University of Maine

Engineering

2012

Discovering sustainable bioeconomy solutions

1865 THE UNIVERSITY OF MAINE

Contents

ENGINEERING

innovating our economic future

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ON THE COVER: In June, the University of Maine's Technology Research Center (TRC) opened in Old Town, Maine, connecting private industry with UMaine researchers in the Forest Bioproducts Research Institute. TRC serves as a one-stop shop for processing and analysis of technologies, validating, demonstrating and helping commercialize fuel, chemical and advanced material technologies from forest bioproducts at an industrially relevant scale. The 40,000-square-foot facility, located on the grounds of Old Town Fuel & Fiber, features state-of-the-art process control and process information systems. See related story beginning on page 8.

WELCOME TO THE 2012 University of Maine College of Engineering magazine, featuring stories of our graduates, faculty and staff who are working together to grow Maine's economy and keep UMaine the top choice in engineering education.

The college provides such a great return on investment. For every $1 of state appropriation, the College of Engineering generates $16 in economic activity, which totaled $60 million in economic development last year. From 2007–11, the college powered economic growth with $12 million in industrial contracts and grants, five spin-off companies, 21 U.S. patents issued, 94 invention disclosures submitted, and more than $68 million in federally funded expenditures.

We expect record enrollment with the fall 2012 incoming class and are seeing growth across the spectrum of engineering programs. In the last four years, the number of UMaine engineering students has grown 25 percent versus just 16 percent for the U.S. as a whole. In 2006, Maine ranked 49th in the country in per capita production of engineering bachelor's degrees. By 2011, production of degrees increased by 27 percent, but this raised Maine's ranking only to 47th. We would need to increase production by another 70 percent to reach the national average.

We are very proud of our new Brunswick Engineering Program, aimed at increasing the pathways to an engineering education in Maine. You will read about this program and more in this magazine.

It is critical that the university and the state continue to invest in engineering education so that we can have the faculty and facilities to keep up with the growth of engineering students and meet the needs of Maine's economy.

One hundred forty eight years of engineering excellence moving Maine forward — the College of Engineering at the University of Maine.

Dana N. Humphrey
Dean, College of Engineering

UMaine's high-altitude scientific balloons and rockets are designed to ascend to 100,000 feet or more — about 20 miles above the Earth. They must be strong enough to carry sophisticated payloads of weather instruments, cameras, GPS transmitters and other devices. Cargo containers attached to parachutes must be sturdy enough to hit the ground without damaging the equipment. Photos by Craig Harrison

Research with a

NASA funds high-flying projects for UMaine engineering students

UNIVERSITY of Maine engineering students with elevated aspirations have two new space engineering projects to explore at the University of Maine, thanks to resourceful faculty members and recent funding from the Maine Space Grant Consortium (MSGC), an affiliate of the NASA National Space Grant College and Fellowship Program.

Rick Eason, associate professor of electrical and computer engineering, and Mike Boyle, associate professor of mechanical engineering, oversee student projects in high-altitude scientific ballooning and high-altitude rocketry, respectively. The programs, now in their second year of funding, are attracting students with wide-ranging interests and a collaborative spirit.

How high-flying are these NASA-funded projects? Both the rockets and balloons are designed to ascend to 100,000 feet or more — about 20 miles above the Earth. They must be strong enough to carry sophisticated payloads of weather instruments, cameras, GPS transmitters and other devices. Cargo containers attached to parachutes must be sturdy enough to hit the ground without damaging the equipment. That equipment must be traceable and retrievable, wherever it lands.

The Augusta-based Maine Space Grant Consortium supporting the two projects is a nonprofit agency set up in 1998 to direct NASA funding to academic and K–12 settings. Similar programs have been established in every state, Puerto Rico and the District of Columbia.

Dana Humphrey, dean of the UMaine College of Engineering, is the board chair of the Maine organization. Consortium director Terry Shehata says the organization's goals are to support space and aeronautic research and education at Maine universities and colleges; support the faculty and students behind that research and education; and inspire K–12 students statewide to consider careers in science, technology, engineering and mathematics by introducing NASA-generated materials and classroom practices for teachers and students.

In 2011, the Maine Space Grant Consortium awarded $12,000 to each of five scientific ballooning and rocketry teams in Maine, including teams at the University of Southern Maine and Maine Maritime Academy, under a new program called the Maine Student High Altitude Platform. The program is designed to inspire Maine K–12 and undergraduate students to consider aerospace-related careers, and help Maine colleges and universities recruit interested students from area high schools. UMaine teams included Boyle's rocketry team and Eason's scientific ballooning team.

ltitude

In 2012, each group received another round of funding to continue its work. UMaine has provided matching funds to the projects.

In addition to the funding provided at the college and university level, the Maine Space Grant Consortium is providing ballooning materials and teacher workshops at three high schools as part of a pilot program, which also involves UMaine's balloon program.

"Contrary to popular belief, Maine has an emerging strength in NASA-related research and education activities," Shehata says. In addition to the rocketry and ballooning projects, examples at UMaine include a new aerospace engineering minor and engineering professor Ali Abedi's wireless technology for the lunar habitat, both funded by MSGC.

Shehata expects the NASA funding to continue and even grow as more Maine schools and students learn about the projects.

Scientific ballooning

"I knew what weather balloons were, but I didn't know people did this academically," says Eason, whose Barrows Hall laboratory is littered with bits and pieces of the ballooning project. "This gives our students hands-on experience in working in teams to design a space project. They get a really broad overview of many different engineering applications and problems."

In January 2011, shortly after being notified of the Maine Space Grant Consortium award, Eason attended a scientific ballooning workshop for post-secondary educators at Louisiana State University. When UMaine started its spring semester later that month, Eason's new course in scientific ballooning enrolled 12 undergraduate students. Interest in the course has remained high, and several senior engineering students worked on the project for their capstone projects.

The weather balloons are made of tan-colored latex. Eason's students custom-design and construct a series of rigid foam cargo boxes, connecting them to the balloon and to each other with common cotton string. The boxes have carried weather instrumentation for measuring temperature, humidity and air pressure, as well as a video camera, a GPS signaling device, and an amateur radio transmitter to follow and find the cargo when it lands. The researchers continue to try other instruments and experiments.

Learning to work with all these technologies in a high-altitude environment is part of the challenge, Eason says, in addition to the complicated logistics of sending them aloft in the first place. Each student on the project also has been required to study for — and pass — the federal amateur radio licensing exam to be able to track and retrieve the balloon's payload.

Rick Eason's students custom-design and construct a series of rigid foam cargo boxes, connecting them to the balloon and to each other with common cotton string. The boxes carry weather instrumentation for measuring temperature, humidity and air pressure, as well as a video camera, a GPS signaling device and an amateur radio transmitter that allows the students to follow and find the cargo when it lands.

Filled with helium at the launch site, each balloon inflates to about eight feet in diameter; at altitude, expansion is as much as 20 feet in diameter.

The balloon will keep ascending until it bursts in response to the decrease in atmospheric pressure. But in order to have better control over how and where the payload falls, students on the ground can signal a heating device that severs the string connecting the balloon to the cargo boxes, allowing them to drift back to Earth on a parachute without getting tangled in bits of the broken balloon.

After one recent balloon launch from the airport in Pittsfield, Maine, members of the balloon team drove north nearly 125 miles to Patten to retrieve the undamaged cargo. Photos and video from that launch and others, including the ever-expanding horizon and the curve of the Earth visible during the balloon's ascent, are available online at the UMaine group's website (eece.maine.edu/umhab).

Using 3D modeling software and metal-shaping tools in the engineering lab, a team of six mechanical engineering students designed and manufactured critical airframe components for a 19-foot rocket and assembled its aerodynamic tail fins, its two-stage aluminum body and specialized nose cone.

Sounding rocket

In their Crosby Hall lab, students in Mike Boyle's sounding rocket group are homing in on a design they calculate will boost their rocket and its payload — a camera and a GPS transmitter, primarily — to an altitude of 100,000 feet or higher.

Using 3D modeling software and metal-shaping tools, the six mechanical engineering students have designed and manufactured critical airframe components for their 19-foot rocket and assembled its aerodynamic tail fins, two-stage aluminum body and specialized nose cone. Each phase of their work is painstakingly documented on the group's website (projectursa.moofruit.com).

The students have installed pressure sensors in the rocket's nose cone and aft end that will collect airflow and air pressure data, allowing them to compare the rocket's aerodynamic characteristics with computer projections. And they entered the national competition for the coveted Carmack prize, a $10,000 purse offered by a group of Silicon Valley innovators for the first student rocket to record continuous GPS data from above the 100,000-foot mark, parachute to Earth without significant damage and be recovered within 24 hours of launch.

"Working with mechanical engineering students is always a pleasure, but this rocket crew is really exceptional," says Boyle. "Their ability to create, design, build and test surpasses that of most experienced engineers."

The rocket design has required combustion modeling, prediction of thrust with time, precision machining, booster testing, assembling of electronic instrumentation — in short, most of the dimensions of a multidisciplinary project in the real world. Much of this work has been accomplished by the students, Boyle notes. In addition, they have effectively teamed with engineers and other professionals from across the country.

The rocketry team also has been supported by Applied Thermal Sciences (ATS), a Sanford, Maine, company that researches and develops propulsion systems. ATS hosts student interns each summer, some of whom have been members of the UMaine rocket team.

"NASA is starting to do a lot of work with suborbital rockets for a number of environmental and space concerns," says ATS founder Karl Hoose. "There's a big push to get more students involved in aerospace and space-related activities to support future workforce needs."

In recognition of the University of Maine mascot, the black bear, the students in Boyle's group have named their undertaking "Project Ursa." One of the group's primary goals is to record high-definition video of their rocket's ascent and descent. That video may prove difficult to watch, however, since the rocket is expected to reach a speed of 2,280 mph on its ascent and 900 mph on the way down before the parachute deploys.

This summer to trial the separation and recovery system, the rocket team static tested the booster motor and its second-stage sustainer. ■

Club activities, internships make electrical engineering come alive

Robotics rules

IT DIDN'T take long for David Hart to find his niche after entering the University of Maine College of Engineering in fall 2009. He joined the Robotics Club in his freshman year and has been active in robotics ever since.

In his sophomore year, Hart served as event director for the Maine VEX Championship at the Bangor Auditorium. VEX Robotics promotes programming in science, technology, engineering and math among middle school, high school and college students nationwide.

"These teams spend an entire year building their robots, trying to make them the best," he says.

Last December, Hart also organized UMaine's participation in the first VEX tournament ever held in southern Maine. Four VEX robotics teams from the state of Maine qualified for the world championships in California.

The Portland, Maine, native says he considered several schools before deciding on UMaine. One campus tour and he was hooked.

"I liked the atmosphere, the location and the program," he says. "It seemed like a place where I could fit in."

Hart enters his senior year having made a place for himself on the Orono campus among a network of like-minded friends.

"The graduating class in electrical engineering is small," he says. "We've all been going to class together since freshman year. It's a pretty tight group."

Why did he choose electrical engineering?

"I was always messing around with stuff, and I wanted to learn more about how electronics work," he says. "And I was good at math."

For his senior capstone project, Hart and a classmate will design and build a brushless motor controller. He's also hoping to have time to explore a few personal interests — downhill skiing is a favorite sport — but he knows the senior year curriculum will keep him plenty busy.

"Being at UMaine has been a great experience," he says. "I've met a lot of people from different backgrounds."

Hart interned last summer at IDEXX Laboratories in Westbrook, Maine. This summer, he worked at Texas Instruments in Portland. Both placements will help him focus his interests and move him toward a career goal, he says.

UMaine's electrical engineering program is challenging, but Hart says motivated students can get the help they need to succeed.

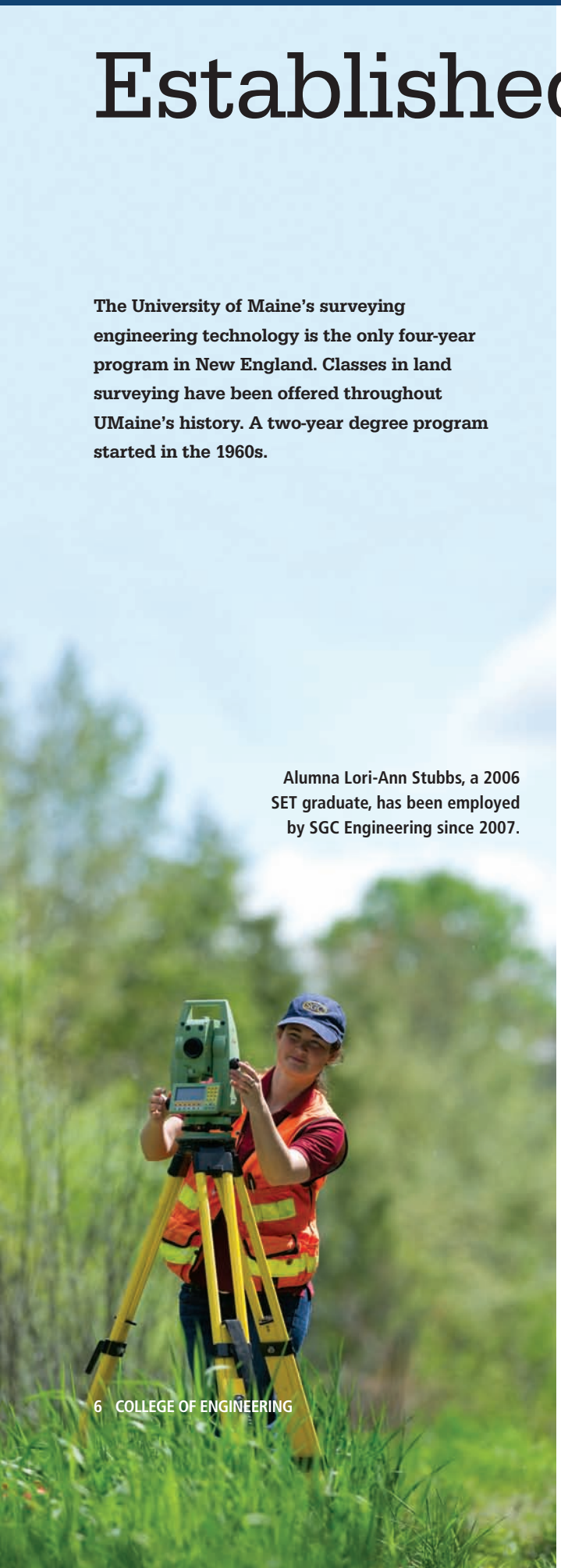
"Everyone I have interacted with here is very willing to help out," he says. "Professors want to see you do well, to succeed in the program and go on and do what you want to do."

For his senior capstone project, David Hart and a classmate will design and build a brushless motor controller.

Established baseline

UMaine continues its leadership role in SET education

The University of Maine's surveying engineering technology is the only four-year program in New England. Classes in land surveying have been offered throughout UMaine's history. A two-year degree program started in the 1960s.



Alumna Lori-Ann Stubbs, a 2006 SET graduate, has been employed by SGC Engineering since 2007.

AS A MEMBER of the Surveying Engineering Technology Program faculty in the University of Maine School of Engineering Technology, Carlton Brown teaches in one of the smaller programs on campus. But survey engineering at UMaine — the only four-year program in New England — has an important history and an essential mission for the future, and Brown says it is positioned for growth.

"There will always be a need for professionals who know the art, science and technology of measuring the shape of portions of the Earth's surface, and of locating things precisely on the Earth's surface," he says.

New technologies — such as geographic information systems (GIS); global positioning systems (GPS); and light detection and ranging (LiDAR) — have changed the way land surveyors practice, he says, but these tools demand an ever-higher level of expertise in a field long defined by the need for precision. Although digital and satellite capabilities have usurped some of the traditional tasks of land surveyors, Brown says survey engineers will always be in high demand.

UMaine has offered classes in land surveying throughout its history. A two-year degree program started in the 1960s.

But in the mid-1970s, professional surveyors across New England were worried that the field wasn't attracting or adequately preparing new young surveyors to enter the field. Standards for entry-level jobs and professional licensure varied from state to state, making it harder for qualified surveyors to practice across state lines.

In 1973, Boston surveyor Fritz Petersohn, then chair of the New England Section of the American Congress on Surveying and Mapping, proposed establishing a professional land surveying program at one regional university that would serve all six New England states. The program would develop a curriculum reflecting a common professional standard for all the states and would prepare students at several levels, including the Ph.D. needed for careers in research and academics. Students from New England would pay a reduced tuition to attend.

After a review of more than two dozen colleges and universities in the region, a request for proposals was issued. With support from the New England Land Grant Deans of Engineering organization, UMaine was selected to host the land survey program.

To this day, UMaine's Surveying Engineering Technology Program still offers the only four-year survey engineering degree in New England, according to Brown. Thanks to an

ongoing agreement with the New England Board of Higher Education, students from other New England states pay approximately half the out-of-state tuition rate.

The program is ABET-accredited by the Engineering Technology Accreditation Commission for Surveying and Geomatics Engineering Technology.

Today, about 50 students are enrolled in the survey engineering program and graduates have no trouble finding jobs in-line with their personal and professional goals, Brown says. The field appeals to those who enjoy working outside and with a degree of autonomy.

Older, nontraditional students typically are well represented in survey engineering classes, as are military veterans and a growing number of women.

While many graduates of UMaine's Surveying Engineering Technology program find jobs in Maine, others are working farther afield. For instance, one 2009 graduate is a project manager at Portsmouth Naval Shipyard, managing the construction of dry docks and other facilities.

A 2008 graduate worked three years for the city of Denver, Colo., as a senior survey technician before accepting his present position with the Arizona Public Service Company. And a 2011 graduate is pinpointing new underwater drill sites for the petroleum industry in the Gulf of Mexico. ■

Point of beginning

TARA HARTSON of Hancock, Maine, is a 2007 graduate of the Surveying Engineering Technology Program and a Maine-licensed professional land surveyor. Since graduating, she has been employed by Herrick & Salsbury Land Surveyors in Ellsworth, Maine, where she interned the summer between her junior and senior years.

Hartson was eager to pursue a career path that would allow her to stay in Maine, earn a good salary, and work outdoors much of the time. For a while, she worked for the National Park Service on the trail crews and considered studying landscape design. Then her sister suggested surveying.

Since graduating, Hartson has worked on projects ranging from subdivisions and residential layouts to airport runways and power lines. She performs legal research and presents projects to municipal planning boards. She estimates she spends at least half her time outside, which is where she most wants to be.

Rapid response

FBRI's new Technology Research Center is a bridge between R&D and commercialization

The University of Maine's Forest Bioproducts Research Institute's new Technology Research Center's analytical capabilities include:

- **Chemical and physical testing for pilot-scale campaigns**
- **Gas and liquid chromatography**
- **Atomic and molecular spectroscopy**
- **Wet chemical characterization**
- **Analytical method development**
- **In-process and final product material characterization**

Its processing capabilities include:

- **Multiple-unit operation**
- **Biomass size reduction, screening, pretreatment, extraction and cooking**
- **Fermentation**
- **Chemical reaction**
- **Pelletization**
- **Liquid-liquid extraction**
- **Distillation**

COMPANIES ON THE verge of sending cutting-edge, forest bioproducts-based technologies into the marketplace have new commercialization testing and demonstration capabilities at the University of Maine's Technology Research Center (TRC) in Old Town, Maine.

TRC, a component of the University of Maine's Forest Bioproducts Research Institute (FBRI), is located on the grounds of Old Town Fuel & Fiber, a pulp mill purchased in 2008 by private equity firm Patriarch Partners.

The 40,000-square-foot fee-for-service center is a manufacturing demonstration facility where industrial groups collaborate with UMaine researchers to validate, demonstrate and help commercialize fuels, chemicals and materials technologies from forest biomass, at an industrially relevant scale.

Product developers have access to the latest physical and virtual tools — from design to process evaluation — in a center that facilitates the development of energy-efficient, rapid and flexible manufacturing technologies, and promotes broad and rapid dissemination of technological advances into the relevant markets.

"The Technology Research Center allows us to take the R&D from the lab and assist with rapid commercialization," says Hemant Pendse, director of FBRI and chair of UMaine's Department of Chemical and Biological Engineering.

Pendse has envisioned TRC since 2004, when he says he began planning for a small-scale manufacturing development facility for technology demonstration and validation. FBRI was created in 2006 with a $6.9 million research infrastructure improvement grant from the National Science Foundation's Experimental Program to Stimulate Competitive Research (NSF EPSCoR) and a 50 percent match ($3.45 million) from UMaine through the Maine Economic Improvement Fund, the state's appropriation for university R&D, bringing the total investment to $10.35 million. At the time, it was the largest NSF EPSCoR grant ever awarded to UMaine.

TRC's facility and equipment were capitalized in 2009 with a $4.8 million grant from the Maine Technology Asset Fund (MTAF). That grant also helped FBRI build a 3,300-square-foot collaboration space addition to Jenness Hall, which includes areas where FBRI technical staff work with visiting researchers and industrial collaborators on bioproducts and the processes necessary to develop them.

Old Town Fuel & Fiber is providing a $2 million match to the MTAF grant in order for the TRC to operate rent-free for five years.

TRC fills a particular niche, Pendse

says. Technologies to be tested there will have already gone through early research stages at the lab and bench scale, but may not quite be ready for process commercialization. The goal for TRC is to be as flexible as possible.

"We'll be able to do pilot-scale campaigns, which means we can do one thing, then stop and do another," Pendse says. "We will never be doing the same thing for very long and we will do a lot of different experiments producing experimental materials for market readiness testing. We want to be large enough for companies or researchers to get useful data, but flexible so we can configure experiments in different ways."

Pendse calls it an industrially relevant scale, meaning TRC has the capability to produce experimental batches — hundreds of pounds of an item, for example — but to get to a larger commercial scale, the company would have to go to a larger, full-commercial production facility.

"We help with early demonstration and deployment, after which the company would then go to the private sector for commercial, sustainable and successful operation," he says.

TRC has the ability to handle any cellulosic feedstock, from forest residue to switchgrass to municipal solid waste. From those feedstocks, companies could experiment on dozens of bioproducts, such as precursors for drop-in fuels like gasoline, diesel and jet fuel; nanocellulose fibers and carbon fibers; and high-value industrial chemical by-products and coproducts.

The center currently supports six faculty researchers, and visiting scientists from industry and other institutions from around the world. There are rich educational opportunities for UMaine students — undergraduates will be able to gain hands-on experience, while graduate students will be able to use the facility for R&D and learn how to collaborate with industrial clients.

Amy Luce, a UMaine chemical engineering alumna and a 13-year industry veteran, oversees TRC's operations. The staff also includes designers, manufacturing experts and product

TRC is a prime example of how Maine R&D bond funding, competitively awarded through the Maine Technology Asset Fund, is investing in building facilities to increase capacity of Maine's R&D and business community to accelerate innovation.

Many of the projects already in development in the lab and ready for pilot trials are the result of public-private partnerships, with investment from federal agencies such as the U.S. Department of Energy, U.S. Defense Logistics Agency, National Science Foundation and U.S. Department of Energy, and collaboration with private companies, including Maine paper companies, land management companies and entrepreneurial start-ups.

evaluators to guide and train users and maintain the infrastructure.

TRC has processing capabilities that go beyond what other facilities can offer in Maine and the U.S. The center is capable of biomass size reduction and screening through physical processes; biomass pretreatment through chemical processes; extraction of sugars and fibers for pulping; fermentation, distillation, liquid-liquid extraction, and microfiltration to separate complex liquids; and biomass pelletizing. FBRI's analytical capabilities available to TRC include chemical and physical testing for pilot-scale campaigns, gas and liquid chromatography, atomic and molecular spectroscopy, wet chemical characterization, analytical method development, and in-process and final product material characterization.

While some processes are currently available on campus on a smaller scale, Pendse says TRC will not be a duplicate facility. Instead, one of the benefits of the center — and an aspect that makes it industrially unique — is a system of sensors and controls integrated with TRC's process equipment.

"These rapid-response, robust sensors are connected to the process and they give you immediate readings, which allow you to make process and experimental changes immediately instead of sending a sample away for testing and waiting a few hours for the results. These sensors help us evaluate effects of process changes and control processes," Pendse says.

Sensors also allow TRC to provide state-of-the-art process control and process information systems. Data from experiments and processing are instantly accessible by both researchers and clients through FBRI's OSIsoft PI system, a real-time data and event management infrastructure. The resulting database will include thousands of hours of process history data, which can be analyzed quickly.

Pendse says this access to historical process information will allow researchers to better plan and optimize experiments. Information gained through a particular client's experiments or trials will not be shared with other clients. TRC staff provides objective, independent testing with procedures in place to protect intellectual property while sharing precompetitive best practices.

TRC is a prime example of how Maine R&D bond funding, competitively awarded through the Maine Technology Asset Fund, is investing in building facilities to increase capacity of Maine's R&D and business community to accelerate innovation. Many of the projects already in development in the lab and ready for pilot trials are the result of public-private partnerships with investment from federal agencies, such as the U.S. Department of Energy, the U.S. Defense Logistics Agency, the National Science Foundation and the U.S. Department of Energy, and collaboration with private companies, such as Maine paper companies, land management companies and small entrepreneurial start-ups.

Bringing this type of real application-based problem solving, innovation, entrepreneurship and product development together gives UMaine students a huge advantage in the expanding tech-based career opportunities. ■

Alumna combines engineering expertise with long-held interest in law

Patented career

KAREN HASTINGS graduated from the University of Maine in 1981 with a degree in chemical engineering and received a law degree from George Mason University in 1988. Since 2007, she has served as an Administrative Patent Judge with the U.S. Patent and Trademark Office (USPTO).

Why chemical engineering?
I participated in the College of Engineering's High School Juniors Program between my junior and senior years. With the encouragement of Stanley Marshall of the UMaine Pulp and Paper Foundation, I applied for and became a lab technician the following summer for S.D. Warren near my hometown of Portland, Maine. This confirmed my interest in chemical engineering as a possible entry into the papermaking field. I received a four-year merit-based tuition scholarship from the Pulp and Paper Foundation, and never looked back.

Were you involved in any co-ops?
I was a co-op student project engineer for Westvaco (now New Page Corp.) in western Maryland my junior year. As a senior, I was also a laboratory instructor for the Chemistry Department.

Where did your career take you?
I accepted a job in the papermaking field from Procter & Gamble in Mehoopany, Pa. I already knew that I wanted to eventually pursue a career in patent law. So I applied at the USPTO, where I knew I would have the opportunity to work as a patent examiner and go to law school in the evenings. I began my career at USPTO in 1983 evaluating patent applications in the papermaking industry. The transition from quickly creating solutions to real-world problems to learning about the best cutting-edge innovations in the field was dramatic and interesting.

What sparked your interest in pursuing a law degree?
I had read an article when I was a junior in high school about this hot field called patent law. I was intrigued right away, but since I knew I had to pay my own way through college and law school, it took me a while to get there. The Washington, D.C. area had numerous nighttime programs available. USPTO even paid for some of my job-related legal coursework.

How did UMaine prepare you?
UMaine delivered a top-rate education in engineering. I also had a concentration in mechanical engineering. The analytical approach required in math and science courses, and particularly in the engineering disciplines, laid a foundation that proved useful for so many aspects of my career and my life.

Read the full interview online (umaine.edu/colleges/engineering-college/alumni-profiles).

As an administrative patent judge, Karen Hastings is charged with deciding appeals from adverse decisions of patent examiners. "It is most fulfilling to be involved in the innovation process and be able to make what I believe is the best decision in each case, and be part of the history of USPTO," she says. Photo by Edwin Remsberg

UMaine mechanical engineering researchers are working to identify effective, impact-resistant materials for protective headgear. Equipment in the Injury Reduction and Rehabilitation Laboratory includes a drop tower with a crash-test dummy head outfitted with sensors to analyze impacts.

Crash course

A biomechanics lab focuses on injury reduction and rehabilitation

A FAMILY OF crash-test dummies is on call in Vince Caccese's biomechanics lab at the University of Maine. Just about every day, they're put into action, revealing what actually happens when a person takes a bad fall, endures the shock of an explosion or suffers a head injury in a car accident, football game or other high-impact event.

Caccese, a professor of mechanical engineering, is one of several UMaine researchers to share a $535,000 grant from the Maine Technology Institute's Maine Technology Asset Fund to outfit a laboratory for the study of injury reduction and rehabilitation. In the Injury Reduction and Rehabilitation (IRR) Laboratory, he and his students are cooking up new ways to simulate head injuries and other traumas, as well as developing new protective materials that can help prevent them.

Other UMaine researchers on the IRR team include mechanical engineering professor Mohsen Shahinpoor; professors Liz Depoy and Stephen Gilson of the Center for Community Inclusion and Disability Studies; Rick Eason, professor of electrical and computer engineering; and John Belding, director of the UMaine Advanced Manufacturing Center.

In the IRR lab, Caccese and his students are studying new material systems to prevent injury due to impact, twisting, vibration or other physical trauma. Among other models, their testing of honeycomb-shaped structures looks promising, providing an optimal combination of strength and flexibility to absorb and diffuse the force of a severe impact.

Padded helmets are an essential component of head-injury prevention, worn by athletes, construction workers, motorcyclists and individuals with previous head injuries, such as military veterans. Now the search is on to identify effective, impact-resistant materials that contribute little bulk, increasing likelihood that a protective helmet or other headgear actually will be worn.

To illustrate how materials are tested, Caccese hoists the disembodied, helmeted head of a crash-test dummy about five feet off the ground and drops it onto an anvil. The twin-wire drop tower allows him to adjust the velocity of the fall and the angle of the impact. Sensors in the dummy's "brain" send information to a computer program that reads and analyzes the impact.

Impact-absorbing material also may have applications for emergency medical providers, including those in combat settings where wounded troops may sustain further injuries during air and ground transport.

Funding for the lab's materials development project includes a $78,000 contract with Alba-Technic LLC, a small Maine company with

links to the Department of Veterans Affairs research center in Tampa, Fla., and the Division of Geriatric Medicine at the University of California, Los Angeles. Alba-Technic is working toward commercialization of the protective technology, using a nearly $1 million Small Business Innovation Research grant from the National Institutes for Health.

The project also has input from the LifeFlight medical helicopter service housed at Eastern Maine Medical Center in Bangor.

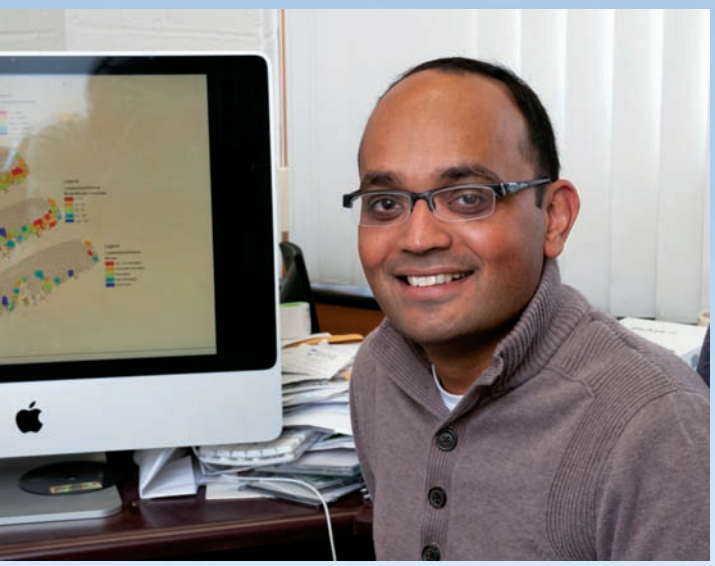
In the Rehabilitation and Neuromuscular Robotics Laboratory, Depoy and Gilson are working with the engineers to develop socially interactive robots to assist individuals with disabilities. The ReNeu Lab also is the development site of hardware that can respond to changes in balance and terrain to provide stability for joggers and skiers with physical disabilities. Similar technology is being used to develop "smart" physical therapy equipment that adapts automatically to a user's strength and range of motion.

For Caccese, who also coaches youth ice hockey, the work is mostly about preventing head injuries. And while he's not specifically focused on sports-related applications for his new protective material, he notes head trauma among young athletes is a serious and growing concern. ■

Mechanical engineering sophomores Allie Hayford and Grant Aylward, pictured above, work with Vince Caccese in the Injury Reduction and Rehabilitation Laboratory, where new material systems are studied to prevent injury due to impact, twisting, vibration or other physical trauma. Pictured left is mechanical engineering graduate student Nathaniel Hayes. More information about the lab is online (umaine.edu/irr).

Water adaptation

Modeling informs resource infrastructure designs, decisions and policies



Shaleen Jain's research projects focus on the nature and causes of regional hydrologic change in western North America, the northeastern United States, the Korean peninsula and African Sahel.

DEVELOPING models to understand the impact of climate change on freshwater resources is the focus of research by Shaleen Jain. An assistant professor of civil and environmental engineering, Jain explores uses of climate information for adaptive environmental management, including the role of water allocation to ensure reliable water supplies for communities and to balance ecosystem health.

Last year, Jain received a National Science Foundation Faculty Early Career Development (CAREER) Award to bolster his research. The five-year award of more than $400,000 also has an educational component. Jain will work with UMaine's New Media Internet Technologies Laboratory to develop a watershed sustainability-related gaming environment for students.

With the program, called SimStream, students will explore the relationships between a stream, its ecosystem and a neighboring city. It was built using Scratch, a programming environment developed by the Massachusetts Institute of Technology.

"We'll be merging computational learning with environmental sustainability in middle schools," Jain says. "We will work with students to develop their own conception of watersheds, where they can include various physical and cultural elements. We really think that issues of environmental sustainability are increasingly urgent and important to include as early in

our K–12 education system as we can."

Students at Stillwater Montessori School in Old Town, Maine, have experimented with Scratch. In addition, Jain will partner with UMaine's Wabanaki Center to develop an educational curriculum on watershed sustainability for middle school students from Maine's Penobscot and Passamaquoddy tribes.

In his research, Jain will collaborate with the Maine Department of Environmental Protection and other water-related stakeholder groups.

NSF CAREER grants are highly selective awards to junior faculty who are promising researchers in their field. Previous CAREER awardees in UMaine's Civil and Environmental Engineering Department include Eric Landis, Jean MacRae and Roberto Lopez-Anido.

Jain, who has been at UMaine since 2006, is also a cooperating assistant professor in UMaine's Climate Change Institute and the School of Policy and International Affairs. He is also part of the core faculty team working with the UMaine-based Sustainability Solutions Initiative (SSI).

In SSI, Jain and Esperanza Stancioff, an Extension educator with University of Maine Cooperative Extension and Maine Sea Grant, are leading research to help communities in the state better understand and prepare for the potential local impacts of climate change. Those impacts include increasingly intense and frequent storms. ■

Analyzing climate risk

LIKE MANY NATIONS with growing populations, South Korea is facing a major overhaul of its water system infrastructure. Those overhauls are even more important on the Korean peninsula, which bears the brunt of some of the most brutal tropical storms on the planet, and where climate change models have predicted even larger and stronger typhoons.

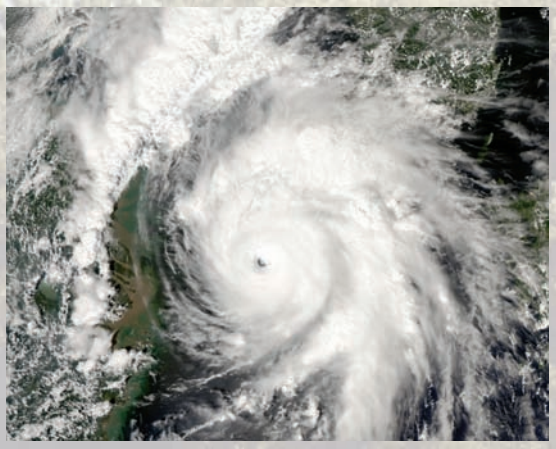
UMaine civil and environmental engineer Shaleen Jain and Jong-Suk Kim, who worked as a postdoctoral researcher under Jain and is now affiliated with the City University of Hong Kong, have come up with a fresh approach for analyzing the nature and impacts of past typhoons on the Korean water system. The climate risk analysis could help officials make informed decisions about how and where they adapt their water systems to accommodate stronger storms.

South Korea is going to build new dams and infrastructure on their streams, says Jain. But current analyses for the country have only taken into account smaller, garden-variety storms that don't have as great of an impact as typhoons.

In their study, Jain and Kim analyzed the last 40 years of changes in seasonal precipitation in South Korea's five major river basins, factoring in how much stream flow is due to a typhoon and how much is related to smaller storms. Their risk analysis identifies "hot spots" in the country where typhoons had huge impacts.

The analysis approach is applicable to other regions that deal with strong tropical storms, such as the southeastern United States, the north and southwest areas of the Indian Ocean, Australia and the South Pacific.

Read the full journal article online (iopscience.iop.org/1748-9326/6/3/034033).



Kompasu was a Category 3 typhoon that moved along Okinawa, Japan and the west coast of the Korean peninsula before striking Seoul in early September 2010.

Photo courtesy NASA

Electrical usage data helps homeowners strategize energy and cost efficiencies

The numbers don't lie

IN A PROJECT with the potential to influence energy production, consumption and policy in Maine, 50 homeowners in the Blue Hill, Maine, area are partnering with a local energy-monitoring company and University of Maine researcher Nathan Weise in a year-long study of residential electricity use. The goal is to see whether homeowners adopt energy-conserving strategies once they understand the details of their usage, according to Weise, a University of Maine assistant professor of electrical and computer engineering.

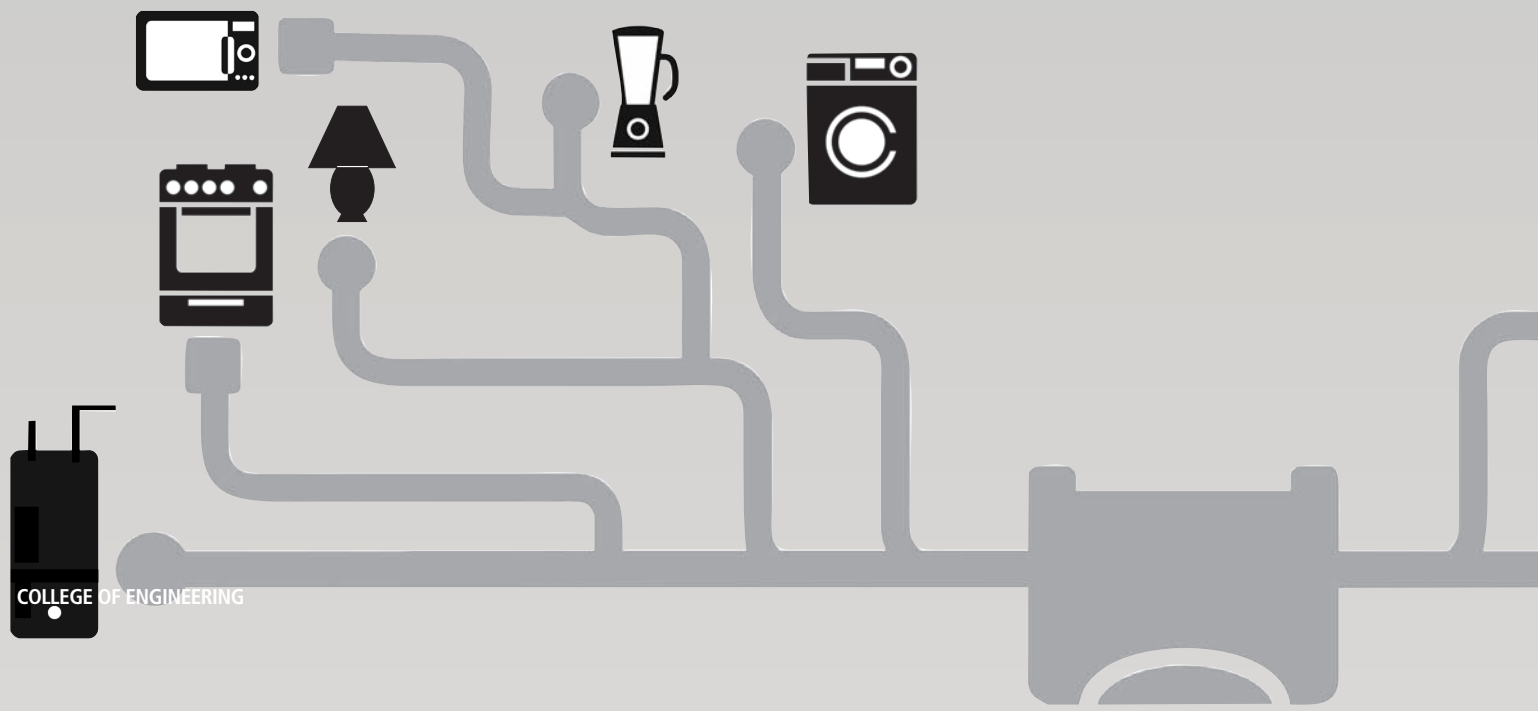
"We will build 50 separate profiles of residential energy use in Maine," Weise says. "The key is for people to see with their own eyes when and how their household electricity is consumed on a circuit-by-circuit basis."

With about $90,000 in funding from the quasi-governmental agency Efficiency Maine, PowerWise Systems of Blue Hill has installed energy monitors at no cost to the participating homeowners. Weise and a team of UMaine students will analyze data from the monitors and provide information to the individual participants. At the end of the study, the data will be aggregated — without identifying the participants — and will be made available to educators, energy efficiency agencies like Efficiency Maine, and other groups.

Homeowners in the study will be able to see exactly how much electricity is used in each circuit on their home panels, including the time of day the power is consumed. Over time, Weise says, clear patterns will emerge and homeowners can consider strategies for lowering their usage and cost.

In some areas of the country, residential electricity is subject to time-of-day pricing, according to Weise, with morning and evening hours typically being the most expensive. Similar pricing structures are under consideration in Maine. Simple strategies, such as setting dishwashers or washing machines to operate during cheaper late-night hours, can save money while decreasing the load on the local power grid, Weise notes.

The monitors also will reveal how much electricity is used by major appliances, such as refrigerators and dryers, providing homeowners with an incentive to consider buying newer models that consume less energy. Smaller investments, such as energy-saving lightbulbs and switches that turn off the flow of "phantom power" to computers and other electronics, can



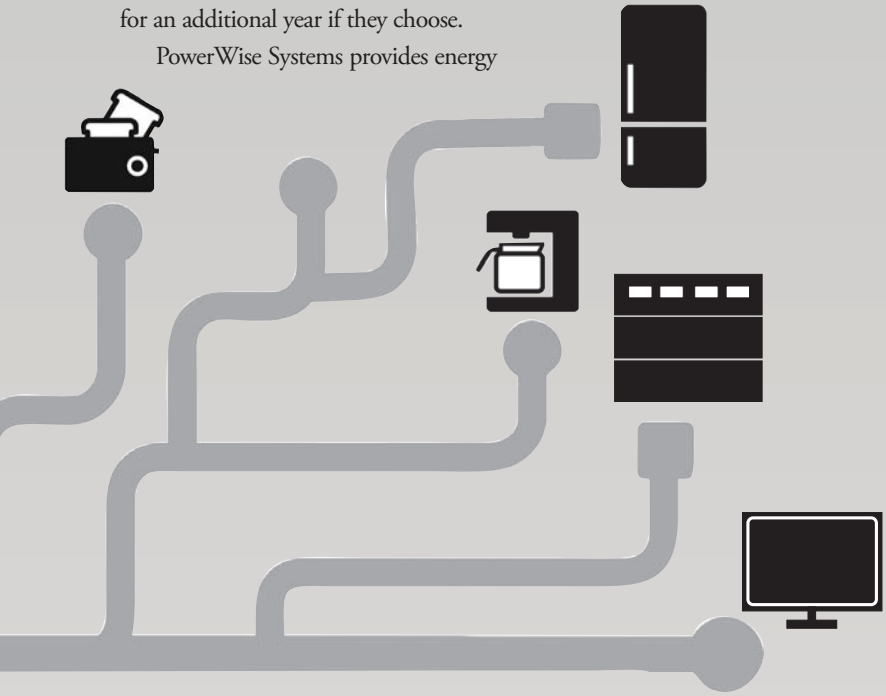
seem more attractive when consumers have the actual figures before them, Weise says.

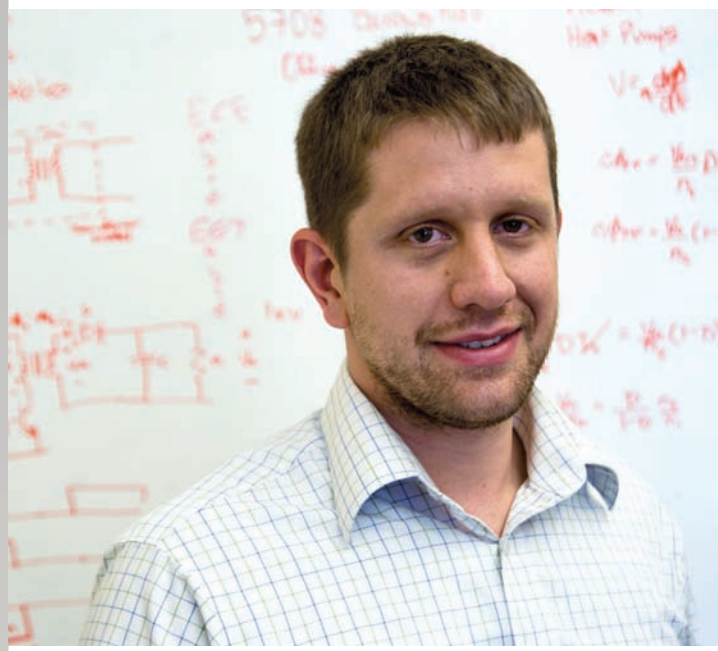
The usage data will be studied in three-month segments. During stage 1, homeowners will have no access to their usage data and will maintain their usual behaviors. In stage 2, homeowners will be able to see their usage on a secure website and make changes themselves in their electricity use. In stages 3 and 4, Weise and his students will consult individually with participating homeowners to suggest energy-saving changes based on their individual data, and PowerWise staff will offer additional information and support.

Homeowners in the study will not be required to make any changes, and can keep the monitors in their homes for an additional year if they choose.

PowerWise Systems provides energy monitoring and education solutions to homes, businesses, schools and institutions. Originally named Powerhouse Dynamics, the company developed one of the first interactive energy monitors on the market. The Powerhouse Dynamics monitor used in the Blue Hill study can keep track of up to 22 individual circuits, as well as the total power used in each home.

"This is the first controlled study in the United States to monitor so many residences with such detailed data," says Joanne Steenberg, vice president of PowerWise. "This study may change how homeowners, power companies and policymakers view energy use, and will create a treasury of information that can be used in education." ■





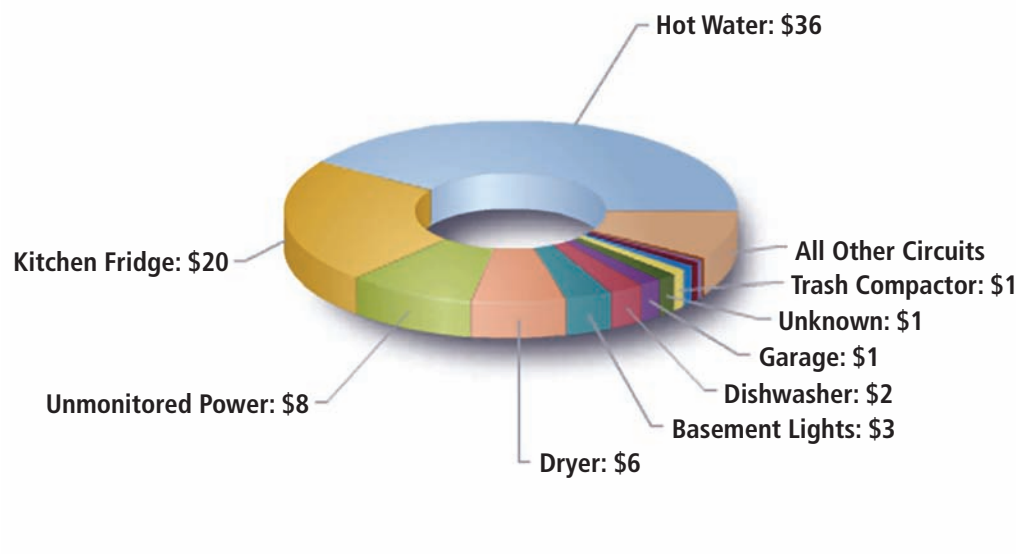
Power to the people

NATHAN WEISE knows that in the not-too-distant future, most of us will own and rely on a fully electric car, one powered by a battery that gets charged in our home garages overnight and in hard-wired parking lots while we're at work during the day. In his electrical and computer engineering research, Weise is examining how a parking lot full of amped-up electric vehicles can become part of the emerging smart grid of electrical energy by storing up excess power and releasing it back to the grid when needed.

"I am looking at ways that the parking lot can become a sort of mini-power plant," says Weise, who did his Ph.D. research at the University of Minnesota on the bidirectional charging of electric vehicles. "I am looking for the technology that will allow those vehicles to contribute energy back to the power grid when it is needed."

Smart grid technology is broadly defined to include all aspects of the physical infrastructure of the electrical system — generation, transmission, metering and more.

Electricity use in 30 days at Nathan Weise's house



Increasingly, suppliers and consumers are looking to update their aging infrastructures to include automated metering and monitoring, two-way communication with a central control location, the seamless incorporation of power from renewable sources, and the ability to "self-heal" the system following a power outage.

We asked him to talk about what's ahead in smart grid technology.

What is driving the interest in smart grid technologies?
Consumers, industry and politics, primarily. Consumers are learning right now what smart grid can do for them, including monitoring their usage patterns more closely, incorporating renewable sources and reducing consumption through the use of more efficient appliances, lighting and so on. The energy industry is driving this development by making more efficient, affordable and user-friendly technologies available to consumers. Politically, if everything in our power systems becomes connected, then stout security measures must be designed to thwart energy-stealing, terrorist attacks or other threats.

How does the emergence of renewable energy sources affect the development of smart grid technologies?
Emergence of renewable energy is the driving force behind smart grid technologies. Consumers want to know how much energy they are using from renewable compared to traditional sources. Independent System Operators and regional utilities want to know the amount of power flowing to or from renewable sources in order to determine the stability, health and status of the energy system.

In what ways does the current electrical grid leave us vulnerable?
The grid is vulnerable in its local capacity. If everyone on your block purchases electric vehicles today and plugs them in at the same time to charge, you will experience a lot of power outages. The current local capacity is not set up or designed for everyone to own and charge an electric vehicle. This will need to change.

What are the most urgent questions?
What exactly is expected of the smart grid? How do consumers, industry and policy makers envision the next generation smart grid? What is the appropriate sequence for reaching our goals? These questions have not really been formulated, much less answered — that's what is so exciting about working with smart grid.

What is the most interesting question?
How all the renewable energy sources and smart grid will be implemented and how they will interact. Again, some of the most interesting questions still haven't really been asked yet.

Will there come a time when electrical energy consumers — residential, industrial, corporate, government — become significantly more energy-independent instead of relying on the shared grid?
As costs come down on solar, wind and other renewable systems, I envision households will produce most or all of the energy they consume. The power grid will be used for backup and to supply energy back to the grid when needed. Advances in technology will make renewable sources more efficient and manufacturing advances will reduce product costs.

What kinds of questions are your students asking?
Initially, their questions are pretty basic. How do power electronics work and how do I control them? How do electric motors work and how do I control them? What is the role of power electronics in renewable, sustainable energy systems? The more they learn, the more challenging their questions get.

How soon will we all be using electric vehicles?
I think within 10 years, most day-to-day drivers will be using electric vehicles. Right now an all-electric vehicle is out of the price range for the average consumer. Once those prices start to fall, I believe there will be a lot more adopters. ■

Brunswick Engineering opens with a new director and its first class

Integrated learning

AN AERONAUTICAL engineer whose research focuses on engineering education as well as aerodynamics and energy efficiency has been named director of the University of Maine's new Brunswick Engineering Program.

Wilhelm "Alex" Friess, who joined the UMaine faculty in April, had been teaching mechanical engineering for the Rochester Institute of Technology (RIT) at its campus in Dubai since 2009.

Friess directs the innovative Brunswick Engineering Program, located at the newly renovated Brunswick Landing in Brunswick, Maine. The program opens with its first class of students this fall.

"Dr. Friess has a distinguished record as an innovative teacher and international engineering experience, including being part of the seven-person team that designed the 2007 America's Cup sailboat from South Africa," says Dana Humphrey, dean of UMaine's College of Engineering. "He'll create a hands-on curriculum that integrates math, science and engineering, allowing students to discover the challenges and joys of being an engineer."

At RIT, Friess taught courses in such topics as mechanical engineering design, renewable energy systems, wind turbine aerodynamics and sustainable energy management. As part of his research, he led the RIT Dubai Residential Energy Efficiency Center, where the focus included building envelope optimization and solar module dust deposition in the desert environment.

Friess also conducts research in engineering education, sailing telemetry, and yacht and sail design. He was a design engineer for Team Shosholoza, the 2007 South African America's Cup Challenger.

A native of Germany, Friess received his master's and Ph.D. in aeronautical engineering from Rensselaer Polytechnic Institute in Troy, N.Y., in 1994 and 1997, respectively.

Friess is the first director of Brunswick Engineering, a two-year, nonresidential program offered by UMaine's College of Engineering that features small classes and an integrated, hands-on approach that leads to a four-year engineering degree. Taught by internationally recognized faculty, the curriculum offers a world-class, affordable engineering education in a convenient location for students in southern Maine.

After two years of coursework in Brunswick, students complete their four-year degrees in civil, mechanical, electrical or computer engineering at the University of Maine, or transfer to the University of Southern Maine.

Alex Friess will direct the innovative Brunswick Engineering Program, located at the newly renovated Brunswick Landing in Brunswick, Maine.

Successful academic and athletic careers combine

The bridge

OF THE SEVEN engineering schools to which Katy Grime was accepted, the University of Maine held the strongest attraction. The spacious campus and proximity to surrounding small towns felt reassuringly familiar to the native of Brownington, Vt.

In addition, she had been in touch with the UMaine women's track coach and been assured that her interest in athletics — her discus performance came close to breaking the record at North Country Union High School — would be supported.

At UMaine, Grime was drawn to transportation and structural disciplines in civil engineering, in keeping with her longstanding interest in bridge design. Although the program is demanding and time consuming, she took advantage of every opportunity to broaden her academic experience and her network of professional contacts.

As a freshman, Grime joined the UMaine chapter of the American Society of Civil Engineers (ASCE). She also participated in two summer internships in Maine — one with Olver Associates in Winterport, which specializes in environmental engineering, another with CES in Brewer, which specializes in site design.

She attended multiple job fairs and industry conferences. In addition, Grime participated for a year in the UMaine chapter of the Society of Women Engineers, worked as a lab assistant on a groundwater research project, and assisted in the construction phase of the Cloke Plaza on campus.

For her senior capstone project, Grime was a member of a team that created a redesign of University Park, UMaine's off-campus residential community for families. The redesign includes new apartment groupings, as well as critical infrastructure, such as roads and utilities.

The group won the Best Project Presentation award at the annual Senior Gala, sponsored by the Maine section of the ASCE.

After graduation this past May, Grime started working in the Bedford, N.H., office of Vanasse Hangen Brustlin Inc., which provides integrated planning, transportation, land development and environmental consulting services for airports, schools, government agencies, healthcare and other sectors.

This past May, graduation weekend was complicated for Katy Grime. She received her degree on Saturday, then competed on Sunday in the America East 2012 Outdoor Track and Field Championship on campus. Grime ranks second on the all-time record list with her 133'3" discus throw in 2011.

Clear resolution

UMaine innovation in localization technology advances the view of the molecule

FPALM — Fluorescence Photoactivation Localization Microscopy

FOR DECADES, scientists have been searching for a way to bypass the diffraction limit of light microscopy, which is governed by the wave-like nature of light and prevents the clear resolution of objects at the molecular level. Although differing theoretical approaches to breaking diffraction have been published for several decades, until recently none had been put to use in developing laboratory optics.

"Our microscope breaks the fundamental rule of optics that has been around since the 1800s and is literally carved in stone," says Sam Hess, an associate professor of physics at the University of Maine.

Hess is one of a small group of researchers who, working independently in three separate teams, published nearly simultaneous papers in 2006 on the invention of a super-resolution, fluorescence light microscope, based on the process of localization. Localization uses one or more images from a light-emitting object to describe its overall position and motion.

Hess' "carved in stone" comment references the work of German physicist Ernst Karl Abbe, who lived from 1840 to 1905 and is credited with

Sam Hess, pictured second from the right, meets with seven graduate students working in his lab, the cornerstone of which is a microscopy system he invented called FPALM — Fluorescence Photoactivation Localization Microscopy.

identifying the resolution limit of the light microscope and describing it with a mathematical formula. A memorial to Abbe at the University of Jena in Germany is inscribed with his diffraction limit formula, which Hess — along with his colleagues and competitors — now has neatly eclipsed.

Hess' microscope uses localization technology to resolve images of objects previously too small to be seen except with an electron microscope. While electron microscopy is capable of imaging tiny details inside cells, it is unable to image living specimens.

"Localization microscopy is able to get resolution in living specimens that is better than conventional light microscopy by a factor of 10 or more," Hess says. The technology now also allows a 3D view of the structures, thanks in part to Hess' subsequent work with then UMaine doctoral student Travis Gould, who is now fulfilling a postdoctoral fellowship at Yale.

By using fluorescent dyes to identify individual molecules and map their coordinates within a structure, researchers can directly study, for example, how the clustering of proteins and lipids within the layers of a cell membrane allows the influenza virus to enter, or how the morphology of the tiny mitochondria within living cells plays a role in muscular dystrophy.

"When it seemed like we had figured it out, I thought 'Somebody must already have done this, or else there's something wrong with my thinking,'" Hess says.

He talked to colleagues at UMaine and then called a friend at the National Institutes of Health (NIH) for feedback. These conversations were reassuring until he learned that an NIH research team was close to solving the very same problem. In addition, a group at Harvard was quietly closing in on the goal.

"The fact that these three groups all published within one month of each other reflects not coincidence, but a kind of synergy that often happens in science," Hess says.

Hess has presented his work at scientific gatherings worldwide. In partnership with colleagues at Jackson Laboratory, the University of Utah and Yale School of Medicine, the patented breakthroughs by Hess and other coinventors are being used to manufacture localization microscopes at Vutara, a Salt Lake City-based company. ■

Alumnus at the forefront of automation engineering

In control

TONY PAINE is president, CEO and co-owner of Kepware Technologies, Portland, Maine, which specializes in advanced communication software for automation. Founded in 1995, Kepware develops communication drivers to automation controllers, I/O and field devices. Paine graduated from UMaine in 1996 with a bachelor's degree in electrical engineering. In 2009, he was inducted into the College of Engineering Francis Crowe Society as a Distinguished Engineer.

In one of your recent blogs, you emphasized the importance of moving information from the shop floor to the top floor. Why is that connectivity essential today?
The top floor is where you want to get complete visibility of your entire enterprise. It is where operational and maintenance decisions are made, and how well they are made can make or break a company in this competitive world. Industry expects that they can make operational and maintenance decisions in real time. Any information that can be obtained, distilled and provided to the right people in the organization (not just management) at the right time will allow them to make the appropriate decisions sooner — allowing an enterprise to function as efficiently and effectively as possible.

Which of the company's innovation breakthroughs are you particularly proud of — and why?
Kepware recognized a couple things in the early days. The first was that hardware vendors don't always develop the best application-level software. Second was that as a small company, Kepware (we were less than 10 people back in the mid-'90s) needed to develop a wide variety of solutions with minimal maintenance and overhead. The concern about maintainability pushed us down the path of creating a single platform that enabled connectivity to a wide variety of disparate devices. Kepware's single platform provided a common interface: configuration and diagnostic tools, runtime behavior and expectations across every piece of equipment.

What's next for Kepware?
To date we have primarily focused on device-level communications. Kepware will invest in adding additional adapters that will provide data to a wider set of applications.

Read the full interview online (umaine.edu/colleges/engineering-college/alumni-profiles).

2011 was an award-winning year for Kepware. Its honors included an Engineers Choice Award for the second consecutive year by *Control Engineering* magazine and a Kinetic Process Innovation Award by Kinetic Information LLC. *Automation World* magazine cited Kepware as a First Team supplier in its Leadership in Automation 2011 program. The company also received a 2011 Business at Work for Maine Award from the Finance Authority of Maine and a 2011 Best Places to Work in Maine award from the Society for Human Resource Management – Maine State Council and Best Companies Group.

UMaine welcomes its first Science Without Borders student

International research

LUCAS RAMOS Is a long way from home. The 21-year-old chemical engineering student hails from Santos, Brazil, a metropolitan area with a population of about 1.5 million, located about an hour southeast of São Paolo.

At the University of Maine, Ramos is on a mission that is both personal and civic. He arrived in the United States in January, one of about 650 undergraduate students selected to participate in the first wave of the Brazilian government's new Science Without Borders program, announced in August 2011. In an ambitious campaign to advance Brazil's economic standing and its technological expertise, the program eventually will place 100,000 promising students at participating colleges and universities in the U.S. and abroad for a full year. The program will cover all the students' expenses as they study in the fields of science, technology, engineering and math, and participate in a professional or academic internship.

And in exchange?

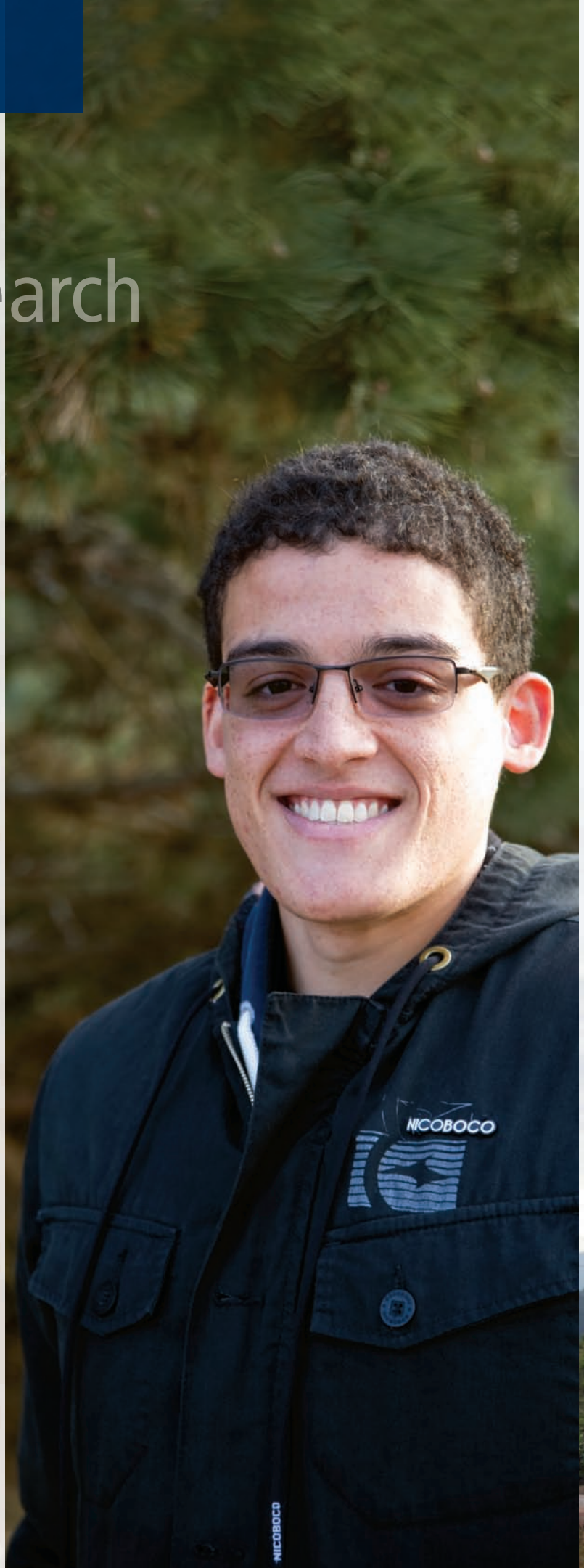
"My official commitment is that I have to stay in Brazil for two years after I graduate," Ramos says. "But my personal commitment is to take everything I learn here at the University of Maine and go to graduate school in Brazil. I want to continue my engineering research through the doctorate level and maybe become a professor."

Such aspirations are rare in his country, according to Ramos, since most engineering students are hired at good salaries as soon as they complete their undergraduate degrees. A growing number of the world's largest corporations have a presence in Brazil, including Monsanto, Cargill, ADM, Chevron, Texaco, Nestlé, PepsiCo, Procter & Gamble, Tyco International, Ford, DuPont, Dell, IBM and Verizon.

Ramos has been studying chemical engineering at the Federal University of São Carlos and will return there to complete his undergraduate work after his year at UMaine. His research interests are in biofuels production and wastewater treatment.

In Brazil, Ramos says, vast quantities of sugar cane are cultivated and processed into ethanol. Wastewater from the process is loaded with organic compounds that can be decomposed by bacteria, producing methane as a secondary biofuel while also making the water safe for reuse in irrigating cane crops.

In Orono, Ramos plans to pursue his research through the UMaine Forest Bioproducts Research Institute.



Lucas Ramos is studying at UMaine through the Science Without Borders program, administered through the Institute of International Education in New York.

EWB-UMaine team members accepting the Newman's Own award.

UMaine chapter wins Campus Community Service Challenge

THE UNIVERSITY OF MAINE student group Engineers Without Borders-UMaine (EWB-UMaine) was named winner of the Newman's Own Foundation Campus Community Service Challenge, which comes with a top prize of $25,000. The award was announced at the America East Conference Basketball Championship tournament in Hartford, Conn., in March.

EWB-UMaine won the challenge for its project in Dulce Vivir, Honduras, where the group has been working to implement a student-designed community sanitation system. The poor sanitation conditions in Dulce Vivir limit economic opportunities of its 120 residents and cause environmental and health concerns.

Last fall, the UMaine chapter also received a $5,000 grant from the Woodard & Curran Foundation — the first issued by the foundation. UMaine was chosen from nearly 30 applications received from nonprofit organizations throughout the eastern United States.

In addition, EWB-USA selected the UMaine project for its 2012 Premier Project Award, presented at the group's international conference.

EWB-UMaine, founded in 2007, is made up of students and their professional mentors. It has been working for four years with Dulce Vivir residents, consulting with the community on its priorities, collecting information needed for the system design and developing contacts needed to ensure the project's success.

In March, the group succeeded in installing a septic tank and constructing a raised-mound leach field. The new septic system designed by EWB-UMaine students eliminates waste in residents' backyards.

An EWB-UMaine team of five students and three professional mentors traveled to Dulce Vivir this spring to complete the sanitation project that culminated four years of planning and site work.

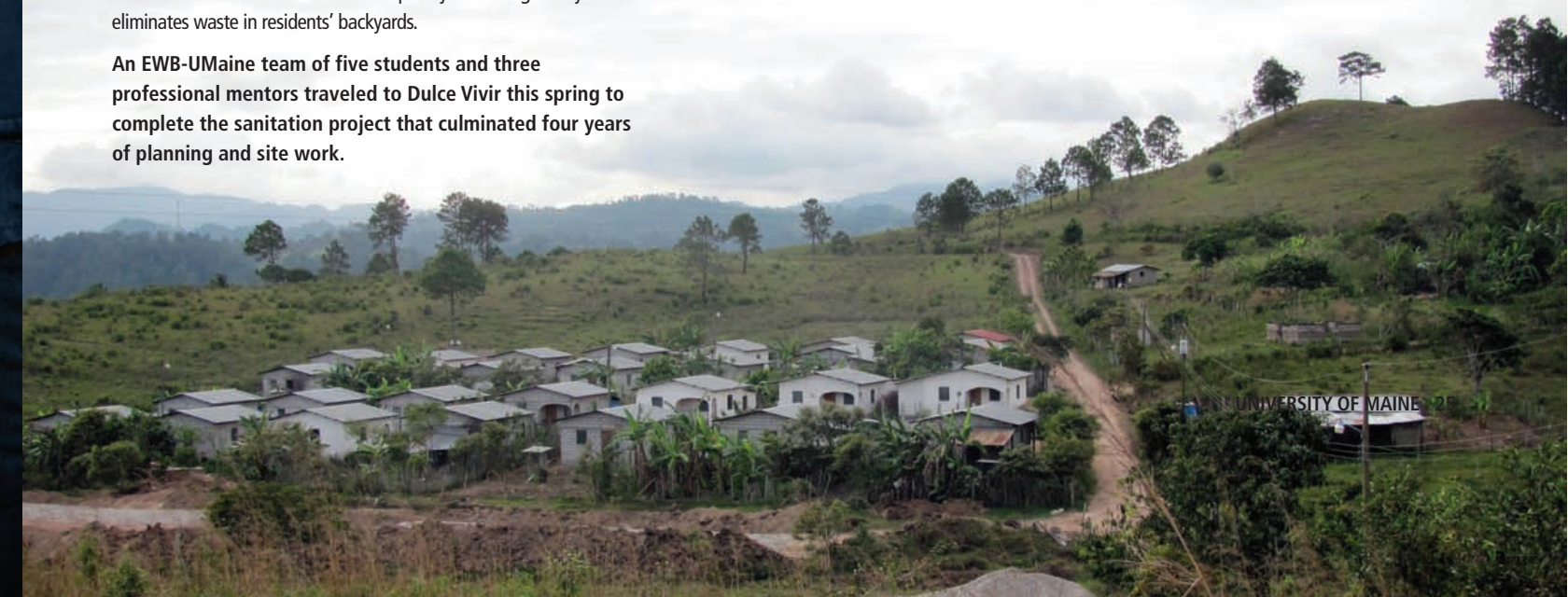
2012 Outstanding Graduates

DANIEL ISAAC GERGES
BIOLOGICAL ENGINEERING

Daniel Isaac Gerges of Yarmouth, Maine, majored in biological engineering with a minor in pre-medical studies. As a sophomore, Gerges received early acceptance to Tufts University School of Medicine through the Maine Track Early Assurance program. He is a Sen. George J. Mitchell Scholarship recipient, and a member of the Senior Skull and Phi Kappa Phi honor societies. Gerges served as president and fundraising chair of the UMaine chapter of Engineers Without Borders. In 2010 and 2011, he had internships at IDEXX Laboratories in Westbrook, Maine, where he worked on research and development of veterinary disease assays. After medical school, Gerges plans to return to Maine as a practicing physician.

RAED AL-SHAMMARI
CHEMICAL ENGINEERING

Raed Al-Shammari of Mubarak Al-Kabeer, Kuwait, majored in chemical engineering. He was a Dean's List student and a member of the American Institute of Chemical Engineers. Throughout his time at UMaine, Al-Shammari was active in UMaine's international student community, including regular soccer games and gatherings. For his capstone research with professors Douglas Bousfield and William DeSisto, Al-Shammari worked to optimize the process of converting lignin — a by-product of the paper industry — into biofuel. He is working with EQUATE Petrochemical Co. in Kuwait. He is also pursuing an M.B.A. at the American University of the Middle East.



Engineering alumnus donates $7.9M

A $7.9 MILLION GIFT from the estate of Thomas P. Hosmer received by the University of Maine Foundation will support maintenance projects at the University of Maine. It is the third-largest single gift given to benefit the University of Maine.

More than 90 percent of the gift is designated for the Thomas P. Hosmer Fund, an endowed fund established at the foundation in 2005 to provide supplemental income for maintenance and repairs that would not otherwise be done due to budget limitations. The remainder of the gift is designated for an endowed scholarship and an endowed lab to benefit the Department of Mechanical Engineering, both of which are in Hosmer's name.

Hosmer graduated from UMaine in 1958 with a degree in mechanical engineering. He was a consulting engineer for Arthur D. Little in Cambridge, Mass., from 1965 to 2002, and from 2002 to 2004 he was a senior mechanical engineer for Nuvera Fuel Cells, Inc., also in Cambridge. He died in May 2011.

Delegation signs tidal energy research agreement with UMaine

A RESEARCH AGREEMENT between the University of Maine's Maine Tidal Power Initiative (MTPI) and the North Japan Research Institute for Sustainable Energy of Hirosaki University is expected to foster scientific cooperation and academic exchange between the two universities, advancing the development of sustainable tidal energy in both the U.S. and Japan.

In Maine, collaborative studies between UMaine and Ocean Renewable Power Company are under way in Cobscook Bay, where dramatic tides have the potential to generate electricity on a large scale. Michael Peterson, the UMaine Libra Professor of Engineering and the coordinator of the Maine Tidal Power Initiative, says MTPI is examining all potential impacts of locating turbines in Maine waters, including engineering challenges, generating capacity, impact on local fisheries and ecological systems, local and regional economic benefits, cultural changes to local communities, and more.

Hirotada Nanjo of Hirosaki University says Japan must redouble its efforts to develop sustainable energy sources following last year's devastating earthquake and tsunami that destroyed nuclear power plants in Fukushima Prefecture on the country's Pacific coast. But the goal of establishing a tidal energy system along the coast of Japan faces powerful opposition from the nation's lucrative tuna fishery, since submerged turbines, pilings and other energy infrastructure could entangle fishing lines.

Other challenges include the presence of nuclear submarines and other vessels in coastal waters.

Groups in Japan have been exploring the potential for tidal power production in Tsugaru Strait for more than a decade, Nanjo says, but the recent nuclear disaster has reenergized that effort.

A student-designed and constructed kinetic sculpture now installed at the Maine Discovery Museum.

Student kinetic sculptures at the Maine Discovery Museum

SEVERAL KINETIC SCULPTURES designed and built by mechanical engineering technology students as capstone projects and demonstrated on campus this spring have been installed at locations throughout Maine, including the Maine Discovery Museum in Bangor, to illustrate for young people the artistic and practical nature of kinetic machines and engineering.

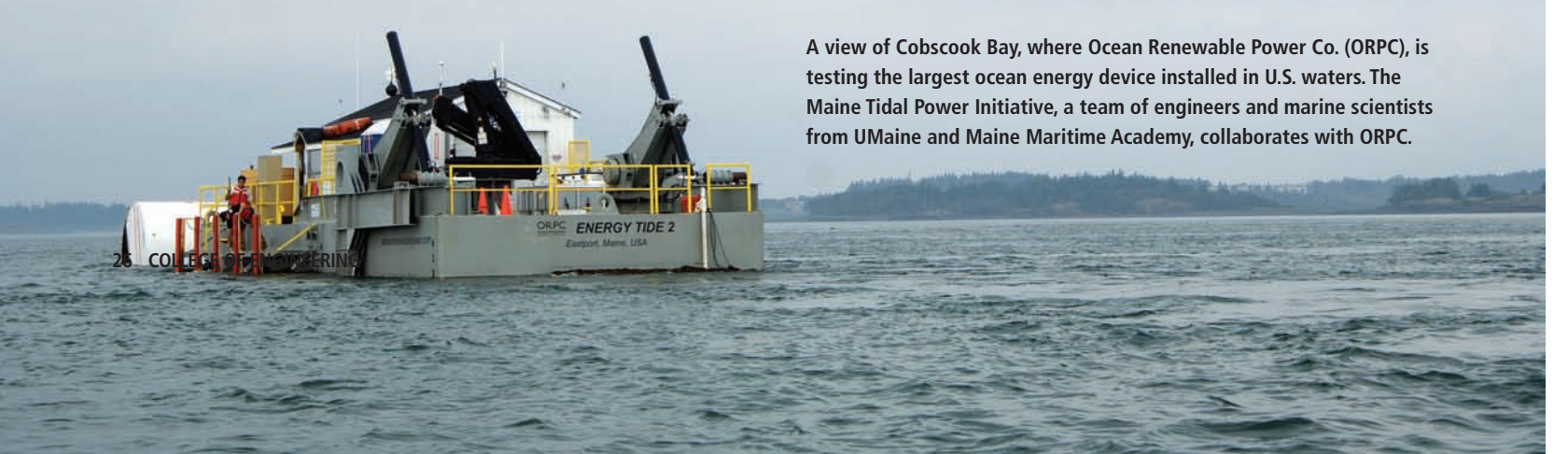
The kinetic sculptures raise small steel balls or marbles to a level where they are released onto sloped, winding tracks to whirl around before popping into funnels and baskets to be corkscrewed back up to descend again, a continuous process powered by small electric motors or hand cranks.

Eight student teams in the Department of Mechanical Engineering Technology (MET) competed for exhibition space in the Bangor children's museum, Bangor International Airport and the Houlton Junior and Senior High School.

The MET students were led by Herb Crosby, professor of mechanical engineering technology, and Joel Anderson, an MET lecturer.

Crosby also plans to take some of the more mobile creations to expositions and demonstrations throughout Maine to educate youngsters about the ingenuity and creativity underlying the field of engineering.

Crosby says the idea came from a conversation with Discovery Museum Director Niles Parker and the inspiration of the kinetic exhibits at Boston's Logan Airport and the Boston Museum of Science.



A view of Cobscook Bay, where Ocean Renewable Power Co. (ORPC), is testing the largest ocean energy device installed in U.S. waters. The Maine Tidal Power Initiative, a team of engineers and marine scientists from UMaine and Maine Maritime Academy, collaborates with ORPC.

2012 University of Maine Award Winners

THREE ENGINEERS RECEIVED the top annual faculty awards at the University of Maine. Professor of Chemical Engineering Joseph Genco is the 2012 Distinguished Maine Professor, an award presented by the University of Maine Alumni Association to recognize outstanding achievement in UMaine's tripartite mission of teaching, research and service. Karen Horton, associate professor of mechanical engineering technology, is the recipient of the Presidential Public Service Achievement Award. The 2012 Presidential Research and Creative Achievement Award recipient is Professor of Chemical Engineering Hemant Pendse. Excerpts from their citations follow:

Joe Genco is one of the University of Maine's truly outstanding professors. As the heart and soul of the university's internationally recognized pulp and paper program for nearly four decades, he has inspired hundreds of students. As a new faculty member, Genco worked with colleagues to reestablish the Ph.D. program in chemical engineering. He also received a National Science Foundation CAUSE grant to revise, strengthen and update the pulp and paper curriculum. He teaches many of the undergraduate core chemical engineering courses, and all of the core pulp and paper technology courses. He established the pilot plant that became the UMaine Process Development Center, and served a decade as its director. His expertise on high-pressure oxygen delignification and ozone bleaching has led to advances in the industry, and his research has improved the cost and environmental position of paper mills throughout the world.

Karen Horton has compiled an extraordinary record of service locally, regionally and nationally. She revitalized the UMaine chapter of the Society of Women Engineers (SWE) and received the national 2010 Outstanding Counselor Award. She also chairs SWE's Government Relations and Public Policy Committee, which has taken her to Capitol Hill and the White House. Since joining UMaine in 1997, Horton helped start a program to interest middle-school girls in engineering; developed a service-learning, applied-research project on the virtual preservation of ruins in the Virgin Islands; and created activities involving professionalism for students in mechanical engineering technology. In addition, Horton was instrumental in securing UMaine's $3.3 million, five-year ADVANCE grant from the National Science Foundation to effect institutional transformation to advance, retain and recruit women faculty in the sciences and engineering.

Hemant Pendse has consistently applied creativity and innovation in research initiatives that have led to significant economic development opportunities for Maine and for industry. He is the founding director of the Forest Bioproducts Research Institute and chair of the Chemical and Biological Engineering Department. He also is one of the world's leading scholars in the fields of colloid instrumentation and forest bioproducts. His research and creative achievements rely on the boundary-spanning interdisciplinary teams he assembles. Colleagues enthusiastically cite Pendse's pioneering work for its quality and profound insights. Equally important, he has been recognized for turning scientific discoveries into innovative economic opportunities. Through his leadership, especially in the area of forest bioproducts research, Pendse has also inspired innovative research and creativity in UMaine faculty and in industry.

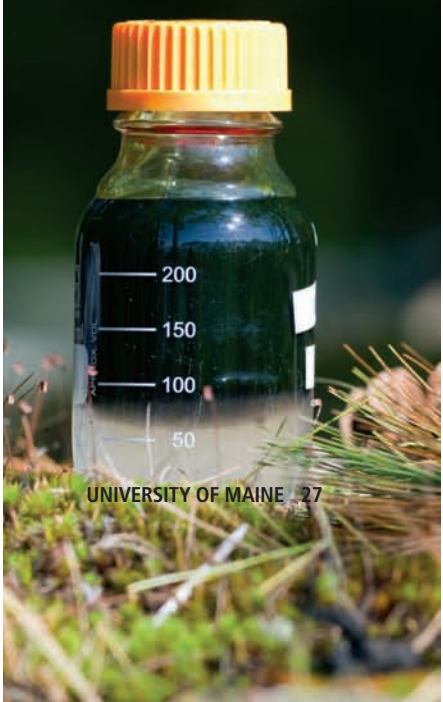
Biobreakthrough

A UNIVERSITY OF Maine engineering team has discovered a revolutionary chemical process that can transform forest residues, as well as materials such as municipal solid waste, grasses and construction wastes into a hydrocarbon oil.

The new oil, based on a mixed-carboxylate platform, was developed by M. Clayton Wheeler, a UMaine associate professor of chemical and biological engineering, and undergraduate students in his lab. The oil has a number of properties that make it better suited to produce drop-in fuels than many biofuels processes being widely researched and even those currently on the market.

In early analysis, the UMaine oil was found to have boiling points that encompass those of gasoline, jet fuel and diesel. As is the case for petroleum crude oil, further refinement to meet performance and emission standards would be needed to use the UMaine oil in vehicles that drive on highways.

The process by which the oil is created, known as thermal deoxygenation (TDO), will work on cellulose found in wood or other carbohydrate-containing materials.



UMaine's Offshore Wind Laboratory

Offshore Wind achieves LEED Gold

THE U.S. GREEN BUILDING Council has awarded the University of Maine's Advanced Structures and Composites Center the LEED Gold certification for its newly constructed Offshore Wind Laboratory. This is the first LEED Gold-certified building on the UMaine campus.

LEED certification was established by the U.S. Green Building Council and verified by the Green Building Certification Institute. LEED is the nation's preeminent program for the design, construction and operation of high-performance green buildings.

The laboratory achieved LEED certification for reductions in energy, water and material use compared to traditional buildings, as well as for its incorporation of natural lighting and other sustainable features. By using less energy and water in construction and operation, LEED-certified buildings save money; reduce greenhouse gas emissions; and contribute to a healthier environment for residents, workers and the larger community.

The Offshore Wind Laboratory is the only facility in the U.S. with the capability to design, manufacture and test under one roof full-scale wind turbine blades and towers, airplane wings, bridge girders and ship hulls up to 230 feet.

Robotic research a hit online

A PAPER DETAILING a biomedical engineering research project by Mohsen Shahinpoor, the Richard C. Hill Professor of Mechanical Engineering and department chair, was a popular download when it was published by the Institute of Physics last October. The paper, "Biomimetic robotic Venus flytrap *(Dionaea muscipula Ellis)* made with ionic polymer metal composites," was downloaded more than 500 times in the first weeks after it was posted, propeling it into the top 3 percent of all papers published by the institute. The paper describes Shahinpoor's novel design of a robotic Venus flytrap using ionic polymeric metal composite artificial muscles as distributed nanosenors and nanoactuators.

CNF pilot plant launched

THE UNIVERSITY OF Maine's Forest Bioproducts Research Institute is building a pilot-scale plant for manufacturing cellulose nanofibrils (CNF), a wood-based reinforcing material of interest to researchers worldwide who are looking for superstrong materials for new and existing composites.

The pilot plant, funded by a $1.5 million grant from the U.S. Forest Service, is at the Process Development Center on campus, with associated drying equipment to be added at the Technology Research Center in Old Town, Maine. It is the only one of its kind in the nation, and will serve as a source of the material for those who want to explore CNF applications. Currently, researchers and companies who want to buy the material purchase it from sources in Japan and Germany.

UMaine is involved in the project with six other universities and the Forest Products Laboratory (FPL). Last April, UMaine and FPL began a research collaboration on the conversion of wood components into novel nanomaterials; the incorporation of an array of nanomaterials into forest products to increase their functionality, durability, and end use performance; and the development of new generations of high-performance wood-based materials. UMaine will be the sole supplier of CNF to researchers from other universities in the consortium, which include the Georgia Institute of Technology, North Carolina State University, Oregon State University, Pennsylvania State University, Purdue University and University of Tennessee.

Sean Ireland of TAPPI and Verso Paper in Bucksport, Maine, is also in the consortium.

Applications for the CNF material include automobile components, paint and coating additives, and water filters. Development and commercialization have been hampered by the lack of CNF material in sufficient quantities to conduct meaningful technology demonstrations. This project will scale-up the mechanical laboratory preparation method to a pilot-scale.

$1.2M DOE grant for sensor research

THE UNIVERSITY OF Maine's Laboratory for Surface Science and Technology (LASST) has received a $1.2 million grant from the Department of Energy to develop new high-temperature sensor technology for reducing emissions and increasing the efficiency of fossil fuel energy plant operations.

Mauricio Pereira da Cunha, a UMaine professor of electrical and computer engineering, and Robert Lad, a UMaine professor of physics, will lead the project to develop novel thin film electrodes, piezoelectric smart microwave acoustic sensor devices, and sensor encapsulation materials that will be engineered to function for long periods of time at up to 2200 degrees Fahrenheit in a power plant environment. The work also includes developing a radio-frequency wireless interrogation electronics unit that will be located outside the high-temperature environment.

UMaine will partner with Environetix Technologies Corp., an Orono-based spin-off company of LASST that employs recent UMaine graduates, to develop the novel sensors and controls.

The UMaine technology is based on tiny wireless battery-free microwave acoustic sensors that can measure temperature and pressure in harsh environments. The sensors will help optimize the coal utilization process and provide information about the maintenance and status of the combustors and steam generator components.

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