 100 nations around the globe.

Education of biological and agricultural engineers is global as well. While only a few engineering programs outside North America met ABET standards 20 years ago, today hundreds of programs around the world graduate competent engineers and technologists. ASABE is recognized as the source of expertise on curricular standards and content for agricultural, biological, food, and forest engineers worldwide. And ASABE’s curriculum and accreditation committees assist new and improving programs globally to ensure that all graduates can competently contribute to solving local and global challenges.

Leaders of nations implore conversion from fossil-fuel-based economies to renewable energy and materials and, at the same time, urge us to bring the carbon footprint under control. We already observe the stress of allocating productive farmland and water to production of food versus non-food biomass and pf using forest resources for paper and building products versus bioenergy and solid biofuel. Biological engineers contribute to the needed systems, process design, management, and products. Agricultural engineers have made major contributions to efficient production, transport, and processing of bio-based materials.

The future is bright for those in the profession today, and it looks no less bright for the next generations. We should be proud of how our Society has adapted to the context in which we operate and how members have risen to the challenges facing the constituencies we serve.

Sincerely,
Jim Dooley, Forest Concepts, LLC
jdooley@forestconcepts.com

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**ASABE CONFERENCES AND INTERNATIONAL MEETINGS**

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

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>Aug. 31-Sept. 4</td>
<td>The Eighth International Livestock Environment Symposium (ILES VIII). Iguassu Falls, Brazil.</td>
</tr>
<tr>
<td>Nov. 10-13</td>
<td>The ASABE Leadership Experience. Location TBA.</td>
</tr>
<tr>
<td>2009</td>
<td></td>
</tr>
<tr>
<td>Feb. 9-12</td>
<td>Agricultural Equipment Technology Conference (AETC). Louisville, Kentucky, USA.</td>
</tr>
<tr>
<td>June 28-July 1</td>
<td>ASABE Annual International Meeting. Reno, Nevada, USA.</td>
</tr>
</tbody>
</table>

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**ASABE ENDORSED EVENTS 2008**

- **Aug.31-Sept.4** 2008 CIGR International Symposium on Food and Bioprocess Technology (4th CIGR Section VI International Symposium). Iguassu Falls, Brazil. dawen.sun@ucd.ie.

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**ASABE ENDORSED EVENTS 2009**

- **Jan. 5-8** First Southeast Asia Soil and Water Assessment Tool (SWAT) Conference. Chiang Mai University, Thailand. [www2.mcc.cmu.ac.th/swat/index.php](http://www2.mcc.cmu.ac.th/swat/index.php).
University of Wisconsin-Madison researchers are field-testing a system under development intended to harvest corn stover (stalks, cobs, and leaves) and grain with one pass through the field. (Photo courtesy of University of Wisconsin-Madison)

Biomass harvesting, handling, transport, and storage

The successful establishment of bio-based industries will require a stable supply of high-quality biomass feedstocks in large quantities at competitive prices. The preceding article in this energy series discussed efforts underway to develop the supply of biomass feedstocks. This feature examines research to move the biomass from the field to the biorefinery via harvesting, handling, transport, and storage, also known as the feedstock interface. The United States Department of Agriculture (USDA) Agricultural Research Service (ARS) is conducting research on the feedstock interface as part of its larger program on feedstock production and works in partnership with the U.S. Department of Energy (DOE) and its laboratories and others in academia and the private sector.

Traditionally, larger amounts of research monies have gravitated toward feedstock development and biomass conversion with the implicit assumption that the intermediate steps of moving biomass feedstocks to the biorefinery would somehow fall into place. This viewpoint is shifting with the increasing realization that meeting 30 percent of the nation’s transportation fuel needs, as outlined in the joint USDA/DOE Billion Ton Study, would require...
189 billion L (60 billion gal) of ethanol a year by 2030 using 454-544 million metric tons (400-500 million dry tons) of biomass. To put this in perspective, 2008 ethanol production is projected at around 34 billion L (9 billion gal) using approximately 44 million metric tons (48 million dry tons) of biomass or one-tenth of the projected future feedstock requirement. Concerns are being raised that the current infrastructure system is not capable of supplying the magnitude of biomass material that will need to be collected, stored, and transported. If bottlenecks in moving biomass to biorefineries are not overcome, this will become a major barrier to procuring capital funding for start-up biorefineries, which will rely on a reliable and timely supply of feedstock.

Equipment and methods will need to be modified and developed to accomplish these production goals most efficiently and with acceptable environmental tradeoffs. Furthermore, it is recognized that this feedstock interface research has to be conducted in an integrated manner—linking various elements to feedstock development and conversion—as new feedstocks and crop management systems will impact harvesting techniques and equipment and conversion methods used in biorefineries requiring specific physical and chemical characteristics that will affect the types of storage, pre-treatment, and processing methods utilized. Researchers are working to improve the current system and are also developing new systems for the future to supply feedstocks on a commodity scale.

**Looking ahead**

Cost-effective harvesting and collection of biomass will be critical to the future feedstock infrastructure. This will require increasingly sophisticated equipment that can simultaneously harvest grain and the desired biomass plant component, like stover (the cobs, stalks, and leaves left behind when corn is harvested), while leaving enough residue on the ground to curb erosion and maintain soil tilth. Current harvesting technologies require multiple passes across the field, which is more costly, leads to significant amounts of soil compaction, and introduces dirt and rocks into the feedstock. To overcome these limitations, USDA and DOE, along with Deere & Company of Moline, Ill., USA, have funded research at several land grant universities, such as the University of Wisconsin and Iowa State University, to develop a dual stream, single-pass harvesting system for corn that makes use of a standard grain combine with a modified head—the part at the front end that cuts and gathers the crop. The result would be an additional cost to farmers of about $10,000 to $15,000 U.S. instead of the six figures it would take for a separate, self-propelled forage harvester to harvest stover.

Plant genetics may also play an important role in helping to reduce harvesting costs by altering the method and timing of harvesting crops. USDA-ARS and the University of Minnesota have examined changing characteristics of plants such as alfalfa and the development of an alfalfa-for-bioenergy management system to make them easier to harvest. Normally, when alfalfa is allowed to mature, it falls over—a trait called lodging, which makes the harvesting process more difficult. A new biomass-type alfalfa is being developed that accumulates more cellulose in the stem that does not lodge as it gets older and taller, which makes it easier to harvest. It can also be harvested less frequently reducing harvesting costs and saving energy. Research sponsored by USDA-ARS is also taking place at the University of Wisconsin on the development of a single-pass, dual-stream harvester for alfalfa and other perennial grasses, such as switchgrass and reed canarygrass, which separates the high-protein leaves from the high-fiber stems. The leaf fraction would remain on the farm as a rumenant animal feed, and the stem fraction would be sold as a biomass feedstock.

**Storage questions**

Once biomass is harvested, it needs to be stored. A number of issues are involved in this including maintaining and monitoring biomass quality so it doesn’t get moldy or spoil, whether to store it in wet or dry conditions, and how to deal with large volumes of biomass. For example, one year’s supply of a biorefinery requiring 1814 tons (2000 tons) per day would cover 41 ha (100 acres) with 8 m (25 ft) of biomass. Researchers are looking at alternative ways to allow more biomass to be stored and pre-treated at farms until they are ready to be supplied to the biorefinery, thus increasing the value to farmers. USDA’s Agricultural Research Service at the Dairy Forage Center in Madison, Wis., USA, is researching and developing methods to pre-treat cellulosic feedstocks, such as corn stover, switchgrass, and reed canarygrass, on farms with acid and lime. The goal is to increase the digestibility of feedstocks while they are stored. This would also allow more biomass to be stored at farms until they are ready to be supplied to the biorefinery.

**Money matters**

The costs involved in collecting and transporting biomass can also be a major hurdle. This has been the case in the U.S. Pacific Northwest where preliminary research by USDA-ARS in Corvallis, Ore., indicates that straw in the region produced from cereal grain- and grass seed-producing operations, is widely distributed at relatively low densities making its transportation uneconomical to an off-site biorefinery. In this situation, conversion technology scaled for on-farm or near-farm use would make the use of the straw more economical and would provide value-added
revenue to seed producers, but the feasibility of developing small-scale conversion technology remains unproven.

Logistical systems are being investigated to reduce biomass transportation costs by diminishing loading time and hauling costs. In the U.S. Southeast, research is taking place to see how round bales of hay can be transported for use in biorefineries. Round bales were originally developed to be used on the farm, and currently no system exists for efficient off-the-road hauling. Virginia Tech is developing working prototypes of machinery for rapid loading and unloading of two 16-bale frames at centralized storage depots. This system is analogous to the cotton module builder where seed cotton is compactly stored in a large module. A prototype unroller-chopper is also being developed to unroll and chop these bales to deliver a constant stream of biomass material at the storage depot location or biorefinery.

Several U.S. national laboratories, including Oak Ridge National Laboratory and Idaho National Laboratory, have been addressing concerns in ramping up biomass supplies to meet national goals and the associated logistical issues involved in large-scale time-sensitive harvesting, collection, storage, and transportation. Oak Ridge National Laboratory has developed a feedstock supply logistics model known as the Integrated Biomass Supply Analysis & Logistics Model (IBSAL) that investigates a number of factors to minimize the delivered cost of biomass by selecting an optimum mix of biomass sources, machinery, handling processes, capacity, and storage and transportation systems to specific biorefineries.

In a future scenario being modeled by Idaho National Laboratory, biomass feedstocks would become a tradable commodity to ease their handling, storage, and distribution to biorefineries. In this new world, biomass feedstocks are processed into a uniform size and consistent quality, and stored at centralized locations known as “satellite depots” (perhaps even combining woody and agricultural residues, energy crop material), similar in concept to today’s grain elevators, until needed by a biorefinery.

Interest in this area is increasing in the private sector as well. A Harvest, Storage, Transportation (HST) Consortium has recently been developed at Iowa State University. Companies, such as Monsanto, ConocoPhillips, Verasun, and others, recognize HST is critical to the success of the biofuels industry and have agreed to sponsor research of mutual interest. In addition, the Iowa Legislature is considering a law to subsidize farmers to deliver feedstock to points or processors—the proposed subsidy $10 per dry U.S. ton (House File 2639).

Looking ahead, the biomass feedstock interface area will continue to be a dynamic one and will evolve in the future. New harvesting and other technologies and management systems will play an important role that will influence the development and use of biomass as a source of energy.
The Recycling King’s Workshop
for Kids

James W. Garthe

It’s a frigid morning at Mayfest, and I have all the scrap metal, tools, and whatnot neatly laid out on the sturdy table, one leg shimmed to level it on the sidewalk. There I stand, an engineer posing as a king, waiting for some kids to show up. Activity is everywhere as booths are being set up by vendors and demonstrators, but no kids are in sight. I drove 18 miles to get here on a Saturday, and no one is showing up. Lo and behold, to my left I notice one kid pointing to my table, then another pops her head out for a glimpse.

“Hey kid, get over here,” I yell. That was a dumb move. Now there are 10 of them, and they’re all grabbing my stuff and asking questions at the same time. Go away.

I happen to be an agricultural engineer trying to help in my community. Like most engineers, I possess unique analytical skills and character traits that make me different from others in the crowd. In our humble, no-nonsense approach, we often shy away from the limelight. However, our profession needs to be self-sustaining, and there is no better time than now to help our neighborhood kids see the merits engineers have to offer the rest of society.

Recycling King or court jester?
The Recycling King routine started as a joke. Some women I work with noticed that I lacked a nametag during my presentations about recycling to high school kids. The nametag they later pinned on my shirt not only displayed my name, but also Recycling King as subtitle, and that moniker started the wheels turning inside both lobes of my brain. I began to reason, “Why not kill two birds with one stone? Educate about solid waste management and recycling from an engineering perspective and instill an appreciation for art at the same time?” A new Penn State extension program for youth was born.

As an adult, have you ever noticed that kids are often uncomfortable addressing grownups? They don’t like the formality of calling you “Mister,” “Mrs.,” or “Ms.”; they don’t want to call you by your first name either. They may not even notice your nametag and, hence, squirm when they want to address you. But the Recycling King gimmick breaks the ice, and wearing a silly crown fashioned from a scrap aluminum road sign brings the adult to the kids’ level. Label the whole event as a workshop for kids, scatter an array of tools on the worktable, toss in a few piles of scrap metal from the dumpster, add a dash of playful humor, and you have a recipe for fun.

The serious side of the King’s routine is that nationwide we have some sore points to which most people tend to “turn the other cheek.” Issues such as roadside litter, illegal roadside dumping, and smoldering burn barrels are commonplace in rural areas. Citizens need to be reminded of simple physics, namely that matter (trash) can neither be created nor destroyed. They need to be reminded as well that tossing rubbish over the road bank is poor placement of a resource that, with judicious planning, engineers can help manage to the betterment of society.

Jim Garthe takes the love of his profession and the desire to inspire curiosity in kids to heart—and to the streets.
The workshop

Since this program is arts-and-crafts-based, it blends well with missions of county fairs, arts festivals, energy shows, spring or fall festivals, school educational programs, and more. It works best for kids aged six and up. One “king” can manage about six to 10 kids; more than that becomes unwieldy and nerve-racking.

At the start of each hour-long workshop, the kids view a flipchart presentation on how solid wastes are managed. Charts are pictorial in nature, and simple words list the way trash is managed, from the most desirable to least desirable ways. The options are the 3Rs (reduce, reuse, and recycle), waste-to-energy, landfilling, illegal roadside dumping, and finally, open burning. The interactive discussion often elicits parental input from the sidelines. Invariably some kids from the previous program want to stay working, so their enthusiasm is harnessed by having them make the presentations for the new group under the supervision of the King.

After each 10-minute introduction to solid waste management, the kids are briefed on the fun part of program. They are shown some of the basic skills: wire wrapping, cutting metal with a hacksaw, filing plastic pipe cutoffs, or sanding a piece of scrap wood. Depending on the number of lackeys helping the King and to keep things somewhat manageable, featured projects sometimes help the kids focus their energies. All participants must wear safety glasses, which are supplied and then returned as they leave.

Having children involved in hands-on activities is entertainment for them. By showing sample artwork others in the King’s court have made, they can begin to sense that craftsmanship counts. They show pride in making something themselves. Some kids are overwhelmed by the sheer mass of material laid out before them. They need to have their hand held for a bit until they can be talked into how to unleash their imagination. Asking them the following sequence of questions usually works:

- What are your hobbies or interests?
- If you want to make this as a gift, what would the recipient like to have?
- What do you see on the table?
- How can you convert this into that?

Subtly knitting various educational themes into the program is challenging. As kids become engaged, it is a good time to scatter some fodder for the brain. Geometric shapes, symmetry, or perspective in art puts math in their minds (at least for a fleeting moment). Science becomes realism as the instructor infuses a few comments about smelting rocks to metals, copper as a conductor of heat or electricity, or solder as an alloy that bonds to other metals. As the projects begin to unfurl and look (sort of) like art, this is a good time to say, “See, you don’t always have to throw this stuff away. It has a second life.” A fun question as they are about to leave is, “After it hangs in your room for a few years and Mom is ready to pitch you or both, then what should be done with your handiwork?” The answers are always telling.

What are we waiting for?

As part of our unwritten professional doctrine, I believe we have an obligation to perpetuate our engineering profession. One way of doing this is by becoming active in our communities and exposing others to our ways. An engineering mind is a sound mind. We have a knack for distinguishing between cause and effect, a skill that so many others just plain don’t have. This cause-and-effect viewpoint makes us especially good at problem solving while also thinking independently. In the junk art arena, our creative thinking allows us to show kids how a twist of a wire can be the difference between a durable, attractive piece and a piece destined for the recycling barrel. Many of their parents lack these skills. Parents seem to migrate to the worktable and learn about technical things, too, thus often becoming champions for our cause.

Hands-on skills seem to be declining in popularity as we move into an ever-more sophisticated electronic communications age. Apparently gone are the days of sweat and toil. Yet the national shortage of engineers remains. As many of us move toward retirement years, I challenge seasoned engineers to look not at winding down into retirement, but rather winding up toward a new career in community volunteerism and challenging young people to consider an engineering profession.

By the way, the personal rewards come when you go home at night, shot, but feeling like you made a difference. After a hard day at the roundtable, one thing this engineer has learned: Even kings need their rest.

James W. Garthe is an instructor in solid waste management and recycling in the Agricultural and Biological Engineering Department, Pennsylvania State University, University Park, USA; jwg10@psu.edu.
Every farmer who has experienced power hop knows it can be costly, painful, and a genuine nuisance. Consider a typical customer experience. Visualize a beautiful spring morning, sun peeking over the horizon, gentle breeze blowing: The promise of a good day in the field. A producer pulls in with his four-wheel-drive (4WD) where he left off the night before and lowers the implement; the engine loads up, the tractor settles into the pull, and “life is good.”

But wait … a slight vibration shakes the cab. It comes and goes for bit, then starts to get worse. The front of the tractor moves up and down, and the farmer can feel the seat suspension working as his knees flex. He starts to worry. Something isn’t right. The motion gets more distinct and continues to grow stronger. Now he has to hold on to the wheel to stay in the seat, and the hitch and implement are pounding back and forth. He steps on the clutch, stops and checks things over, but nothing seems to be wrong. He starts up again, and the same sequence occurs. He tries a little experimenting. Throttling back helps, running in a lower gear helps, and raising the implement a bit stops the motion completely.

What is going on? This didn’t happen yesterday. Everything was fine when he quit last night. Then it comes to him. He has heard about this happening to other producers. Could this be “power hop”? Maybe so. Now what?

Good question

It is a story heard all too often. And the story almost always comes down to three key complaints: Power hop is time consuming to deal with, it seems to affect operations at the worst possible moment, and it can be uncomfortable for the operator and hard on the equipment.

The good news is that today there is a better understanding of power hop than in years previous, and some management tools are available to minimize the problem. The bad news is that there is not yet a comprehensive solution to prevent power hop from happening in the first place. So, what can agricultural engineers do?

Our vision should be to take “hop” and make it a dance again.
Back up to the basic question
What is power hop? As explained in the 2008 ASABE Distinguished Lecture, Power Hop Instability of Tractors, found at http://asae.frymulti.com/request.asp?JID=6&AXID=24199&CID=phit2008&T=1, hop is a “porpoising” type of fore/aft pitch and bounce instability that occurs in 4WD and mechanical front-wheel-drive (MFWD) tractors running on rubber tires and operating under drawbar loads. It typically begins as a small but increasing motion that builds to uncomfortable, even damaging levels, and requires operator intervention to stop. While power hop can occur on various surfaces, it becomes a more profound problem when it happens in a field where a farmer is trying to work. To see examples of power hop in action, visit http://filebox.vt.edu/users/rgrisso/hop.htm to view the videos from the distinguished lecture.

What do we know about the cause?
Years of testing and research, much of which is detailed in the Distinguished Lecture, have gone into modeling and understanding the cause of power hop. Current thinking has settled on a two-dimensional model showing power hop as a self-excited vibration affected by three factors: the quantity and location of vehicle mass, and the combined vertical stiffness and damping of the front tire plus operation surface and the rear tire plus operation surface.

Piqued by Power Hop
My old mentor and boss, Lloyd W. Hurlbut (ASAE President 1960–61) always said that you weren’t really involved in a project until you woke up at night thinking about it. I wonder if he figured it would last into retirement. I was getting close to understanding the cause of power hop when I was retired in 1999. I’m not staying awake at night, but after nine years, I still manage to think about it nearly every day. There is a KT analysis going on in my head!

Recently I was reminiscing over my six years at the Nebraska Tractor Test Lab followed by my years at John Deere, taking tractors to Nebraska for testing. I realized I had never seen power hop on any of the test tractors I worked with—both MFWD and 4WD. All were operated at rated inflation pressures. Interestingly, the only power hop I saw while working at the Nebraska lab was on a 2WD tractor.

What was unique about the tractors I helped test? They were all in the era of bias ply tires. Not that we should return to bias ply tires, but I believe the key to fully understanding power hop lies in understanding the physical differences between bias and radial tires. More specifically, further investigation should be made of the obscure tangential spring (not to be confused with the torsional spring) of the tires and how it interacts with the vertical spring.

We still don’t have a factory fix for power hop, we simply rely on farmers/customers to “fiddle” with tire pressures, which ultimately results in reduced tractive efficiency (higher than rated pressures). I am hopeful that someone younger may step forward with an interest in finally resolving the problem. I would certainly be happy to share my thoughts and experiences with them.

ASABE member Frank M. Zoz is retired from John Deere PEC, Waterloo, Iowa, USA; fmzoz@tix.com.
The model in the diagram above results in a “hop function” and shows that if this function is greater than zero, the tractor cannot hop. Although this correctly predicts power hop occurrence on rigid surfaces (concrete or pavement) for both MFWD and 4WD tractors, it does not always work in field conditions, particularly with 4WD tractors. When considering the effect of changing the front or rear stiffness for power hop control, the function always predicts the front as the correct end to stiffen. Field experiences with 4WDs show stiffening the rear also works, sometimes more effectively than stiffening the front. Field experience further shows power hop to occur more often as travel speed increases and also suggests that power hop occurs more easily on tractors with higher horsepower-to-weight ratios. Neither travel speed nor power-to-weight are factors in the current model.

Some of these problems may be the result of difficulty in defining the combined tire plus operating surface stiffness and damping parameters in soil. There may also be factors and forces in play that are not yet accounted for in the current model, which have more significance in the field than they do on rigid surfaces.

**How do we fix power hop?**

This is a tough question. Unfortunately, we do not yet have a “cure” for power hop; all we have is a method of control. And to make matters worse, the settings that control hop one day in one field condition may not control hop another day in another field condition, so the control method can be an ongoing process.

The recommended procedure for controlling power hop has the operator begin by setting the tractor for optimum tractive performance: correct ballast weight and weight distribution for the power level and minimum allowable tire inflation pressures for the weight. If hop does not occur with this setup, “Life is good.”

If power hop does occur, however, life gets tougher. As noted, the current model says that the front is the end to stiffen for power hop control. The simplest way to increase stiffness is by raising tire inflation pressures on the end one wants to stiffen, but only up to the maximum allowable pressure for the tire. Doing this at the front almost always controls hop on MFWD tractors, but with 4WD tractors, it is not as clear-cut. Particularly in softer soils, stiffening the rear tires on 4WD tractors can control power hop, sometimes with lower pressure increases than would be required on the front, resulting in smaller efficiency and soil compaction penalties.

Farmers with hopping 4WDs are currently encouraged to experiment with each end separately to see which one will control the hop with the least amount of change away from the optimum. Either approach has costs. Raising tire inflation pressures above the optimum reduces the tractive efficiency of the tires, which raises the costs of operation. It also increases soil compaction and makes for a rougher-riding vehicle. Further still, adjusting tire pressures

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Related Image: Correctly inflated radial ply tires, also from the Distinguished Lecture by Wiley and Turner.
on 4WD dual- and triple-tire tractors is difficult and time consuming. If producers later forget to return tire pressures to optimum levels or simply decide not to reset them because of the time and effort involved and the risk that the tractor may hop again, they suffer ongoing inefficiency in their operation.

**What is our opportunity?**

A comprehensive solution for power hop on rubber-tire tractors is needed—not just a control, but a true “fix” that neither reduces tractor efficiency nor requires operator intervention for changing field and weather conditions. To solve the problem of hop will require work and new thinking on the part of agricultural engineers and the industry.

From a research perspective, more understanding is needed about the causes of hop and why the current models do not always reflect what is experienced in the field. *What we are missing that could account for the field effects we observe that do not fit the current model?* One example: Could there be other spring possibilities that might be considered in the modeling? (See sidebar) Perhaps a different model is needed?—or additions that could complete the current one?

From an industry perspective, here is a prime opportunity for cooperation: to produce a true factory fix or cure. This will require different thinking about the tractive device, the vehicle-to-soil connection. Changes here have the best chance of being the “fix” that still maintains efficiency. The development of a different tire-stiffness-to-footprint relationship could be one solution. At the present time, we typically have lower-stiffness/higher-tractive efficiency tires, such as radial ply design, and we have higher-stiffness/lower-tractive efficiency tires, such as bias ply designs. Radials tend to power hop while bias usually do not; but radials tend to be more efficient than bias when they don’t hop. The ideal could be a tire with bias-type stiffness and radial-type tractive efficiency. Other possibilities to fix hop could include the control of stiffness using automatic pressure adjustment up and down or controls on axle suspension (active designs) to remove hop motions, but either would be expensive and possibly less efficient.

Developing a “cure” for power hop is a significant opportunity for ASABE members to help increase efficiency in agricultural traction operations. Our vision should be to take “hop” and make it a dance again.

Retired after 34 years of design and test of agricultural machinery, first with John Deere Harvester Works, East Moline, Ill., USA, and then with the Agricultural Technology Centre, Lethbridge, Alberta, Canada, ASABE member Reed Turner is now a consulting engineer in traction and performance measurement; reed.turner@gmail.com.
Irrigation has allowed Georgia farmers to get the most out of their land for the past three decades, and Georgia engineers have had a major impact on keeping farmers informed.

In the 1970s ...

Irrigation usage exploded due to high corn, soybean, and wheat prices. Areas of southwest Georgia, too sandy for dryland farming, were cleared and put into row crops and vegetable production using center pivots. In the Coastal Plain region, farmers chose travelers or center pivots. No government intervention, incentives, subsidies, or construction was used to fuel Georgia's irrigation growth. Farmers made these business decisions, like most in Georgia, with minimal state or county interference.

At the time, it seemed Georgia's water supply was inexhaustible. The Floridian aquifer would never run short. This mostly untapped reservoir was one of the largest in the United States, and it was recharged annually. No permits were required for either wells or ponds. No reporting was required for irrigation or other water use. No permitting was required for wells used by municipalities and industries until 1972.

Regulatory environment changes in the 1980s

When the Georgia groundwater permitting legislation passed in the early 1970s, agricultural withdrawals—like individual homeowners—were exempted. Less than 81,000 hectares (200,000 acres) were irrigated at the time. The systems were considered “too spread out” and too few to be of concern. By the early 1980s, the Georgia Department of Natural Resources and its Environmental Protection Division (EPD), which control permits and reporting, surmised that irrigation had grown to more than 405,000 hectares (1,000,000 acres) and was quickly becoming a major user of water. They started pushing for tighter controls.

In 1988, withdrawals capable of pumping more than 379,000 L/day (100,000 gal/day) for agricultural purposes were brought into the permit system. If an irrigation system required a 4,500 L/min (1,200 gpm) pumping rate and that capacity pump was installed—that is what was permitted. Although the regulators made varying assumptions about actual irrigation application per permitted acre, farmers could technically use that pump 24 hours a day, 365 days a year. Only economics held them in check. No reporting was required after the permit was issued. No conservation plan and no drought emergency provisions were needed. No fees were required. The regulatory agency...
Farmers learn best from neighbors

When a farmer saw a neighbor putting up a pivot and succeeding, he wanted one, too. Skills improved. Farmers who installed systems in the 1970s learned one could not take equipment and scheduling straight from the West and make it work in the Southeast. Most Georgia soils held too little water. Water supplies and irrigation had to be large and applications frequent enough to completely replace crop use every three to four days, and do that continuously for 20 to 30 days between drought-spaced rainfalls. Over time, farmers learned this as well and put in suitable systems or adapted their rotations and crop management. The energy crunch prompted farmers to convert to low-pressure systems.

In a panic: water war

The end of the 1990s ushered in a new dimension to irrigation in Georgia: fear!

What had seemed an inexhaustible supply was now challenged by Florida and Alabama, commonly called the tri-state water war, and later by EPD as inadequate for all users in the Southeast. The 1998 and 1999 winters did not bring the usual recharging rainfall. Surface and groundwater supplies were lower than usual. Farmers prepared for a typical summer of drought-spaced rainfalls. Over time, farmers learned this as well and put in suitable systems or adapted their rotations and crop management. The energy crunch prompted farmers to convert to low-pressure systems.

Second thoughts

Today, the Georgia, Florida, and Alabama compacts have been extended multiple times. Farmers and EPD have had second thoughts about the Flint River Drought Protection Act. In 2004, legislation was put in place for development of a statewide water management plan. The “plan” was submitted to the state legislature during the 2008 session. It has passed both the house and senate and was signed by the Governor in late February.

What does all this have to do with Georgia’s agricultural engineers?

Where do they fit in—what role did/should they play? Since the early 1970s, University of Georgia (UGA) engineers have conducted irrigation surveys. The last survey was in 2004. The next will be this year, 2008. The survey gives a snapshot of agricultural irrigation in the state, and it has been used to develop water use estimates for agriculture. Over the years, it shows farmers are replacing inefficient systems with center pivots that consume less energy, using more drip irrigation to save labor, and turning away from diesel-powered pumps in favor of electric ones.

UGA engineers with funding from the EPD developed the publication, “Water Conserving Practices Appropriate for the Southeast.” The publication (PR 32) has a table in the back that indicates the water savings if agricultural irrigation systems are retrofitted with water-efficient alternatives. Items like sprinkler package selection for pivots, converting from traveler to pivot or drip, implementing irrigation scheduling methods, and pivot end-gun shut offs are examples. This publication was used as the basic background for cost-share programs implemented in the state. The next step will be to work with the cost share agencies (NRCS and SWCC) to actually document the effectiveness of the changes implemented. The engineers worked to develop

continued on page 18
Tom Adams

Water supplies in southeastern states reached historic lows during 2007. According to Georgia state climatologist David Stooksbury, this condition is expected to continue in 2008. Although reservoirs have filled in some locations during the winter months, low levels are expected to persist during the summer and fall. Periods of drought are not uncommon in the southeastern Sunbelt, and the region has experienced two decades of rapid growth in population, but water infrastructure improvements have lagged, according to supply experts such as Mark Crisp at the Atlanta engineering firm C. H. Guernsey. Increased employment opportunities from the expansion of several commercial and industrial sectors, including agribusiness, forest products, and food processing, is driving some of the growth. Electric utilities’ massive need for steam and cooling water is second only to agriculture in the region’s water consumptive activities.

In past decades, the southeast region met increased electrical demand by building coal and nuclear power plants. According to the U.S. Energy Information Agency (EIA), the region depends on fossil fuels and nuclear power for 94 percent of its power generation. Since 2000, in Georgia all new electricity is generated from natural gas-fired combined-cycle package plants. According to EIA, increasing natural gas use by the electric utility sector nationwide is driving up natural gas imports and prices. Natural gas is used to make hydrogen, the principle unit cost associated with the production of nitrogen fertilizer.

Much ado leads to prayer, plans, and sustainable practices

Water shortages in the Southeast generated a beehive of activity last year. Public prayer meetings were organized to pray for rain. Plans for new reservoirs are still being drawn and water wells dug. Local governments organized intensive residential water conservation campaigns.

In Georgia, the universities and state government teamed to provide workshops to assist business, industry,
institutions, and local governments with conserving water. The Georgia Environmental Partnership (the University of Georgia Faculty of Engineering Outreach Service, the Cooperative Extension Service, the Georgia Tech Enterprise Innovation Institute, and the Georgia Department of Natural Resources) conduct water conservation workshops across the state.

However, it is increasingly recognized that long-term water security will only be attained through implementation of sustainable societal practices. These practices are being adopted by the 35 learning institutions comprising the University System of Georgia through the leadership provided by Michael F. Adams, president of the University of Georgia, and the University System’s Chancellor, Errol B. Davis, Jr. A Sustainable Energy Management Plan is being adopted by the University System that encompasses water and utility use and supply. Originally conceived to control increasing energy costs, the Plan recognizes the connectivity between water, energy, and solid waste issues. According to the plan, in cooperation with businesses and industry, colleges and universities will be a showcase for sustainable practices. Students are learning while participating in planning and design. Many sustainable practices are already being designed and used—construction of green buildings, water harvesting, grey water use, storm water management, distributed energy generation, and the production and use of renewable energy and fuels. It is now widely recognized that sustainable practices also offer opportunities for reducing institutional operating costs.

Energy tech on the rise

In recognition of the relationships between climate change, water resources and fossil fuels in electrical generation, Georgia is supporting the proposal for the establishment of an International Renewable Energy Technology Institute (IRETI) in the United States. In partnership with the U.S. and Swedish governments, Georgia, Minnesota, New York, and businesses worldwide are proposing to unleash the power of entrepreneurship by establishing centers for renewable energy education, applied research, and outreach. Partnering with international business, the centers of IRETI will work to exchange and implement successful commercial renewable energy technologies.

For southeastern states in the United States, biomass is a major renewable energy resource. Technologies of interest include distributed energy generation through combined heat and power (CHP) biomass plants, district heating plants using woodchips and biomass pellets, central biomass powered and hybrid solar HVAC systems in homes and businesses, biomass heaters for on-farm animal housing, and liquid transportation fuels from biomass. These technologies are successfully used in Europe, the Americas, and other countries and greatly reduce dependence on fossil fuels and electricity and electricity generated from fossil energy.

Implementation of renewable energy technologies will assist in improving water supply and water quality. The southeastern states need access to wind energy generated in western and midwestern states. Electrical transmission interconnectivity with other regions is lacking. Even so, Florida Power and Light has become the largest owner of wind turbines in Texas, California, and across the United States. Additionally, it is anticipated that advances in photo voltaic and geothermal technologies will offer opportunities for decreasing carbon dioxide emissions, water use, and contamination in the Southeast.

Research being conducted in the Biorefining and Carbon Cycling Initiative at the University of Georgia Department of Biological and Agricultural Engineerin investigates the production and use of biochar. Pennsylvania University, Cornell, Bayreuth University in Germany, and federal agricultural research stations in Brazil are among other programs worldwide that are conducting investigations examining the effects of biochar in the soil and its use as a means for carbon sequestration.

Biochar may be especially useful in depleted, sterile soils. Biochar appear to offer many of the benefits obtained from compost and soils with high levels of organic matter such as reducing fertilizer, pesticide and water requirements, and increasing bioactivity. Biochar may eliminate the need to replenish organic matter, especially beneficial to Oxisols as exist in the Amazon River Basin and in Georgia. Measurements in Japan and by Gerhard Bechtold, University of Bayreuth/Munchen, Germany, indicate that biochar is inert and has been shown to persist in the soil environment for thousands of years.

Recommended reading from the author:


ASABE member Tom Adams is CEO for the consulting firm Tunstall Adams, Inc. and former director of Engineering Outreach Service, University of Georgia, Athens, USA; tadams@tunstalladams.com.
water conservation strategies specific to Georgia’s Flint and Coastal zones to help the EPD adopt water conservation guidelines for new permits in order to lift the moratorium.

Serving the state’s producers, delivering the goods

Many methods exist to help determine when it is time to irrigate and if enough water is applied. Agricultural engineers helped deliver the education to the farmer. Field research shows that the average producer can save one irrigation per season by adopting a scheduling method. Even if water savings were limited to one crop, the water conserved through the adoption of a scheduling method would amount to several billion liters/gallons of water annually.

Before Georgia implemented a statewide metering program for agriculture, EPD wanted to have a valid, statistically sound estimate of water used by agriculture. UGA engineers provided it. More than 410 permitted irrigation withdrawals were monitored between 2001 and 2005. The total land area monitored was 17,130 hectares (42,330 acres), representing a two-percent sample of the agricultural irrigation land from the agricultural withdrawal permit database. Forty-five percent of the monitoring sites were ground water, which is consistent with the ground water withdrawal percentage in the database.

The important result is that irrigation water use was not extremely high for these drought years. On the average—the top 25 percent of all monitored sites—34 cm per 0.4 hectares (13.3 in. per acre) were used in 2001 and 39 cm per 0.4 hectares (15.5 in. per acre) were used in 2002. The varying amounts are indicative of the varying rainfall in the state.

In 2003, the state implemented an agricultural metering program. The Georgia Soil and Water Conservation Commission (SWCC) required that all permit holders be contacted and their withdrawal location verified in order to install a water meter. UGA engineers, crop and soil scientists, and county agents had started a similar program in 1999. In 2006, UGA contracted with SWCC to update the remaining 4,500 permits that needed contact information and withdrawal locations. By the end of 2008, almost 20,000 of the state’s 24,000 permits will be updated by UGA.

Making a difference

One can easily see that engineers do a lot more than “crunch numbers” and “stare at computer screens.” They get out in the world, make the effort, and keep our state, national, and global society informed.

ASABE member Kerry Harrison is a senior public service associate in the University of Georgia Biological and Agricultural Engineering Department, Tifton, USA; kharriso@uga.edu.
An exciting opportunity has begun in Tanzania: a chance to improve the living conditions of farmers by moving them from below-subsistence production to having sufficient surplus to market and realize profit.

Tanzania is one of the poorest countries in Africa. The per capita income is $280 per year, compared to $36,000 in the United States. Fewer than 10 percent of the citizens can read English, and fewer than 20 percent can read Swahili. Fewer than 30 percent of citizens have a seventh-grade education, and fewer than 1 percent of citizens have completed college.

Education is the key! Those who have completed high school in Tanzania earn more than $800 per year and have an unemployment rate three to five times lower than the general population. Those with a high school education average two to three children instead of seven to nine and have lower HIV/AIDS rates. The educated live 10 years longer, on the average. The average life expectancy in Tanzania is 46. A staggering 88 percent of Tanzanians are peasant farmers who cultivate by hoeing.

Agriculture in the Iringa Region is presently estimated to be at 90 percent of subsistence, based on what has to be imported. The goal is to reach 120 percent of subsistence so that local Tanzania farmers can begin to have a little cash for educating their children, buying tools and supplies, building homes, and processing facilities for crops.
In 2003, the Institute of Agriculture (IA) was formed at Tumaini University in Iringa, Tanzania. The mission of the IA is to teach improved farming practices to the people of the Iringa Region and to increase the Iringa Region's agriculture production to 120 percent of subsistence.

The immediate goals are to:
1. provide short courses to train pastors, farmers, and students;
2. sponsor demonstration plots with companion congregations;
3. enhance seed and fertilizer distribution and information transfer; and
4. transfer Sokoine University and University of Minnesota researched practices to the Iringa Region farmers.

Three demonstration farms have been established at Mpanga, Lulanzi, and Mgongo. Each has unique needs and solutions are sought. The solutions need to be repeatable and cost-effective for other sites.

The Mpanga demonstration farm is located in a swampy area of Tanzania with abundant water that allows production of rice. The goals here are to increase production, such that the yield exceeds costs and the farmers realize profit that allows them to improve their standard of living. Lulanzi is located in a hillier area of Tanzania. The farm is demonstrating crop rotation and contour strip cropping to show that cultivation should be done...
Mgongo is about 8 kilometers (5 miles) from Iringa. The primary need here is water management. Water management could be achieved by constructing a dam that would cost about $30,000, but the likelihood of a local village doing this without outside funding is remote so the concept was discarded.

On a local level, the hope is to find 10 villages with a pastor willing to cultivate two 0.2 ha (half-acre) plots to demonstrate these improved farming practices to the villagers. Churches in Minnesota that are affiliated with companion congregations from the Iringa Diocese in Tanzania are asked to commit to providing $2,000 per year for three years so that the soil tests can be done, fertilizer applied, and crops rotated. So far, 10 villages with sponsoring churches have been identified for the project.

Concerned citizens in the United States support the effort in Tanzania. The U.S. Institute of Agriculture Advisory Committee is comprised of active and retired University of Minnesota professors (including the author), agri-business leaders, and leaders from the St. Paul Area Synod of the Evangelical Lutheran Church in America (ELCA). Chair Phil Larsen is working with the group to develop long-term business plans for support, governance, operations, financial support, communications, human resources, and University of Minnesota relationships with Tumaini University in Iringa. Mark Jensen and his wife, Terry, are ELCA missionaries who are specifically assigned to the Institute of Agriculture project. The Jensens were dairy farmers, and Mark holds a degree in agricultural education. Bishop Dr. Owdenburg Mdegella of the Iringa Diocese of the Evangelical Lutheran Church of Tanzania oversees the coordination with the companion congregations in Tanzania.

The project also seeks to train Tanzanians to be agricultural consultants in the villages. The first, Ibrahim Wikedzi, studied at the University of Minnesota-Morris and the University of Minnesota-St. Paul, and now lives in Tanzania working as an agricultural specialist. He is employed by the University of Tumaini’s Institute of Agriculture to work on the project’s demonstration farms and the demonstration plots of the companion congregations. A second Tanzanian, Gabriel Malima, has been selected for the project, and plans are underway for his education in the United States.

The IA also seeks to develop markets—both domestic and export—for the excess crops that will result as production moves above 100 percent subsistence level.

For more information, contact Fred Bergsrud at bergs003@umn.edu or Mark Jensen at babumzeemjensen@yahoo.com or 1341 Cypress Lane, Annandale, MN 55302, USA; 952-829-5326.

ASABE member Fred Bergsrud is a University of Minnesota Professor Emeritus; bergs003@umn.edu. Contributing to the article were ASABE member Sonia Jacobson and U.S. Agricultural Advisory committee members Roger Blomquist and Phil Larsen.
Energy consumption is by far the most important criteria in green home design and performance. Limiting energy use far outranks such factors as material selection and energy source considerations in determining the “greenness” of a house.

Two paths to conservation

Energy conservation can be achieved in two different ways: reducing the amount of primary energy consumed to supply the useful energy requirement (energy efficiency) and reducing the end point use of nonessential energy. Energy efficiency in homes can be increased by such measures as improving the thermal performance of the building and installation of high efficiency heating and cooling equipment, lighting, and appliances.

Unfortunately, incorporating energy efficiency measures alone does not automatically result in less energy use in homes. Although the efficiencies of residential building shells, space conditioning equipment, lamps, and appliances have improved significantly in recent years, the total residential energy consumption in the United States is increasing, and this is projected to continue. Reasons for this include the increased size of homes and changes in the amount, types, and uses of electrical and electronic devices.

Therefore, it is essential to recognize the impact and importance of the second way to achieve energy conservation in homes: reducing the use of nonessential energy. This requires a raised consciousness, education, and awareness on the part of home occupants and their willingness to put their knowledge into practice.

There are numerous and well-publicized practices and techniques that occupants can adopt to reduce their consumption of nonessential energy, such as adjusting thermostats lower in the winter and higher in the summer, turning off lamps in unoccupied rooms, lowering the temperature setting of the water heater, turning off electrical equipment completely when not in use, and only space conditioning occupied rooms. The effectiveness of such energy conservation measures in significantly reducing overall energy consumption relies completely on the behavior of the individuals involved.

For further reference as suggested by the author:
- Alliance to Save Energy, www.ase.org
- Rocky Mountain Institute, www.rmi.org

One of the most important ways to keep pollution out of the home (“Please, take off your shoes and stay a while!”) is a green practice any homeowner can adopt, says author Zimmerman. His residence’s front entrance is a testimony to obliging visitors.
It's not as easy as driving a car

It follows that the actual energy performance of homes is affected by both fixed (design parameters, space conditioning equipment, lighting, appliances, etc.) and variable (occupant behavior) factors. This concept also applies to the actual energy performance of passenger vehicles, which is affected by both the vehicle characteristics and the driving behavior of operators. There exists a simple, easily calculated, and universal energy performance indicator for passenger vehicles in the form of the fuel utilization measurement, which is calculated in units of km/L (miles/gal). Consumers have access to published fuel utilization ratings of vehicles and can calculate actual values for their own vehicle/driver combinations. Unfortunately, a well-known, commonly used, and analogous energy performance indicator does not exist for home/occupant combinations.

How can home-owning engineers and others measure, compare, and evaluate the actual energy performance of home/occupant combinations? Two simple and easily calculated indicators are discussed below: The first characterizes thermal energy performance, and the second characterizes electrical energy performance.

On the road to thermal energy performance

Space conditioning is typically the largest single component of energy consumption in homes. The performance of home thermal envelopes and envelope/heating system/occupant combinations during the heating season can be estimated, measured, compared, and evaluated by calculating the Home Heating Index (HHI).

HHI is defined as the annual heating load divided by the amount of conditioned space floor area divided by the number of heating degree days (HDD). The unit is Btu/ft²/HDD (kJ/m²/HDD). HHI is particularly helpful because it enables the comparison of the thermal performance of thermal envelopes and envelope/heating system/occupant combinations in different climate regions.

The HHI of the thermal envelope (designated the envelope or shell HHI) of a house can be estimated via calculations based on envelope design parameters such as R values and air leakage rates. The HHI of envelope/heating system combinations can be estimated via calculations based on both the envelope design and heating system design parameters such as combustion and distribution efficiencies.

The actual HHI of an occupied house is a simple and straightforward calculation once the amount of energy used for heating is determined based on billing records. If combustion fuels such as natural gas, propane, or fuel oil are used for space conditioning, but not water heating, then the amount of fuel used for heating is directly available from billing records. Of course, this amount of fuel must be multiplied by the amount of energy per fuel unit to determine the total energy consumed per heating season.

In cases where combustion fuels are also used for water heating, an estimate of the amount of fuel consumption for this purpose is needed. One way to do this is to base water heating energy consumption on the amount of fuel used in the shoulder months during the spring and autumn seasons when little or no supplemental heating is required. This monthly amount of fuel is then subtracted from the total amount billed for each of the “heating” months to determine the net amount of fuel actually required to heat the home.

The actual HHI can also be calculated when wood is used as a major or supplemental source of heat. However, estimating the amount of energy in wood fuel is more difficult due to variability in the moisture content of wood and also the following when the wood fuel is measured on a volume basis (cord): 1) the density of the wood and 2) the volume of the free air space compared to the actual volume of wood.

The envelope HHI for all-electric homes and the actual HHI for such homes with electric resistant heat can be calculated using the same procedures as described above. However, values obtained for the actual HHI for all-electric homes with heat pumps must be interpreted on a different scale due to the effect of the coefficient of performance (COP) of heat pumps on energy use.

<table>
<thead>
<tr>
<th>Thermal Performance Rating</th>
<th>Index Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Btu/ft²/HDD (base 65°F)</td>
</tr>
<tr>
<td>Very poor</td>
<td>&gt; 10</td>
</tr>
<tr>
<td>Poor</td>
<td>7.5—10</td>
</tr>
<tr>
<td>Moderate</td>
<td>5.0—7.5</td>
</tr>
<tr>
<td>Good</td>
<td>2.5—5.0</td>
</tr>
<tr>
<td>Very good</td>
<td>&lt; 2.5</td>
</tr>
</tbody>
</table>
Although a “home cooling index” similar to HHI has not been established, it is important to note that the combination of factors that improve the thermal performance of homes and households in terms of heating (lowering the HHI) will also result in improved thermal performance in terms of air conditioning. Therefore, HHI can function as an indirect measurement for a home cooling index. Also, the air conditioning load has a major impact on residential electrical energy consumption, which is addressed in the following section.

Typical envelope HHI values and associated qualitative ratings are listed in Table 1.

**Gearing up electrical energy performance**

The residential housing sector is a major consumer of electrical energy. The amount of electrical energy used in homes varies widely due to such factors as the energy source for space and water heating, climate (particularly in terms of air conditioning), type of space conditioning equipment, size of residence, and behavior and number of occupants. One way to account for some of this variability and still have a useful indicator is to measure the actual electrical energy performance of home/occupant combinations using the Home Electrical Energy Index (HEEI). HEEI is defined as the annual electrical energy consumption divided by the area of conditioned space. The unit is kWh/ft² (MJ/m²).

Calculating the actual HEEI is simple and straightforward once the amount of electrical energy used annually is determined based on billing records. Once HEEI known, comparisons and evaluations can then be made on a regional basis for the following three common space and water heating combinations: 1) combustion fuel for both, 2) electrical energy for both, and 3) combustion fuel for space heating and electrical energy for water heating.

Unfortunately, published data on residential electrical energy consumption (including HEEI values) useful for comparison and evaluation purposes are limited. Typical values for two categories of homes: 1) natural gas space heating (type of water heater not identified but typically gas) and 2) all-electric for various regions of the USA as indicated in one reference are listed in Table 2. The major affect of air conditioning is clearly evident in the regional consumption data.

Hopefully, simple, easily understood, and standard energy performance indicators (such as HHI and HEEI) will become the norm for home/occupant combinations just as the fuel utilization measurement has become the norm for passenger vehicle/driver combinations. ASABE members and other readers are encouraged to calculate and use such indicators as HHI and HEEI in combination with the plethora of information available in print and on the web in order to reduce energy consumption and live “greener.”

Modest but well-informed choices can make a major difference. As an example, I designed and built a simple, straightforward, and economical energy-efficient home (all-electric with resistant heat) in Ohio (East North Central) in 2000. As occupants, my wife and I practice sensible and appropriate, but not drastic or extreme, energy conservation measures. The average values for HHI and HEEI for the six years we have lived in the home are 1.5 BTU/ft²/HDD (30 kJ/m²/HDD) and 5.5 kWh/ft² (210 MJ/m²), respectively. These data clearly document the actual energy conservation (and degree of greenness) achievable in a practical, real-world situation.

ASABE member Allen Zimmerman is a professor at The Ohio State University, Wooster, USA, 44691; zimmerman.7@osu.edu.

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### Table 2: Typical Home Electric Energy Index Values—USA Regions*

<table>
<thead>
<tr>
<th>Region</th>
<th>Natural Gas Heat kWh/ft²</th>
<th>MJ/m²</th>
<th>All-Electric kWh/ft²</th>
<th>MJ/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>New England</td>
<td>2.9</td>
<td>110</td>
<td>8.3</td>
<td>320</td>
</tr>
<tr>
<td>Middle Atlantic</td>
<td>3.3</td>
<td>130</td>
<td>7.9</td>
<td>310</td>
</tr>
<tr>
<td>South Atlantic</td>
<td>5.7</td>
<td>220</td>
<td>9.7</td>
<td>380</td>
</tr>
<tr>
<td>East North Central</td>
<td>3.8</td>
<td>150</td>
<td>10.8</td>
<td>420</td>
</tr>
<tr>
<td>East South Central</td>
<td>7.0</td>
<td>270</td>
<td>12.0</td>
<td>460</td>
</tr>
<tr>
<td>West North Central</td>
<td>4.2</td>
<td>160</td>
<td>9.3</td>
<td>360</td>
</tr>
<tr>
<td>West South Central</td>
<td>7.9</td>
<td>310</td>
<td>12.4</td>
<td>480</td>
</tr>
<tr>
<td>Mountain</td>
<td>5.5</td>
<td>210</td>
<td>10.5</td>
<td>410</td>
</tr>
<tr>
<td>Pacific</td>
<td>4.5</td>
<td>170</td>
<td>9.4</td>
<td>360</td>
</tr>
</tbody>
</table>

Iowa State Engineer Develops Laser Technologies to Analyze Combustion, Biofuels

Let’s say a fuel derived from biomass produces too much soot when it’s burned in a combustion chamber designed for fossil fuels.

How can an engineer find the source of the problem? It originates, after all, in the flame zone of a highly turbulent combustion chamber. That’s not exactly an easy place for an engineer to take measurements.

“It’s fairly obvious when a combustor is not running well and producing a lot of soot and other pollutants,” said Terry Meyer, an assistant professor at Iowa State University, Ames. “But then how do you solve that problem? To do that we can open up the black box and look inside the combustion chamber itself.”

The tools that Meyer is developing to do that are highly sophisticated laser-based sensors that can capture images at thousands and even millions of frames per second. Those images record all kinds of data about what’s happening in the flaming mix of fuel and air.

“The goal is to probe this harsh environment to provide the knowledge required to reduce pollutant emissions and enable the utilization of alternative fuels,” Meyer said.

By selecting lasers of different wavelengths, Meyer’s combustion sensors can record where pollutants such as soot, nitric oxide, and carbon monoxide are being formed. The sensors can also look for unburned fuel and capture data about fuel sprays, fuel-air mixing and energy release.

Meyer’s lab is now working on a two-year project to develop and advance laser techniques that are expected to help engineers improve the combustion systems that move vehicles, produce power, and heat buildings. An important goal of the project is to analyze and improve the performance of alternative fuels in modern combustion systems.

Meyer’s research is supported by an $87,000 grant from the Grow Iowa Values Fund, a state economic development program. This grant is supplemented by a contribution of products and engineering expertise from Goodrich Corporation’s Engine Components unit in West Des Moines, Iowa, a producer of fuel system components for aircraft engines, auxiliary power units, power-generating turbines, and home heating systems. ConocoPhillips, the third largest integrated energy company in the United States, is supporting similar projects in Meyer’s lab. The projects are part of ConocoPhillips’ eight-year, $22.5 million research program at Iowa State. Meyer’s research is also drawing interest and support from sources such as the National Aeronautics and Space Administration and the U.S. Air Force.

Meyer started working with laser diagnostics when he was a doctoral student at the University of Illinois at Urbana-Champaign. The work continued when he spent six years as a scientist developing and applying laser techniques for the Air Force Research Laboratory at Wright-Patterson Air Force Base in Dayton, Ohio.

Meyer made the move to Iowa State in 2006 and is working to apply some of the military’s sophisticated laser technologies to civilian applications. Meyer’s system of high-speed lasers, frequency conversion units, mirrors, and cameras is being built in his Multiphase Reacting Flow Laboratory on the ground floor of Iowa State’s Black Engineering Building.

It is work that could have impacts far beyond his lab. Meyer said his research aims to reduce reliance on fossil fuels, which currently account for 85 percent of the world’s energy use.

For more information, contact Terry Meyer, trm@iastate.edu, or Mike Krapfl, Iowa State University News Service, mkrapfl@iastate.edu.
A typical 1,000-head beef feedlot produces up to 254 metric tons (280 tons) of manure in just one week. That’s a lot of manure—and for hundreds of U.S. cattle feedlots, disposal is an important management issue.

Fortunately, Agricultural Research Service (ARS) scientists in the Environmental Management Research Unit at the U.S. Meat Animal Research Center (USMARC) at Clay Center, Neb., have developed and tested a new method of runoff control.

In the United States, feedlot runoff is often stored in a large pond or basin. From there, it is either distributed as nutrient-rich irrigation water or processed for safe disposal. This method is approved by U.S. Environmental Protection Agency, but it is far from perfect. Over time, nutrients can percolate through the soil into groundwater. Also, pond maintenance is expensive and difficult.

In the United States, feedlot runoff is often stored in a large pond or basin. From there, it is either distributed as nutrient-rich irrigation water or processed for safe disposal. This method is approved by U.S. Environmental Protection Agency, but it is far from perfect. Over time, nutrients can percolate through the soil into groundwater. Also, pond maintenance is expensive and difficult.

Research leader and ASABE member John Nienaber worked with agricultural engineers and ASABE members Roger Eigenberg and Bryan Woodbury to design an alternative system in which runoff containing manure solids enters temporary storage basins at the base of the sloped feedlot.

The basin is large enough to hold runoff for several hours to allow the solid waste to settle to the bottom. The remaining liquid is then drained through distribution tubes that provide even dispersal over a grassy field or “vegetative treatment area” (VTA).

The VTA system, conditionally approved by EPA, has many benefits. It requires minimal management, significantly reduces waste storage time, eliminates the need for costly runoff pumping, and removes standing water.

This manure-disposal technology could also be applied to other livestock. The system should be less expensive to construct and maintain than the traditional system, though the cost and suitability would vary with topography, climate, and animal type.

For more information, contact USDA-ARS public affairs specialist Laura McGinnis, Laura.McGinnis@ars.usda.gov.
Making sure that U.S. peanuts are top-quality requires drying them enough to prevent growth of fungi that can seriously decrease their market value. Now, Agricultural Research Service (ARS) scientists have developed a way to determine moisture levels without destroying the peanuts’ shells, or pods, as is currently done.

Market value is directly tied to peanut quality, and one of the most important quality factors is moisture content. Peanuts must be dried, or cured—to ensure the moisture content does not exceed 10.5 percent—to guarantee quality is preserved and to prevent growth of microbes naturally present in farm fields. One of these, the fungus Aspergillus flavus, can produce a potentially dangerous mycotoxin called aflatoxin.

ARS engineers and ASABE members Chari Kandala and Stuart O. Nelson have pursued an alternative to opening pods for testing placing intact peanut pods between two plates of an impedance analyzer and using radio frequency to determine the pods’ moisture content.


U.S. producers have systems in place to reduce moisture content, but the trick is to make sure optimal levels are reached throughout an entire batch of drying pods.

In the Southeast, freshly dug peanuts—which contain up to 40 percent moisture—are allowed to dry on the vine until they reach an average moisture value of about 20 percent when they are harvested. Soon after, they’re mechanically dried in special trailers until they reach less than 10.5 percent to meet grading standards and allow for safe storage, given adequate ventilation. During drying, processors must measure the peanuts’ moisture contents at regular intervals to prevent drying the peanuts too much, which increases costs and lowers peanut quality.

According to Kandala, the impedance analyzer is better than current methods at measuring pockets of moisture in the entire batch of peanuts.

For more information, contact Sharon Durham, USDA-ARS public affairs specialist, Sharon.Durham@ars.usda.gov.
Two engineers at the University of California, Riverside are part of a binational team that has found semiconducting nanotubes produced by living bacteria—a discovery that could help in the creation of a new generation of nanoelectronic devices.

The research team believes this is the first time nanotubes have been shown to be produced by biological rather than chemical means. It opens the door to the possibility of cheaper and more environmentally friendly manufacture of electronic materials.

The team, including Nosang V. Myung, associate professor of chemical and environmental engineering in the Bourns College of Engineering, and his postdoctoral researcher Bongyoung Yoo found the bacterium *Shewanella* facilitates the formation of arsenic-sulfide nanotubes that have unique physical and chemical properties not produced by chemical agents.

“We have shown that a jar with a bug in it can create potentially useful nanostructures,” Myung said. “Nanotubes are of particular interest in materials science because the useful properties of a substance can be finely tuned according to the diameter and the thickness of the tubes.”

The whole realm of electronic devices which power our world today, from computers to solar cells, depend on chemical manufacturing processes which use tremendous energy, and leave behind toxic metals and chemicals. Myung said a growing movement in science and engineering is looking for ways to produce semiconductors in more ecologically friendly ways.

Two members of the research team, Hor-Gil Hur and Ji-Hoon Lee from Gwangju Institute of Science and Technology (GIST), Korea, first discovered something unexpected happening when they attempted to remediate arsenic contamination using the metal-reducing bacterium *Shewanella*. Myung, who specializes in electro-chemical material synthesis and device fabrication, was able to characterize the resulting nano-material.

The photoactive arsenic-sulfide nanotubes produced by the bacteria behave as metals with electrical and photoconductive properties. The researchers report that these properties may also provide novel functionality for the next generation of semiconductors in nano- and opto-electronic devices.

In a process that is not yet fully understood, the *Shewanella* bacterium secretes polysacarides that seem to produce the template for the arsenic sulfide nanotubes, Myung explained. The practical significance of this technique would be much greater if a bacterial species were identified that could produce nanotubes of cadmium sulfide or other superior semiconductor materials, he added.

“This is just a first step that points the way to future investigation,” he said. “Each species of *Shewanella* might have individual implications for manufacturing properties.”

Myung, Yoo, Hur, and Lee were joined in the research by Min-Gyu Kim, Pohang Accelerator Laboratory, Pohang, Korea; Jongsun Maeng and Takhee Lee, GIST; Alice C. Dohnalkova and James K. Fredrickson, Pacific Northwest National Laboratory, Richland, Wash.; and Michael J. Sadowsky, University of Minnesota.

The Center for Nanoscale Innovation for Defense provided funding for Myung’s contribution to the study.

For more information, contact Iqbal Pittalwala, iqbal@ucr.edu.
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Requirements: A Ph.D. in Agricultural Engineering, Biological Systems Engineering, Civil Engineering, or a closely related field is required. A strong commitment to extension and research; excellent communication skills; ability and desire to work cooperatively on multi-disciplinary education and research projects; and knowledge of livestock and waste management systems are required.

To apply for this position: Go to http://employment.unl.edu, requisition #080371 and complete the Faculty/Academic Administrative Information Form attaching cover letter, C. V. and list of references. Review of applications will begin August 1, 2008 and continue until the position is filled. For more information about the position, contact Dr. Ronald Yoder, (402) 472-1413, or ryoder2@unl.edu.

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As I write this, our television is blaring how the fastest growing segment of American society is those over 100 years old. ASABE is in good company. As my father likes to say, “When you’re over the hill, you pick up speed!” This leads to my favorite topic: our Society’s centennial celebration, though now at the end, and the momentum that we have created. (Some of you may think that I’ve held this pedal on the organ for long enough!)

I hope that you truly celebrated our 100th anniversary and reveled in the proud heritage of our profession. The celebration for the American Society of Agricultural and Biological Engineers officially concluded at the Annual International Meeting in Providence, R.I., June 29-July 3.

When planning our centennial, we didn’t want just balloons and fireworks. Being the practical, frugal agricultural and biological engineers that we are, we wanted more than one feel-good party; we wanted to showcase our dynamic profession. The Board of Trustees set one of the 2008 strategic goals as “exploiting the momentum gained from our Centennial.” I suggest that you check out our Centennial Web site (www.asabe100.org) for a review and an engaging power point presentation to keep the adrenalin flowing.

Centennial accomplishments

Our first centennial goal was to achieve greater recognition for agricultural and biological engineers. Over 1,600 news releases were sent to increase the exposure of our profession. Having a former president of the United States address our meeting brought significant attention with the Associated Press covering President Clinton’s salute to our profession. We also brought our celebration to Washington, D.C., where our Centennial reception gained for the Society added exposure on Capitol Hill.

Many of our members and staff dedicated hours of their time in developing special projects.

• The May issue of Resource magazine, devoted entirely to the centennial, highlighted accomplishments of the past 100 years and featured intriguing looks at what the future might hold for the profession. It’s a keepsake issue of our Society magazine complete with an historic timeline pullout poster that can be found on many members’ walls.

• Several new books are available. Two captured the history of the profession. Three Decades of Change - ASAE to ASABE, completes the 10-year history of the Society, picking up where Seven Decades That Changed America left off. In The Vision that Cut Drudgery from Farming Forever, author Sherwood DeForest tells the story of J.B. Davidson, credited with launching the agricultural engineering profession. And a Centennial Cookbook is filled with the best recipes from our international membership. All are all available from the ASABE bookstore and make great gifts.

• ASABE is on YouTube! Forty-nine historic landmark videos are now available on www.youtube.com—check it out! The short (4 min.) and long (25 min.—“The ASABE Century”) videos, both of which were shown at our Minneapolis celebratory meeting, are available for your local events.

• The Society initiated a corporate partnership program with 35 organizations providing centennial support, and we continue to develop and strengthen relationships with industry.

• The High-School Multi-Media Competition is repeating with the state winners announced. The finalists will have presented in Providence, by the time you read this, and we need some sponsors for this important avenue of awareness building to continue in the future.

• And many of us are still sporting the centennial lapel pins that were given out at the Minneapolis meeting. Blatant advertising at its best!

These are some of the activities from the centennial, but of greater importance is the health of our professional society—ASABE.

One of the best business books that I have read is Managing Corporate Life Cycles by Ichak Adizes. The life of an organization parallels human life: going through birth, infancy, and growth, prime, “fat and happy,” decline, and death. Unlike humans, organizations don’t have a fixed lifespan. The goal is to maintain the organization at the prime level.

How do we keep it going?

Spread the word! Promote your profession, your Society, and celebrate the exciting future, which lies ahead. Our centennial has given us momentum to keep us in our prime. We are over the hill, and ASABE is picking up speed!

Charles Sukup is president of Sukup Manufacturing Co., Sheffield, Iowa, USA and the 2006-2007 ASABE past president who presided over the centennial festivities; charlessukup@netins.net.
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