2009

College of Engineering Magazine

University of Maine College of Engineering

Dana N. Humphrey

UNIVERSITY OF MAINE

COLLEGE OF

ENGINEERING

Researching Solutions to the Energy Puzzle

COLLEGE OF ENGINEERING

innovating OUR ECONOMIC FUTURE

DEAN'S MESSAGE

A MAJOR FOCUS of the University of Maine College of Engineering is energy. In fact, energy is engineering. We're the ones who develop energy sources. We design the plants and the technology that convert energy into electricity and fuel for our homes and cars. We're the ones who design the systems to move energy from where it is produced to where it is needed.

Our current work follows in the energy traditions set by professors Dick Hill and Norm Smith.

Today, UMaine is playing a key role in developing offshore wind power through the AEWC Advanced Structures & Composites Center. Maine's offshore wind potential is 3 to 20 miles from the coast. We are developing offshore platforms, advanced wind turbine blades and systems to get that energy to shore and distributed to homes and businesses in Maine. All this is possible through collaboration with our business and industry partners.

In Maine, tidal fluctuations of 10 to 60 feet create a large source of energy that could potentially be harnessed to generate electricity. UMaine mechanical engineers are conducting tidal power research in partnership with Maine Maritime Academy and Ocean Renewable Power Company, LLC, in Portland.

The Chemical and Biological Engineering Department is developing the process to extract the ingredients for ethanol and other high-value biofuels from wood. Extracting hemicellulose — a process developed at UMaine — is an essential first step to obtaining ethanol and a key research development that is fueling the creation of a full-scale pilot plant at the Old Town Fuel and Fiber Mill.

In addition, we are developing smart grid technology to manage the delivery of Maine's energy resources. The research involves collaborations among the Electrical and Computer Engineering Department, the Electrical Engineering Technology Program and industry partners.

The College of Engineering is putting research to work to create more affordable and reliable energy for the future — energy that is innovative, makes sense for Maine and is under our control.

Dana N. Humphrey
Dean, College of Engineering

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CHEMICAL AND BIOLOGICAL ENGINEERING

Hemant Pendse, Chair
Chemical and Biological Engineering

"In the Chemical and Biological Engineering Department, our engineering training provides a unique background for solving problems, especially those involving physical, chemical and/or biological changes in materials to address many of the world's toughest challenges, including energy. In making bioplastics or biofuels, Maine's wood extracts are going to play a significant role in our country's energy future."

Overview This year, the department has seen students and faculty get well-deserved regional and national visibility in several areas. Professor Joseph Genco was recognized as a 2009 TAPPI Fellow, and undergraduate Sarah Enman was named the PIMA Student of the Year. At the AIChE Annual meeting in Philadelphia, our ChemE car team made it into the Top 10, and at the Spring Regional at UMass-Amherst, two UMaine ChemE car teams took the two highest honors. Students Michael Browne and Benjamin Freedman conducted experiments on the uptake of toxins in human lung cells aboard the Weightless Wonder at the Johnson Space Center in Houston. This year also saw department faculty — Hemant Pendse, Peter van Walsum, Clay Wheeler, Joseph Genco and Adriaan van Heiningen — consolidate their leadership in biofuels research involving use of woody biomass to produce ethanol, butanol or mixed alcohols, as well as jet fuels. Grants from the Department of Energy and Defense Advanced Research Projects Agency support this research.

green ENERGY

Creating a sustainable bioeconomy

Maine and its abundance of natural resources provide an ideal location for biofuel research, which is ongoing through the University of Maine's Forest Bioproducts Research Initiative (FBRI).

Through FBRI, researchers from a variety of disciplines are working to create biofuels — such as automobile and jet fuel — and other bioproducts from natural resources, including wood and algae.

"The Forest Bioproducts Research Initiative Technology Center will become a 'one-stop shopping' place for anyone dealing with woody biomass anywhere in the world."

— Hemant Pendse

The UMaine initiative is a multidisciplinary collaboration of scientists from educational institutions and businesses across the state and beyond who are working to develop effective and efficient methods for transforming waste products from paper and algae processing, and other wood-based enterprises, into fuels, plastics and other materials.

In connection with the extraction process used to take the sugars from wood to make biofuel, researchers also are looking at microscopic carbon nanotubes found in wood and plant fibers. If this research is successful, the carbon nanotubes could be used in anything from high-resolution TVs to targeted drug delivery.

"This embodies the creative use of the next generation of (pulp and) paper mills for energy generation. It also embodies so much of what the public agenda is about — basic research, technology transfer, education and economic development."

— Richard Pattenaude, Chancellor, University of Maine System

"Together, these projects put UMaine in the position of strength to deal with the entire spectrum of technical issues involved in biomass conversion," says Hemant Pendse, chair of UMaine's Department of Chemical and Biological Engineering.

In an effort to create a "one-stop shopping" atmosphere for anyone dealing with wood biomass anywhere in the world, UMaine has leased and is working to renovate 40,000 square feet of warehouse space in Old Town, Maine, to establish the Forest Bioproducts Research Initiative Technology Center.

The project received $4.8 million from the Maine Technology Asset Fund, administered by the Maine Technology Institute.

Renovations focus on the high-bay processing areas with utilities distribution suitable for a flexible environment for pilot-scale industrial research with biomass from forest or agricultural sources. The focus is on processing sufficient quantities of raw materials to produce enough finished product for commercial evaluation.

The technology center will work on the validation and commercialization of various technologies from UMaine, as well as those of other collaborators and third-party technology providers. Even before renovations have begun, several companies have shown significant interest or made plans to use the FBRI Technology Center.

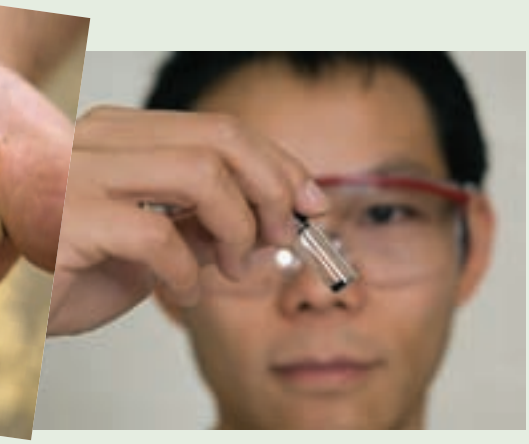
"This will be one of the premier fee-for-service facilities of its kind in the world, supporting well-established and emerging technology clusters in the state of Maine, and fostering new collaborations with clients worldwide," says Michael Bilodeau, director of UMaine's Pulp and Paper Process Development Center.

The FBRI Technology Center complements the Process Development Center in Jenness Hall, where renovations are under way to add 4,000 square feet to house FBRI's on-campus headquarters. The new base of operations will include offices for FBRI scientists and visiting collaborators.

Michael Bilodeau, director of UMaine's Pulp and Paper Process Development Center

Artist rendering of the state-of-the-art FBRI Technology Center

Professor Adriaan van Heiningen, pioneer of the integrated forest products refinery concept



The mission of the Forest Bioproducts Research Initiative is to advance understanding about the scientific underpinnings, system behavior and policy implications for the production of forest-based bioproducts, and to provide and promote technology validation and partnerships that will meet societal needs for materials, chemicals and fuels in an economically and ecologically sustainable manner.

CIVIL AND ENVIRONMENTAL ENGINEERING

"This is an exciting time to be in engineering. Current global events are forcing us to confront challenges that will require creative and innovative solutions. Civil engineers are among those working to develop a sustainable environment for a high quality of life."

Eric Landis, Chair
Civil and Environmental Engineering

Overview The past year has been a busy and productive one for students and faculty in the Civil and Environmental Engineering Department. Interest in our programs continues to be high, as we now boast more than 300 students. Our seniors completed a dozen design projects, ranging from municipal improvements in the Town of Orono to a water supply system in Honduras. We are positioned to lead Maine's offshore wind energy research initiatives through the efforts of faculty in the AEWC Advanced Structures & Composites Center. And in Boardman Hall, we continue to improve our laboratory infrastructure to enhance hands-on experience for students. In the coming year, we will focus on curricular elements aimed at sustainability, the critical challenge of our era. To address this grand challenge, our students must be able to integrate a wide range of technologies over a very broad social and political spectrum. This is, indeed, an exciting time to be in engineering.

harnessing WINDS

Turning to offshore resources

The Gulf of Maine has been characterized as the Saudi Arabia of wind. To Professor of Civil Engineering Habib Dagher, it is a wellspring of one of the Northeast's greatest renewable energy resources.

Dagher, director of UMaine's AEWC Advanced Structures & Composites Center, is collaborating with companies on the design, manufacture and testing of floating wind turbine technology off the Maine coast in waters 200 to 3,000 feet deep. The turbines would feature towers 300 feet tall with 200-foot blades prototyped, manufactured and tested by AEWC researchers.

"If we do it right, we can take care of ourselves and export not only lobsters from the Gulf of Maine, but clean energy."

— Habib Dagher

In early 2010, AEWC is expected to open an Advanced Wind Blade Prototyping Facility, where full-scale trial blades can be designed, fabricated and tested under one roof. Funding for the facility came from the Maine Technology Institute, which last fall awarded nearly $5 million to two AEWC initiatives focused on the renewable energy and transportation industries. The allocations were made possible by a $50 million Maine Technology Asset Fund (MTAF) R&D bond Maine voters approved in 2007.

In the past year, Dagher's deep-water wind research has made national

Gov. John Baldacci discusses offshore wind energy with professor Habib Dagher, a member of the Governor's Ocean Energy Task Force.

"Maine's deep, offshore wind resource can have a major impact as we work to manage our nation's energy issues. University of Maine expertise, ingenuity and commitment will be key to our success in this realm, and I am proud that this capacity exists at our state's land-grant university."

— Sen. Susan Collins

headlines. In June, he met with U.S. Energy Secretary Steven Chu to discuss a proposal to establish a national center for offshore wind research at the university. In summer 2008, Dagher was on Capitol Hill advocating for increased funding for wind energy research and development before the U.S. Senate Homeland Security and Governmental Affairs Committee.

Most recently, AEWC was awarded a 2009 Academic Pioneer Award by the Ocean Energy Council.

Research has shown that ocean winds are steadier and stronger, and can produce more energy than onshore wind turbines. There also is less visual impact to the landscape. Those Dagher proposes for the Gulf of Maine will be located 3 to 20 miles from shore.

Dagher says concerns about disrupting the natural habitats of whales, fish and birds can be overcome in an environmentally responsible manner.

It's important that alternative energy research progress rapidly, especially in Maine, in light of an estimated 80 percent of the state's residents who use heating oil, Dagher says. If other viable fuel options aren't discovered and implemented, the region's heating crisis likely will intensify.

As defined by Dagher, the current sustainable energy plan for the state is to generate five gigawatts of offshore wind in the next 10 to 20 years by installing 1,000, 5-megawatt wind turbines in the gulf. Within 50 nautical miles of Maine's coast is the potential to produce 149,000 megawatts of power using offshore wind — the equivalent of 40 nuclear power plants, Dagher says.

"If we do it right, we can take care of ourselves and export not only lobsters from the Gulf of Maine, but also clean energy," says Dagher.

Despite the potential for offshore wind as a sustainable energy source, Dagher cautions that it isn't the whole story. Becoming more energy responsible also includes increasing smart grid technologies to efficiently transport electricity to consumers, converting traditional heating systems to modern heat pumps, and expanding the use of electric hybrid vehicles.

Architectural rendering of the Advanced Wind Blade Prototyping Facility addition to AEWC Advanced Structures & Composites Center.

ELECTRICAL AND COMPUTER ENGINEERING

Mohamad Musavi, Chair
Electrical and Computer Engineering

"The Electrical and Computer Engineering Department provides a strong educational and research foundation to prepare students for rewarding careers, while helping build an environmentally friendly society. Our hands-on undergraduate curricula, many having laboratory components, and our graduate program, emphasizing solutions to real-world problems, have led to an almost perfect record of students accepting employment or going on to research arenas."

Overview Benchmarks in 2009 include the first Haskell Energy Conference hosted by the department, at which more than 200 participants exchanged ideas on renewable energy. In addition, the Electrical and Computer Engineering Department (ECE) is working with the major utilities to develop a road map for a Maine Smart Grid. Faculty have participated in several funded projects, including three Maine Technology Asset Fund grants in collaboration with Maine industries, an Air Force grant for high-temperature acoustic wave sensor research, a UMaine NSF EPSCoR grant in sustainability science, two NSF-REU grants for work in sensors and supercomputing, and a NASA grant for enhancing science, technology, engineering and math for K–12 students. Our department's faculty and students also received several awards; and the William G. Stoy and Judith Kenoyer Stoy Scholarship, the Dr. Waldo "Mac" Libbey Professorship, and the Dr. John F. Vetelino Excellence Fund were established. Outreach activities included helping disadvantaged students through the Maine Junior Engineering Technical Society and the Maine Learning Technology Initiative Conference, in which 10 of the 800 youths who participated received $10,000 in scholarships.

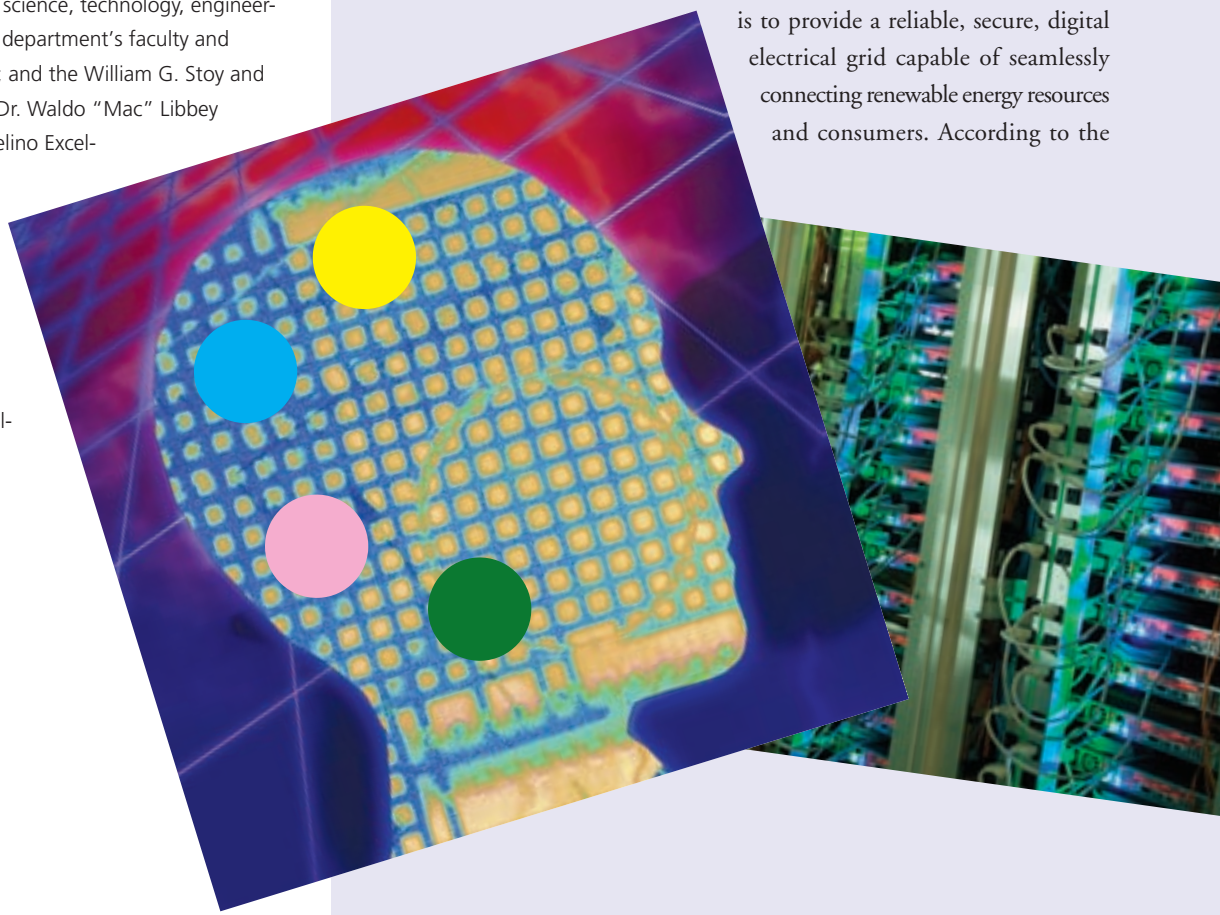
smart DESIGN

Bringing smart grid technologies to Maine

Maine's geography is perfect for developing substantial sources of renewable energy, including onshore and offshore wind, biomass and tidal. Thousands of megawatts of potential renewable electric energy have been identified; hundreds of megawatts have been, or are in the process of being tapped. That potential, coupled with Maine's juxtaposition to the rich renewable resource potential of the Canadian Maritimes, makes smart grid technologies essential to the successful delivery of renewable energy to consumers in the Northeast.

Just a 5 percent efficiency using smart grid technologies would equate to the elimination of fuel and greenhouse gas emissions from 53 million cars.

The Smart Grid is the Internet of the electric energy delivery system. The objective of the Maine Smart Grid is to provide a reliable, secure, digital electrical grid capable of seamlessly connecting renewable energy resources and consumers. According to the



"Smart grid is a transformational technology for our industry, and the potential benefits for consumers, utilities and the environment are huge. The ECE's research program will make the University of Maine a key partner as companies like ours expand our investments to bring the next generation of grid technology to Maine."

— Sara Burns, President and Chief Executive Officer, Central Maine Power Company

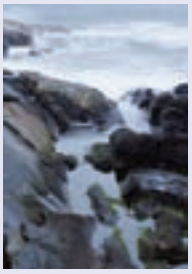
Department of Energy, just a 5 percent efficiency using smart grid technologies would equate to the elimination of fuel and greenhouse gas emissions from 53 million cars.

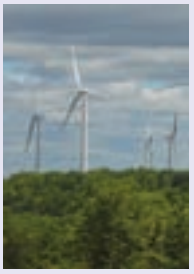
"Developing such a grid is not a trivial task, considering that both the renewable energy resources and consumers introduce many uncertainties that have to be dealt with for an efficient and reliable operation. Such a grid requires capabilities in many disciplines, including smart devices, communications, intelligent information processing, computer control, and power systems," says Mohamad Musavi, chair of the Electrical and Computer Engineering Department.

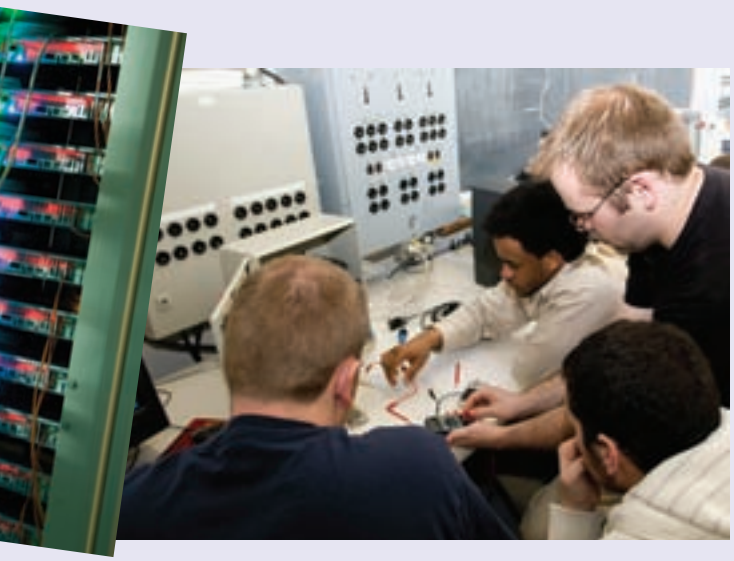
In its collaboration with power utilities to develop the Maine Smart Grid and to educate the skilled workforce needed to operate it, ECE will build on its strong, integrated research capabilities in sensors, communications and computational intelligence — the building blocks of any smart grid.

Initially, UMaine will coordinate smart grid demonstration projects among participating utilities, and the Maine Smart Grid team will develop and implement smart grid functions critical to participating utilities.

"The integration of the Maine Smart Grid with existing renewable energy sources, such as wind power, not only will satisfy the state's energy needs, but also the needs of other states, resulting in significant economic development for Maine," says Musavi.







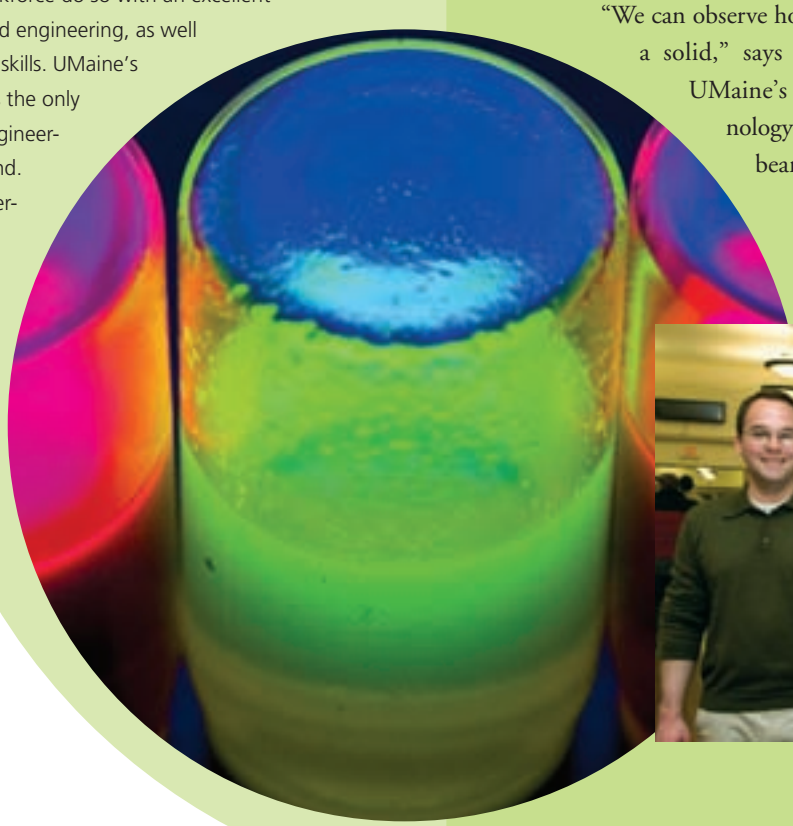
Think of a smart grid as a nervous system that provides two-way communications for collecting information from all aspects of electric energy generation, delivery and consumption to provide reliable, efficient and secure control functionalities for the national energy infrastructure.

ENGINEERING PHYSICS

"We see our graduates returning to Maine for further study or to start businesses, succeeding internationally as researchers and leaders, and moving into significant new careers, often involving substantial community service. As individuals' interests change, engineering physics continues to provide the skills that they need for success."

Susan McKay, Interim Chair
Engineering Physics

Overview This past year, engineering physics students have worked with NASA on the development and evaluation of fabrication procedures for electrodes used in spacecraft, analyzed the behavior of viruses in cell membranes using super-resolution microscopy (new technology invented at UMaine that was named Method of the Year by *Nature Methods* in 2008), and developed high-temperature sensors for aircraft engines. They also investigated the structural properties and applications of nanoparticles and quantum dots in research being conducted by assistant professor Robert Meulenberg, who joined the department in September 2008. Close to half of the department's students choose to pursue graduate work after earning an engineering physics degree. Those who enter the workforce do so with an excellent background in physics and engineering, as well as strong communication skills. UMaine's Energy Physics Program is the only accredited program in engineering physics in New England. The quality of the Engineering Physics Program and the accomplishments of our students would not be possible without the talents and dedication of our award-winning, internationally recognized faculty.



solar SOLUTIONS

Studying the power of the particle

They can't be seen by the naked eye, but using a high-powered electron microscope, University of Maine materials physicist Robert Meulenberg studies minuscule nanoparticles with the potential to make products and materials more efficient and durable.

Meulenberg's research focuses on understanding how a nanoparticle's size, shape and surface affects the overall properties of a semiconductor. He heats vials filled with colored organic solvent to up to 1,500 degrees Celsius using electrical current. The solvent evaporates to a gas, leaving the nanoparticles, the sizes of which are directly related to the amount of current applied to the sample. Ultimately, one vial can contain millions upon millions of nanoparticles.

"LASST is a special facility because we have at least four or five disciplines working here together under one banner."

— Robert Meulenberg

To view the nanoparticles, Meulenberg places the material on small wafers that are then put in the intense X-ray beam of a synchrotron.

"We can observe how the electrons behave in a material — in a solid," says Meulenberg, who conducts research in UMaine's Laboratory for Surface Science and Technology (LASST). "You can see anything with these beams."

Meulenberg works primarily with silicon, germanium and cadmium selenide. Sili-

"It is an exciting time to be in the energy business. So much is changing very rapidly, allowing us to vastly improve the service we offer to our customers. We are fortunate to benefit from the top-notch engineering workforce, as well as the research performed at the University of Maine College of Engineering. Their expertise will serve us well into the future."

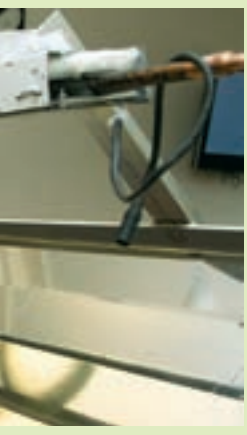
— Robert Hanf, President and COO, Bangor Hydro-Electric Company

Robert Meulenberg and his colleagues in UMaine's Laboratory for Surface Science and Technology are looking at the use of nanoparticles to increase the energy production of solar panels. They are creating thin film coatings that fluoresce at different wavelengths.

con, which is commonly used in computer chips and photovoltaics in solar panels, is likely the most important material in the electrical industry, he says.

Although still early in the research phase, some nanoparticles have shown promise in making solar panels more efficient. Currently, solar panels typically capture only a fraction of the energy that potentially could be used because only certain wavelengths of the sun are utilized.

Meulenberg is working with LASST Director Robert Lad and Electrical and Computer Engineering Professor Rosemary Smith to study ways of making solar panels capture that wasted energy. The research focuses on the creation of thin film coatings that fluoresce at different wavelengths. In solar panels, these thin films could increase the number of wavelengths captured from the sun, resulting in more energy production.



UMaine Conservation and Energy Compliance Specialist Misa Saros and Chris Straka, CEO of Ascendant Energy of Rockland, Maine, show off a new solar panel system like the one being installed at Wells Dining Center on campus. UMaine is a partner in Ascendant Energy's project to establish a Solar Center for Excellence: Advanced Photovoltaic Production Facility, funded this past spring with a more than $575,000 award from the Maine Technology Asset Fund.

MECHANICAL ENGINEERING

"The Mechanical Engineering Department is on the cutting edge. With our eye toward the future, we are offering exciting courses and establishing advanced laboratories in biomedical engineering, robotic surgery, smart materials and nanotechnology, and developing cutting-edge research on tidal and wind energy to meet our energy needs."

Mohsen Shahinpoor, Chair
Mechanical Engineering

Overview With our expanded focus on biomedical engineering, the Mechanical Engineering Department (MEE) has opened new facilities — the Robotic Surgery Lab, as an extension of the previously established Biomedical Engineering Lab, led by Mohsen Shahinpoor; the Remote Monitoring of Deployable Space Structures Lab in the Advanced Manufacturing Center, led by Vince Caccese and Shahinpoor; and the Cell Mechanics and Tissue Manufacturing Laboratory in AMC, led by Alireza Sarvestani. New initiatives include biomedical robotics research and development by Caccese, Senthil Vel, Michael Peterson, Shahinpoor and Sarvestani; and the Artificial Muscle Research Initiative (artificialmuscles.org). Ashish Deshpande has joined the faculty to further expand our strength in biomedical engineering in orthopedic surgery and R&D, and David Rubenstein was appointed as an adjunct professor in aerospace engineering. The first online astronautics course in Maine will be offered this fall. We are focusing on advanced nanocomposites, robotic surgery, advanced robotics, biomedical engineering education and research, undergraduate research related to energy, and tidal and wind energy education and research.

Patrick Bates of Wayne, Maine, a graduate student in mechanical engineering, is working with professor Michael Peterson on experimental testing of a 1/10 scale model of a prototype tidal turbine. Testing will be done in the 100-foot long UMaine tow tank.

current THINKING

Turning to the tide

Tidal power is tapped by submerged turbines with foils that are turned by ocean currents, similar to the way that wind moves turbines on land. But before full commercialization occurs, researchers need to understand how turbines will fit into the ocean environment and how much energy can responsibly be extracted.

"We know how much power potentially could be produced, but we don't know how much you can extract commercially and have it be economically feasible and environmentally responsible," says Michael "Mick" Peterson, UMaine Libra Foundation Professor of Engineering.

"(Eastport) is the most viable site with the highest tides in the continental United States. If tidal energy is going to be commercialized in the U.S., it's going to be in Maine."

— Michael "Mick" Peterson,

UMaine researchers are using a $951,500 federal appropriation to lead a collaborative effort to advance development of Maine's tidal power resource. They are assessing current prototypes and models of turbines that can be submerged in the ocean to produce power using tidal currents. The researchers also will evaluate the potential environmental impact of harnessing tidal energy off the coast of Eastport in the Western Passage of Passamaquoddy Bay.

UMaine oceanography professor Huijie Xue is an expert in oceanographic computer modeling, which is key to understanding how much energy is produced by ocean currents. She points out that Maine's jagged coastline contains many channels and passages perfectly suited for capturing tidal power. Indeed, Cobscook Bay in Maine and the Bay of Fundy in Nova Scotia have some of the highest tides in the world.

"Tidal and ocean energy represents a tremendous opportunity for the State of Maine and I am encouraged that the funding provided in the budget will ensure that my alma mater, the University of Maine, will be on the vanguard of producing these advanced technologies. UMaine's engineering program is world renowned and I look forward to continuing to be a partner in promoting this renewable energy."

— Sen. Olympia Snowe

"(Eastport) is the most viable site with the highest tides in the continental United States," says Peterson, one of the driving forces behind the project. "If tidal energy is going to be commercialized in the U.S., it's going to be in Maine."

The impact to the ocean environment and how to lessen that effect is another issue researchers are working to understand.

"Since we've been talking about tidal energy, and it's been around for a long time, there's been obvious concern that when you put a turbine in the water that there could be potential (environmental) impact," says fish biologist Gayle Zydlewski with the university's School of Marine Sciences. "If we do it right, it can be done in a safe and sustainable way."

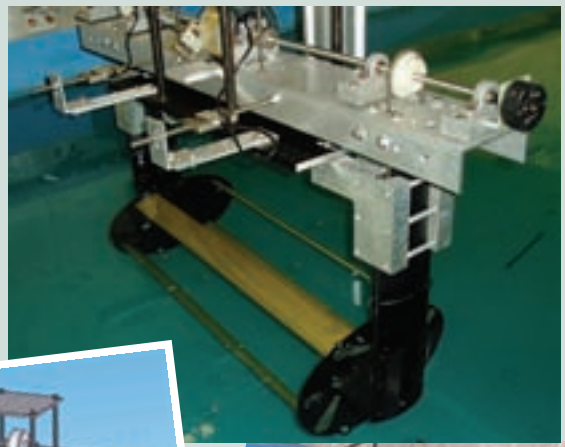
Once the environmental and commercial viability questions are answered, it is likely that the technology can be implemented fairly quickly.

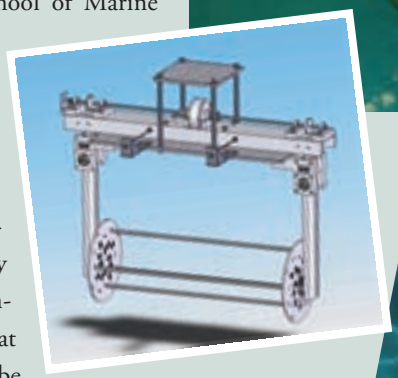
Maine Maritime Academy (MMA) and Portland-based Ocean Renewable Power Company, LLC (ORPC), partners in the ongoing research, bring specialized skills and knowledge that will allow the research and turbine development to advance efficiently and safely, serving the state's economy and the environment.

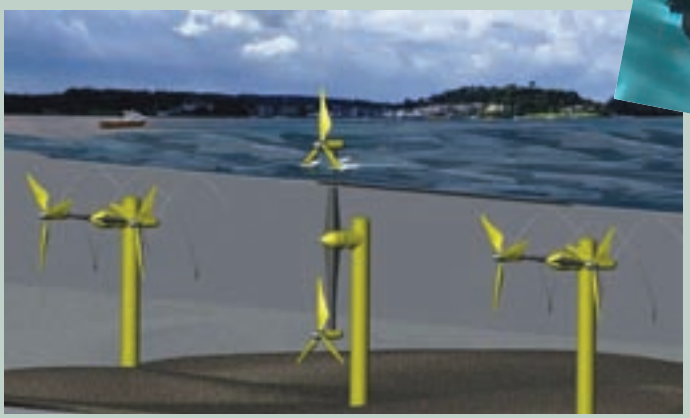
"It's a technology that is something that we can implement in a fairly short term — a matter of years," says MMA engineering professor Rich Kimball. "For example, offshore wind has a much larger potential, but that's going to be a longer timeframe to get that developed."

In addition to involving students from both UMaine and MMA in creating a new industry, there is abundant opportunity for Maine's small coastal communities to benefit from the prospect of jobs and positive economic spin-off.

"This funding will allow us to kick off an important project that is going to have significant economic impact in Washington County and throughout the state," says Chris Sauer, ORPC president and CEO, who estimates that in the next seven years, tidal energy has the potential to be a billion-dollar industry in Maine.







Artist rendering of a tidal turbine array off the coast of Eastport, Maine. The center tower is shown with one of its turbines up for maintenance. Drawn by team member Scott Lessard using Solidworks.

SCHOOL OF ENGINEERING TECHNOLOGY

Scott Dunning, Director School of Engineering Technology

"During this period of economic challenge, students are moving toward technical degrees that will prepare them for secure, high-paying jobs. This is reflected in our 20 percent enrollment growth in the last two years. With our strong ties to industry and applications-oriented engineering training, the School of Engineering Technology is ideally suited to meet that need."

Overview The School of Engineering Technology keeps on growing with enrollment reaching an all-time high of 450 this spring. Central Maine Power and TRC, an engineering and environmental consulting firm in Augusta, Maine, have both established scholarships in our Electrical Engineering Technology Program in recognition of the quality of the graduates they continue to need and recruit each year. Eighteen students in our Construction Management Technology Program competed at the Associated Schools of Construction bidding competition in Fairfield, N.J., where they took third place out of 12 teams. Our mechanical engineering technology seniors competed among themselves to design and build biomass boilers. Our Surveying Engineering Technology Program announced a generous donation from Carlson Software that will give students access to the full power of the Carlson Survey 2009 in developing survey plans. And our Mechanical Engineering Technology Program has leveraged a significant alumnus donation to upgrade much of its machine tool equipment to industry standards.

energy SAVINGS

Doing more with less

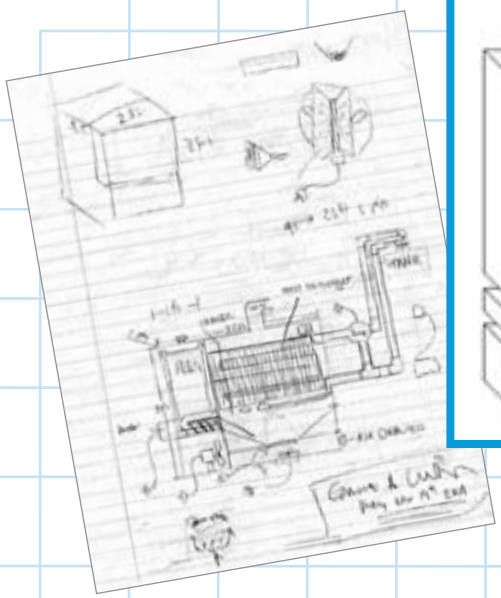
From construction of wind blades to the turbine engines that turn them to create wind power, engineers are on the front lines of creating and maintaining today's changing energy mix.

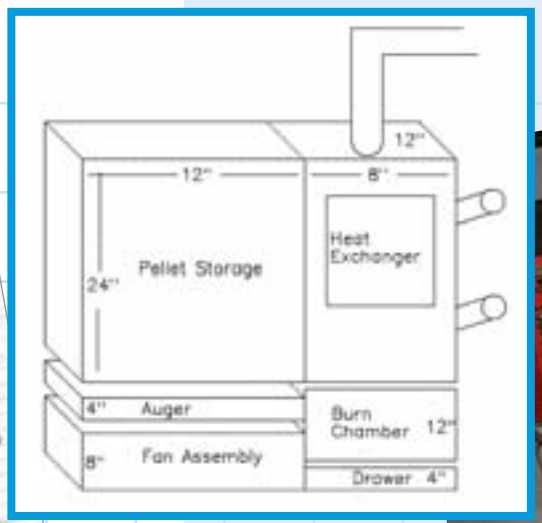
In addition to training the next generation of highly qualified energy engineers to work in today's energy industry, faculty at the School of Engineering Technology (SET) are working to increase efficiencies in the industry itself, researching fuel cells, teaching local energy management courses, and traveling around the world to train others in energy management.

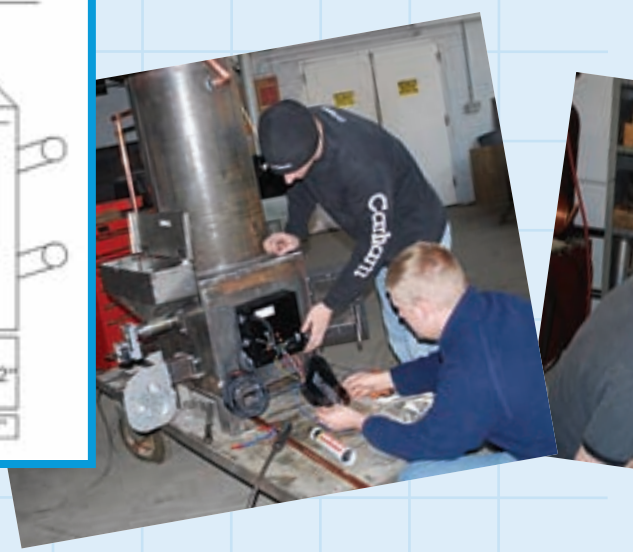
"Interest in energy management has spiked worldwide as a result of increased energy prices. Everyone is desperate to find ways to stem their energy costs and find the right energy-efficient mix."

— Scott Dunning

Intelligent energy use not only helps protect our environment, it also improves productivity and saves money and jobs, making it good for the bottom line. Unfortunately, most small and midsize manufacturers lack the time, money and in-house expertise to assess and implement many energy-efficient technologies that assist in pollution reduction while reducing costs.





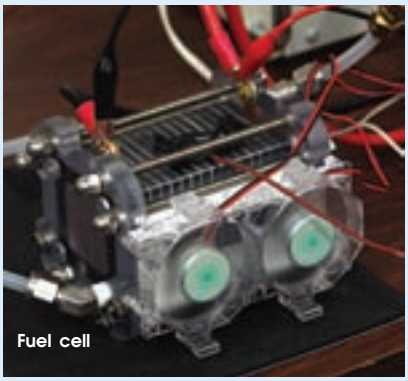


"Because of Maine's abundant natural resources, we have tremendous opportunities with respect to alternative energy in this state. The research being done at the University of Maine is providing the tools necessary to capitalize on our resources, harness renewable and alternative forms of energy, create good jobs for the people of Maine, and stabilize our economy for the future."

— Gov. John Baldacci

Starting in the early 1990s, faculty members Scott Dunning, David Dvorak and Tom Christensen worked directly with Maine companies to identify and accurately quantify energy savings through the new University of Maine Industrial Assessment Center (IAC). IAC ran about seven years, until the cost of energy went down, and assisted more than 200 companies to realize more than $6 million in savings.

"Interest in energy management has spiked worldwide as a result of increased energy prices. Everyone is desperate to find ways to stem their energy costs and find the right energy-efficient mix," says Scott Dunning, director of the School of Engineering Technology.



Fuel cell

When energy costs increased dramatically last year, demand also shot up for consulting expertise in the energy management field. While the University of Maine is no longer engaged in IAC, the College of Engineering's Advanced Manufacturing Center (AMC) continues to serve Maine companies with consulting expertise in energy management, product design, and building and engineering services.

In fuel cell research, Dvorak received a prestigious Fulbright award, which allowed him to spend six months at the School of Renewable Energy Science in Iceland, teaching and doing research on fuel cells.

Recent research included a fuel cell testing project supported by the U.S. Navy, and done in collaboration with engineers at Maine Maritime Academy and Bath Iron Works.

Dvorak is currently working with Mohsen Shahinpoor, chair of the UMaine Mechanical Engineering Department, to develop a fuel cell with increased efficiency to reduce dependence on energy conversion technologies.

"Fuel cells normally use platinum as catalyst diffused into a graphite electrode. This has traditionally been a problem with having highly efficient fuel cells," says Shahinpoor.

"In this novel research, we are developing a family of novel fuel cells by diffusing the catalyst into the ionic membrane itself by a special chemical plating technique, which will be superior to existing technologies. This approach may revolutionize fuel cell manufacturing," he says.

Other SET faculty involved in energy innovation include Charles Maguire, who has developed the first energy management course in the College of Engineering. The course has become popular with alumni who have enrolled and, as a result, realized energy savings in their homes and businesses. In addition, in the past two years, Dunning has traveled to Hong Kong, Dubai, Sharjah, Tokyo, Milan and Montreal, providing energy management training in conjunction with the Association of Energy Engineers.

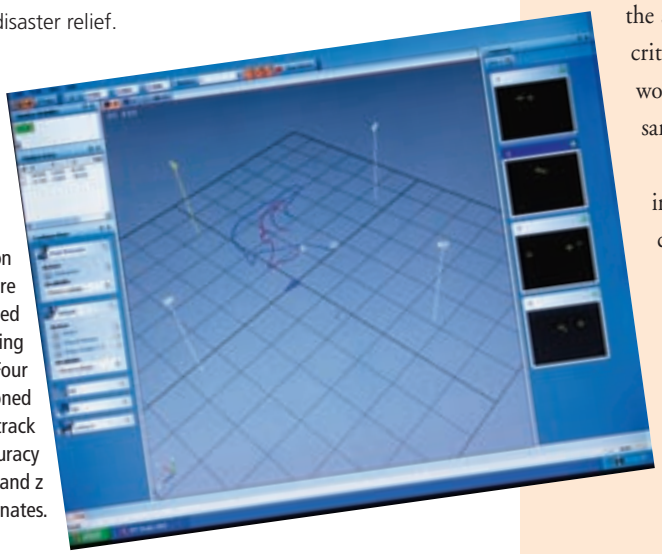
Each year, mechanical engineering technology students in professor Herb Crosby's engineering technology class tackle a relevant project for their capstone. This year, the challenge was designing, fabricating and testing efficient wood-fired boilers. The goals were to produce a safe product that created a minimal environmental footprint, while still being cost-effective and user-friendly. The projects were presented to the public and judged as part of Maine Day activities.

SPATIAL INFORMATION SCIENCE AND ENGINEERING

"The Department of Spatial Information Science and Engineering continues its role as an international center of excellence in geographic information science. With new sensors and mobile devices, spatial information plays an increasingly critical role. We cover all the bases: scientific, technical, psychological and legal."

Mike Worboys, Chair
Spatial Information Science and Engineering

Overview The Department of Spatial Information Science and Engineering, along with its twin National Center for Geographic Information & Analysis, continues to advance research and education in geographic information science. Our focus is on the acquisition, modeling and use of spatial information, and the design of spatial information systems. As information devices become smaller, more mobile, and embedded in our lives, spatial information continues to play a key role. Research highlights this past year include models of indoor and outdoor spaces, contributions to our understanding of the spatial epidemiology of cancer and the conceptualization of space for persons with visual disabilities, management of vast networks of spatial sensors for detecting movements of wildfires and pollution plumes, robotics, and protection of privacy as information about our location and activities becomes more widespread. In addition, we are just embarking on a large project with emergency agencies on the management of critical spatial information for disaster relief.



Precision Position Tracker (PPT) software showing two infrared markers moving throughout the lab. Four cameras positioned around the room track millimeter accuracy of a user's x, y and z coordinates.

virtual ENVIRONMENT

Facilitating human-computer interaction

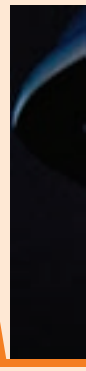
Nicholas Giudice is helping lead Spatial Information Science and Engineering's new programmatic research emphasis on human-computer interaction, and the connection between human-spatial cognition and interface design. His research adopts a neurocognitive engineering approach, drawing on principles from experimental psychology, cognitive neuroscience and human-factors engineering.

The nonvisual interfaces could be used by persons with low vision — one of the fastest growing demographics of our aging population — as well as by people in situations where vision may be impaired.

Giudice's Virtual Environment and Multimodal Interaction (VEMI) Laboratory houses the university's first fully immersive virtual reality installation. This state-of-the-art system features a head-mounted display and inertial and optical trackers that enable a person to freely navigate the lab space while immersed in a computer-simulated world.

Because much of what is perceived through vision is spatial, the principal question motivating his research is whether nonvisual modalities and interface technologies can provide the same underlying spatial content normally subserved by vision. Giudice's work attempts to identify spatial commonalities between the senses by studying what invariant environmental information is most critical for spatial knowledge acquisition and navigation. For instance, would learning a visual and tactile map of the UMaine campus lead to the same representation in memory? Giudice's research suggests that it does.

"Since the underlying spatial cues from both inputs convey equivalent information about positions, boundaries, configuration and the like, we can develop a common, a modal spatial representation in memory that is equally accessible to supporting action," says Giudice, whose work on the mental and neural substrates of functionally equivalent spatial representations is supported by a National Institutes of Health (NIH) grant, done in collaboration with researchers at the University of California–Santa Barbara and Carnegie Mellon University.



Lab Manager Richard Corey immersed in a virtual world, seeing images through a head-mounted display, showing data and imagery in stereo to both eyes.

"Engineers have the capability to improve the human condition worldwide. From addressing the causes and consequences of global climate change, to the creation of alternative biofuels, UMaine research innovations and engineering applications will continue to shape the way we live."

— Richard Fox, '68, Chairman and CEO, CDM Corporation

Another line of research in the VEMI lab focuses on the optimal information requirements for use in multimodal spatial displays to support real-time environmental learning and navigation of complex buildings.

Research in the lab compares information presented from visual virtual reality, 3-D virtual acoustic displays and speech-based interfaces. Two related projects involve development of a "cyber assistant" to provide blind and low-vision navigators with information about position, orientation, local geometry and object identification for indoor travel. This work is timely, as the World Health Organization estimates that more than 12 million Americans have some form of uncorrected vision loss, with these projections doubling by the year 2030.

The research is supported by a collaborative National Science Foundation (NSF) grant with colleagues at the University of Pennsylvania, University of Minnesota and the University of California–Santa Cruz, as well as an NIH Small Business Innovation Research Phase II grant with Koronis Biomedical Technologies.

"Outdoor navigation has been aided greatly by GPS-based devices and large electronic databases of streets and landmarks," Giudice explains. "By contrast, indoor navigation remains problematic, as there are no analogous systems and much of the information to support accurate spatial learning and indoor wayfinding is accessible only through vision (e.g., signs, landmarks and you-are-here maps)."

In a related NSF-sponsored project, Giudice and Mike Worboys, chair of the department, are developing a formal model and information framework for a portable, context-aware system to provide seamless navigation assistance in outdoor and indoor spaces.

Nicholas Giudice and his guide dog URO, with grad student Kit Cuddy and programmer Timothy McGrath in the VEMI Lab. The monitor on the right shows the imagery being seen in the virtual reality headgear.

COLLEGE OF ENGINEERING

students

Photos that make cents

THE BLACK AND WHITE PHOTOGRAPHS that University of Maine civil engineering undergraduate Sara Fortin takes may be grainy and the subjects — campus buildings — sometimes barely recognizable, but the information she's gathering is keeping money from slipping through the cracks.

Using a thermal imaging camera, Fortin is able to see where heat is leaking from the 200 buildings on campus. White radiating from a building means heat loss; black represents cold.

"I'm really interested in green technology, energy efficiency and the environmental aspects of civil engineering," says Fortin, who took the suggestion of her brother, a recent UMaine physics graduate, and asked physics professor Tom Hess if he had any projects for her work-study job.

Fortin, who is from Madawaska, Maine, hopes to use this energy auditing experience to get a job in a similar field when she graduates.

"The university has a lot of places where we can save energy, and we were thinking of some ways to measure where the worst heat leaks are on campus," Hess says.

Sara Fortin uses a laptop and a thermal imaging camera on a pistol-grip tripod to collect images that show where heat is being lost from campus buildings.

Powerful promise

IN A DAVID VERSUS GOLIATH matchup, University of Maine senior Christopher Look of Jonesboro, Maine, went up against some of the world's renowned technology companies with his invention to aid soldiers in the field. And while he didn't win the $1 million United States Department of Defense Wearable Power Prize (the DuPont/Smart Fuel Cell (SFC) team took top honors), Look was a top 20 finalist out of the 170 teams that entered the international competition.

In spring 2008, Look, an engineering physics major and a specialist in the Army National Guard, began working with UMaine professor Tom Hess on his capstone project to create a system to provide soldiers with lightweight, wearable power for their combat equipment. Such portable "Land Warrior" devices power cell phones, portable water filtration systems, ventilators, mapping equipment and temperature-regulated clothing.

On an average four-day mission, a soldier carries about 20 pounds of batteries to power such equipment. That's why the military is working to reduce the weight and size of the power supply.

Look's design is an unassuming black box, about the height and width of a legal notepad, about 3 inches thick, with nylon straps that attach to a soldier's vest. The device weighs 8 pounds and lasts longer than the current battery packs used by soldiers.

Look has continued development on his invention, and has received requests from the U.S. Navy for more information on his design.

2009 College of Engineering outstanding graduates

Heather Martin

Heather Martin of Richmond, Maine, was the 2009 outstanding graduating student. Martin majored in civil and environmental engineering, with a concentration in structures. She was a member of All Maine Women honor society, a Pulp and Paper Foundation Scholar and a UMaine Top Scholar. In the UMaine chapter of Engineers Without Borders and for her senior capstone project, she participated in a sustainable sanitation development project in Dulce Nombre, Honduras. For the past two summers, Martin interned with Stantec Inc., in Scarborough, Maine. In 2007, she was a research assistant in the UMaine Micromechanics Lab. She is working in structural engineering with Kiewit Constructors Inc., in New York City.

Maurizio Chiaramonte

Maurizio Chiaramonte of Milan, Italy, was the 2009 outstanding graduating international student. He majored in civil and environmental engineering, with a concentration in structures. He was a member of Tau Beta Pi and the American Society of Civil Engineers. Chiaramonte worked on the Penobscot Narrows Bridge project in Prospect, Maine, first as a concrete and soil technician with Fessenden Geo-Environmental Services, Bangor, Maine, and then as a research assistant with UMaine's AEWC Advanced Structures & Composites Center. He also was an AEWC research assistant on a Department of Homeland Security project. Chiaramonte is pursuing a master's degree in structural engineering at the University of Washington.

A strong bond

UMaine's concrete canoe tradition

AN UNUSUAL RIVALRY 35 years ago between two Midwest universities racing 500 to 600-pound, tub-like concrete boats on water gave University of Maine civil engineering professor John Alexander and some of his students an idea that would lead to one of the nation's first concrete canoe racing teams, and a longstanding tradition at UMaine.

The UMaine students built two concrete canoes, 16 feet long and weighing just under 200 pounds — svelte by comparison to the Midwestern "tubs," Alexander recalls — and they entered them in Maine's annual Kenduskeag Stream Canoe Race, a 16.5-mile course.

Then, says Alexander, "we had the bright idea of inviting all of the engineering departments up and down the East Coast to come and enter the race."

For each of the next 14 years, UMaine hosted as many as 20 visiting concrete canoe teams, drawing as many as 500 university students to Maine.

As concrete canoe teams, and regional and national competitions, grew in popularity, the American Society of Civil Engineers (ASCE) began prescribing major design parameters to ensure consistency. Students are otherwise free to modify canoe designs from year to year, perfecting the concrete mix for buoyancy by using tiny, lightweight glass beads instead of sand, and adding more air than would be used normally in concrete for a highway bridge abutment or a foundation.

At UMaine, several dozen team members now meet throughout the academic year to build a new canoe. The process demands the kind of cooperation and diplomacy skills students will need as career engineers, says Dan Pitman, a 2009 team cocaptain and third-year civil engineering major from Farmington, N.H.

"We're pretty tight-knit," he says. "We hold meetings once a week at 6 and we have a work day on Saturdays. We love it."

Since 1974, the UMaine team has produced some close finishes, winning many regional competitions and performing respectably in the ASCE national competition. In the last four years, UMaine has won the New England regionals three times to earn a berth in the nationals.

The UMaine team and friends at the 2009 Concrete Canoe competition at Lake Wyola, Amherst, Mass., April 18, 2009.

Back row, left to right: Robert Sypitkowski (DEP) and members of Engineers Without Borders: Michael Parker and Brandon Newmanin Honduras.

Environmental Impact

MECHANICAL ENGINEERING major Michael Parker of Bradford, Maine, is one of two University of Maine students tapped to receive a Morris K. Udall Scholarship.

The scholarship, considered the highest national recognition for students in environmental fields, encourages college students "to preserve and protect their national heritage through studies in the environment and Native American health and tribal public policy."

Parker and Laura Wood of Scarborough, Maine, an ecology and environmental sciences major, were among 80 Udall Scholars chosen from 515 applicants nationwide.

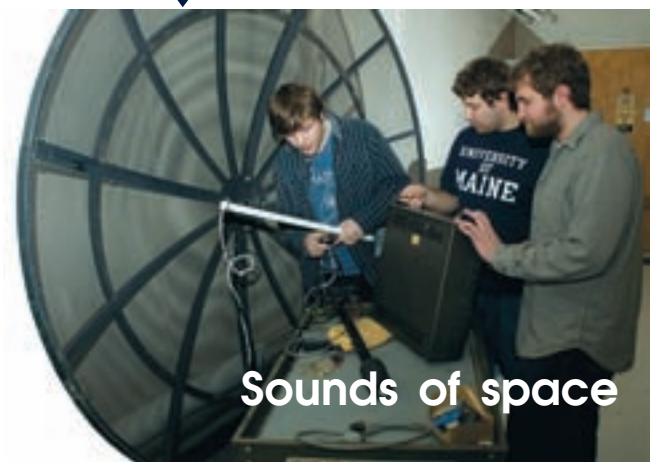
Parker's honor is a landmark for UMaine, where these scholarships typically go to students in the environmental sciences and ecology, rather than mechanical engineering. But his research and involvement on and off campus set him apart.

"Generally, this doesn't happen to mechanical engineers," says Jean MacRae, an associate professor of environmental engineering and faculty advisor to the UMaine chapter of Engineers Without Borders. "Mechanical engineers can have a huge impact on the environment, especially if attention is paid to efficiency. Michael sees the whole picture. He's a mechanical engineer, but he's not fixated on the gadgets. He sees how the things we make can affect our environmental and social systems."

Parker serves as the copresident of UMaine Engineers Without Borders. He has been integral in working with the community of Dulce Nombre, Honduras, toward sustainable water and sanitation solutions. In Orono, he was a coordinator of the Green Campus Initiative, and he has worked to design the renovation of a building on campus to meet LEED certification standards. The idea of offshore wind power intrigues him, and to that end, he is considering staying on for his master's degree at UMaine.

Brittany Boser

Brittany Boser of Three Rivers, Mass., a member of the UMaine women's basketball team, graduated in May with a degree in chemical engineering. During her time at UMaine, Boser made the America East All-Academic Team and the ESPN The Magazine/CoSIDA Academic All District Second Team. She served as UMaine's team captain during the 2007-08 season. Boser was a member of Tau Beta Pi and All Maine Women honor society. She also earned both the Presidential Academic Scholarship and the Walter Hunt Scholar Athlete Award. In 2008, she served as a laboratory research assistant in the Chemical Engineering Department working with nanoparticles. Boser plans to get a graduate degree in chemical engineering.



Sounds of space

Christopher Miller, left, a junior in engineering physics from Penobscot, Maine, and physics seniors Aaron Tanenbaum of Orono, Maine, and Alexander De Carlo of Bangor, Maine, prepare the equipment for the radio astronomy station installation on the roof of Bennett Hall.

WITH THE INSTALLATION of a radio frequency monitoring station on the roof of Bennett Hall on campus, University of Maine students hope to eavesdrop on the clicks and beeps of space using radio astronomy — a field they haven't experienced because of a lack of equipment.

With help from Paul Smitherman, a graduate student in the Department of Spatial Information Science and Engineering, and some funding from the College of Engineering, Student Government, and the Department of Physics and Astronomy, members of UMaine's Society of Physics Students retrofitted a satellite dish for the station.

They also raised money for an amplifier and other accessories, created a metal stand to support the dish and searched for archaic satellite parts. And when they came up empty-handed for some pieces, the students replicated them from old photographs.

The satellite dish and amplifier installed this past spring will record sounds from the sky to a computer inside the building. At first, the dish will be stationary and students will use the Earth's rotation to collect data. Eventually, the satellite dish will rotate using a computer-controlled motor.

Wind blades in high school

IN MAY, STUDENTS from 18 high schools and vocational centers throughout Maine met at the University of Maine Field House for Wind Blade Challenge 2009. UMaine's AEWC Advanced Structures & Composites Center, Maine Composites Alliance and the North Star Alliance Initiative partnered to develop the challenge to encourage students and teachers to explore the use and application of composite materials in expanding alternative energy industries.

Thirty-one teams competed to design the most efficient wind blade using a kit of composite resources. For nine weeks, the students researched wind blade design, developed prototypes and manufactured blades with the aid of Maine composite companies.

"The Wind Blade Challenge is the first time students from across Maine can leverage their skills in math and science, as well as their growing knowledge of alternative energy, into a real-world project," says Paul Williamson, program director of the Maine High School Wind Blade Challenge. "This project also allows the students to work with the leading composite companies and manufacturing labs in Maine, which fosters relationships between Maine high schools and Maine businesses."

The challenge, to be held annually at the university, is considered a model for similar programs nationwide.

Blaine West, left, and Chris Pickering from Sumner Memorial High School, East Sullivan, Maine, pictured here with AEWC director Habib Dagher were the winners of the Maine High School Wind Blade Challenge. The winning team built a five-bladed rotor that earned the highest power-generation scores: 66.56 watts/minutes and peak watts of 23.91.

Learning in a submarine

THE BEATLES may have all lived in a yellow submarine, but the gray submersible created by students from the Mechanical Engineering Department only seats one. No matter, because one person — and his or her scuba gear — is all it takes to maneuver a human-powered submarine.

The annual design project for seniors, led by Professor Michael Peterson, culminates in an international submarine race in Maryland. Like any capstone, it is intended to use hands-on experience to drive home concepts and skills.

This year, rather than modify the existing 6-year-old submarine, the 14-member team decided to start from scratch. As the students fine-tuned the oscillating hydrofoils that propel the sub and weighed the benefits of epoxy vs. Plexiglas windows, academic principles became tangible and other lessons emerged.

"It's more of a group project than anything, and that's what the engineering field is getting into," says Seth Swanberg of Caribou, Maine, who graduated in May with a degree in mechanical engineering. "You all have to work together. You can't possibly expect to know everything. A mechanical engineer has to work with an electrical engineer, for example. The project is really irrelevant. It's learning how to work together."

The team placed third in the competition.

At left, professor Michael Peterson and Yousef Mohamed, a senior mechanical engineering capstone student, inspect the oscillating hydrofoil propulsion system used on the student-designed human-powered submarine, pictured above.

A passion for undergraduate education

IN 1960, WAYNE HAMILTON was fresh out of Case Western Reserve with a new master's degree in civil engineering in his pocket and a plan to spend a couple years teaching before moving on with his career.

He had three job offers, and opted for the University of Maine. And that's where his plan went awry.

For more than 37 years, with the exception of 15 months spent getting his Ph.D. at Oklahoma State in a program funded by the National Science Foundation, Hamilton taught at least one course in civil engineering at UMaine every semester.

"What kept me here were the people I was working with, the (academic) programs and the fact that this was a great place to work," he says.

Among those at UMaine who changed Hamilton's life was civil engineering professor Frank Taylor, who had already been on the faculty for 20 years.

"He was the epitome of a professional," Hamilton says of his mentor, with whom he shared an office. "He was one of those people who took students' interests to heart."

Hamilton served as department chair from 1969–77, during which time the Civil and Environmental Engineering Department launched its surveying program, and offered one of the first Ph.D.s in environmental engineering in the country. In 1977, he started what would be a 19-year stint as associate dean of the College of Engineering, a position that he accepted on the condition that he continue to teach.

He received the college's Ashley Campbell Award in 1987 for outstanding contributions to undergraduate education. Last fall, he was the ninth emeritus faculty member to be honored by the college at the James and Maureen Gorman Emeriti Faculty Luncheon.

"My real passion is for undergraduate students, seeing them come in and develop, seeing them change over a four-year period," says Hamilton, who taught five more semesters after retiring from UMaine in 1997. "Coming out of high school, most of them have little clue what they really want to do. Once they get past calculus and physics, as the faculty get them involved in projects, the students begin to see how they can apply their knowledge."

As past associate dean, Hamilton worked with a number of students who transferred or needed readmittance into the college. He was known for having an open door for any student, beginning at 7:30 a.m. His conversations often lasted long after the students graduated.

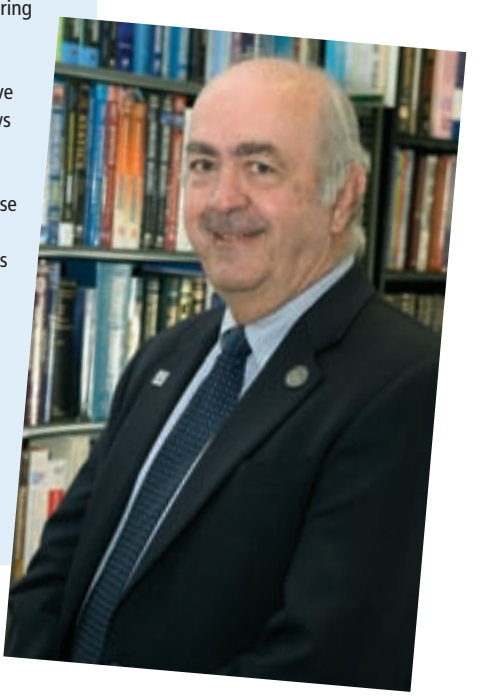
"I learned some of the hopes and aspirations they have," he says. "I also realized that these students and their parents are coming in here looking to a better life. In a lot of cases, they wanted to be able to go from here and help their communities."

Student favorite

PERFECT. THAT'S HOW students in applied mechanics evaluated Chair and Professor Emeritus of Mechanical Engineering Donald Grant.

"(He) is one of the greatest teachers and academicians I have ever known as a colleague," says Mohsen Shahinpoor, chair of Mechanical Engineering. "I call him the teaching prophet because he has been teaching for over half a century and almost always gets a perfect evaluation grade by the students."

Grant, who joined the UMaine faculty in 1956, was the Richard C. Hill Professor of the Mechanical Engineering Department. He also chaired the department from 1989 until his retirement in 2007.



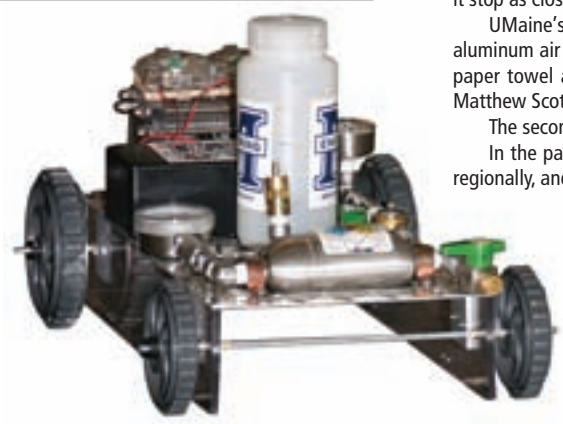
Honored alumnus

A RENOWNED FILM PRODUCER who graduated from the University of Maine in 1979 with a degree in civil engineering was one of five alumni honored by the University of Maine Foundation in June at its 75th anniversary celebration on campus. Lawrence Bender of Los Angeles, Calif., has produced such influential mega-hits as *Kill Bill, Vol. 1* and *Kill Bill Vol. 2, An Inconvenient Truth, Good Will Hunting, Pulp Fiction, Anna and the King, Jackie Brown* and *Reservoir Dogs*. Those films have been honored with 21 Academy Award nominations, including two for Best Picture.

The University of Maine's Sustainable Bioplastics Initiative has received a second Maine Technology Institute Cluster Enhancement Grant for $500,000. The project started with a seed grant to research the feasibility of making polylactic acid (PLA) plastics — found in yogurt containers and disposable utensils — using the starch from cull potatoes. UMaine researchers also have discovered that wood by-products from Maine's forest product facilities, such as pulp mills, are viable sources of fermentable sugars. The only U.S. plant currently making PLA plastic is in Nebraska, using corn to produce the necessary starch. Companies wanting non-genetically modified organism (GMO) materials don't have any options, but Maine is poised to fill that void while creating jobs and developing a new industry for the state.

CHEMICAL AND BIOLOGICAL ENGINEERING

Potatoes to plastics



ENGINEERING PHYSICS

Protein focus

WITH THE HELP of a newly invented microscope system, scientists at the University of Maine are taking a close look at a protein from the influenza virus that allows infection to occur. The microscopy system, called FPALM (Fluorescence Photoactivation Localization Microscopy), was invented to enable scientists to look at the molecular organization of cells by imaging samples labeled with a special kind of fluorescent marker.

Influenza uses the protein hemagglutinin (HA) to infect healthy cells. In the first step of infection, HA enables the virus to attach to the membrane of a healthy cell.

It is believed that the arrangement of individual HA molecules in the membranes is crucial for infection to occur. Until now, the limited resolution of conventional microscopes made it impossible to create images of such molecules on a small enough scale to test the biological models that predict how they may be organized.

The recent extension of FPALM to include 3-D imaging and provide information about the orientation of single molecules will help address important biological questions. Already, the ability to image living cells has helped UMaine scientists disprove several existing models of membrane organization.

The UMaine researchers, including Samuel Hess, a FPALM co-inventor, along with colleagues at the Albert Einstein College of Medicine in New York and the National Institute of Child Health and Human Development in Maryland, published their findings on HA in the journal *Nature Methods*.

The FPALM microscopy system breaks a fundamental limit on the resolution of lens-based microscopes, known as the diffraction barrier, which has existed for more than 100 years.

THE UNIVERSITY OF MAINE'S ChemE car teams took the two highest honors at the annual race sponsored by the American Institute of Chemical Engineers at the University of Massachusetts–Amherst.

The Blue Team took first place out of nine teams, stopping less that 2 inches from the finish line on a nearly 70-foot course. This fall, the students will head to Nashville, Tenn., for national competition.

The White Team finished second at a distance of about 5 feet from the finish line. It also won the Safety Award and received second place in the poster competition.

The goal of the race is to power a car by chemical means a given distance; the winner is the car that can stop the closest to the line. A timing mechanism is used in each vehicle in an attempt to make it stop as close to the line as possible.

UMaine's cars have been works in progress since last fall. The Blue Team's winning car uses an aluminum air battery to power two electric motors. The battery is made of aluminum foil, salt water, paper towel and activated carbon, according to team captain and chemical engineering student Matthew Scott. The car runs on 13 batteries producing up to 9.5 volts.

The second-place team powered its car with alkaline batteries.

In the past four years, UMaine's ChemE car teams placed first the three times they competed regionally, and placed third and ninth in the national competition.

CHEMICAL AND BIOLOGICAL ENGINEERING

Winning ChemE cars

Surface acoustic wave devices, which will serve as fluid transport and processing components of the endospore detection microsystem, are fabricated through a thin film photolithographic process using a piezoelectric substrate.

LASST

Traceable bombs

WHEN THE NATIONAL Science Foundation put out a call to researchers to develop sensor technologies that could track the origin and movement of explosives used in terrorist bombings, Paul Millard figured that he and his two close collaborators at the University of Maine were positioned ideally to address the problem.

Representing three different, yet complementary fields — biological engineering; electrical and computer engineering; and biochemistry, microbiology and molecular biology — Millard, Mauricio Pereira da Cunha and John Singer collaborated to develop a unique multidisciplinary project proposal.

For the last few years, engineers Millard and Pereira da Cunha have conducted basic and applied research in molecular sensors to detect pathogenic bacteria, as well as viruses currently threatening fish raised in Maine's aquaculture industry. With NSF support, they then expanded their research into the human-safety realm, merging DNA-recognition strategies with sensor technology to detect bacterial undesirables, such as salmonella, *Vibrio cholerae* and enteropathogenic *E. coli O157:H7* in the environment.

To Millard and his colleagues, much of that work seemed to provide a logical lead-up to the NSF's newest challenge: Devise a method that law enforcement officials could use while investigating a terrorist bombing to determine where the explosive materials were manufactured and the route they traveled to the scene of the attack.

Unique identifying markers or taggants are incorporated into individual lots of explosives. One of the most common explosives taggants in use today consists of tiny multicolored plastic chips bonded to a magnetic material, acting as a bar code of sorts to identify the factory that made the explosive material, and on what date and in what batch, as well as its distributor and the places that sold it.

DNA can also be valuable as a taggant, but the equipment necessary to read the genetic code is fairly expensive, is not portable and requires skilled technicians to operate.

Millard believes he and his colleagues have hit on a method that will allow them to overcome the limitations of the DNA-recognition method. Instead of using naked, vulnerable DNA, the team will use bacterial endospores, such as bacillus and clostridium.

NSF has provided nearly $400,000 for the novel three-year explosive tracking project.

MECHANICAL ENGINEERING

Clean sledding

THE UNIVERSITY OF MAINE Clean Snowmobile Team ranked fifth in the 2009 Society of Automotive Engineers Clean Snowmobile Challenge in Michigan in March. The team also walked away with a cold start award.

UMaine's 2009 performance and reengineering of a stock snowmobile was an improvement over the team's ninth-place finish last year.

The Clean Snowmobile Challenge is a collegiate design competition of the Society of Automotive Engineers, held annually at Michigan Technological University. The goal is to reduce emissions and noise while maintaining or boosting the snowmobile's performance. This year, the internal-combustion entries adapted their engines to run on flex-fuel, with varying ratios of ethanol and gasoline.

In redesigning its base machine, which is a second-generation, tuned four-stroke powered 2007 Yamaha Phazer, the UMaine team wanted to reduce exhaust emissions of hydrocarbon and carbon dioxide without changing the level of NO_2 pollutants.

The students also needed to adapt the machine to use ethanol-based fuels, such as butanol, while reducing the snowmobile's noise emissions.

All of these goals needed to be met in the most cost-effective way possible because teams are awarded points on the overall value of the sled they design.

"The greatest success of the year is the huge improvement in the UMaine paper score," says Michael Peterson, UMaine team advisor and mechanical engineering professor. "This is a testament to the leadership of the team by Kate Wheeler (from Manchester, Maine) and her cocaptain Brendan Goodwin."

Goodwin, from Lincoln, Maine, was the designated snowmobile rider for the team during the competition.

"Most impressively, the team worked productively throughout the year and right through the pressure of the competition," says Peterson. "When emotions are high, the ability to work as a team is critical, and this year's UMaine Clean Snowmobile Team was the most balanced and calm student competition team ever."

MECHANICAL ENGINEERING

Operating with robots

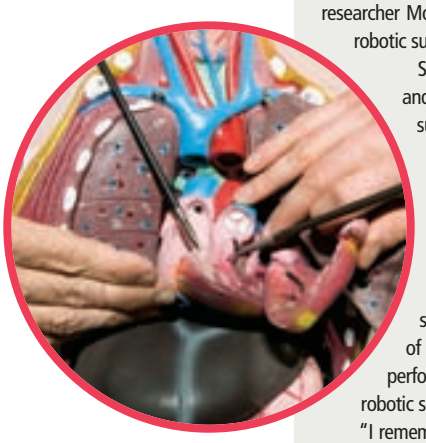
IN MAINE'S FIRST biomedical engineering laboratory, robotic building blocks of technology have the potential to help revolutionize human surgical procedures. Mechanical engineering researcher Mohsen Shahinpoor, who directs the lab at the University of Maine, admits that robotic surgery is in its infancy. But what he envisions for it is far-reaching.

Shahinpoor's focus is on the development of advanced robots for endoscopy and laparoscopy procedures that are less invasive and traumatic than traditional surgeries.

"A revolution is occurring in the medical surgical field. Robotic surgery is eliminating almost 90 percent of the trauma associated with traditional surgery involving cutting people open," says Shahinpoor, chair of the Department of Mechanical Engineering.

Today in endoscopic robotic surgery, the surgeon makes three or four small incisions, a few millimeters in diameter, in the abdomen. Via the tiny incisions, optical fibers and associated electronics control the lighting and imaging of the internal body organs, while robotic forceps and other surgical instruments perform the necessary surgery. The surgeon sees it all on a computer screen. Such robotic surgery reduces a patient's trauma, recovery time and risk of infection.

"I remember when no one knew what was going to happen to the patient after major brain or heart surgeries," says Shahinpoor, who focuses his own research on developing smart materials to aid in the prevention of heart failure. "Now with robotics developed by mechanical engineers using smart materials, surgeons are more confident that patients are going to make it."



Mohsen Shahinpoor, chair of the University of Maine Department of Mechanical Engineering and director of the state's first biomedical engineering lab, and senior Mark Liimakka of Old Town, Maine, demonstrate the use of robotic forceps in heart surgery.

Latest Francis Crowe Inductees

IN MAY, eight professionals were inducted into the University of Maine College of Engineering Francis Crowe Society for their outstanding contributions that advance the art and the science of engineering.

- Ralph Carter, president of Rockwell Software, a business unit of Rockwell Automation, Austin, Texas.
- Dale Flanders, who holds 74 U.S. patents and founded Axsun Technologies, Billerica, Mass.
- David Sleeper, president and owner of Realty of Maine, who started his career as a nuclear submarine engineer in Connecticut.
- Mark Jadkowski, president and chief operating officer of Global Relief Technologies, Portsmouth, N.H.
- Paul Elkin, a manager at TRC, an engineering and environmental consulting firm in Augusta, Maine.
- Gunther Gruelich, a retired licensed land surveyor and engineer in Massachusetts.
- Bollie Bollenbach, vice president of Pizzagalli Construction Co., Portland, Maine.
- Douglas Cutchin, immediate past president of The Sheridan Corp., Fairfield and Portland, Maine.

Honoring a former dean

CONSTRUCTION HAS BEGUN on a new campus plaza named in honor of Paul Cloke, former dean of the College of Engineering.

"Making the (Cloke) Plaza a public place, a laboratory and a pedagogical example for the rest of the campus is a great opportunity," says Buster Simpson, the design artist on the project.

Designed to be a campus gathering place, Cloke Plaza will be anchored by an illuminated, reflective, free-standing bell tower or campanile, juxtaposed to the historic Wingate bell that will ring on the hour. The campanile will be supported by a 38,0000-pound slab of granite from Freshwater Stone in Orland, Maine.

The two 30-foot by 60-foot carbon arcs were engineered and fabricated at UMaine's AEWC Advanced Structures & Composites Center.

AEWC

Bridge in a backpack

Researchers at the University of Maine's AEWC Advanced Structures & Composites Center have developed technology that allows bridges to be built almost anywhere in a matter of days, rather than months.

This rigidified, inflatable composite arch system — nicknamed "bridge in a backpack" — is lightweight and easy to transport, making it ideal for soldiers to use in the field, and also in emergency situations, such as earthquakes and floods where people need to be evacuated.

The system, which also received funding from the Maine Department of Transportation and the Federal Highway Administration, already has been successfully implemented, most recently in a road construction project to replace the Neal Bridge in Pittsfield, Maine.

Not only does the technology serve as both formwork and structural reinforcement for short- and medium-span bridges, but also for temporary buildings, underground storage facilities, tunnels, overpasses and hangers.

The arches can be formed, placed, filled with concrete and backfilled, allowing for a high-strength composite alternative to precast concrete. The system also is less expensive to use than traditional building methods and materials, eliminating the need for heavy equipment and large construction crews to handle the weight of heavier building materials.

"AEWC is all about doing things in a smart way, using Yankee ingenuity. The research that goes on up here at the university creates commercialization opportunities throughout the state."

— Gov. John Baldacci, Feb. 20, 2009

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ELECTRICAL AND COMPUTER ENGINEERING

Flying wireless

THE CANEUS FLY-BY-WIRELESS Sector Consortium, part of an international nonprofit organization serving the aeronautics, space and defense communities, has tapped Assistant Professor Ali Abedi of electrical and computer engineering to help it pull the plug.

No, it's not closing down. The consortium is powering up to create wireless micro and nano technologies for aerospace applications, and has named Abedi to lead the effort.

Abedi directs UMaine's WiSe-Net Lab for wireless sensor network research. Currently, he is working on a novel coding scheme for a battery-free wireless sensor communication system in cooperation with professor Mauricio Pereira da Cunha, director of the Microwave Acoustics Lab. The system is meant to operate in harsh environments where the battery-powered sensors now used in NASA's space shuttle cannot function.

CHEMICAL AND BIOLOGICAL ENGINEERING, AND ENGINEERING PHYSICS

R&D investment

THE MAINE TECHNOLOGY INSTITUTE (MTI) selected four University of Maine projects to receive $6.8 million from the Maine Technology Asset Fund (MTAF) for projects that will lead to significant economic benefits for Maine. In addition to the direct awards, UMaine is a partner in seven other projects granted more than $9 million in MTAF funding. This was the second round of funding from the $50 million MTAF R&D bond Maine voters approved in 2007. Last year, MTI identified the first 14 projects to receive nearly $30 million. UMaine researchers developed five of the funded projects, which were awarded more than $13 million.

The new UMaine proposals receiving awards are:

- The University of Maine Innovative Industries Initiative, $3.69 million, for construction a New Media Innovation, Research and Development Center at UMaine. A least eight independent Maine-based new media companies will be involved in the project.
- Maine Center for Autonomous Marine Survey (MCAMS), $1.2 million, to establish a coordinated technical center for autonomous survey vehicles that will make new technologies for measuring crucial ocean properties in the Gulf of Maine easily accessible.
- University of Maine Pulp and Paper Process Development Center, $1 million, to update UMaine's pulp and paper pilot plant.
- Strengthening Biotechnology & Supporting the STEM Education Initiative in Maine, $883,000, to renovate and expand Bennett Hall to include an image processing laboratory and commercialization space to enhance the types and number of samples imaged by FPALM, a new fluorescence photoactivation localization microscopy system developed at UMaine to study cellular molecular organization.

2009 ENGINEERING
spotlight

ELECTRICAL AND COMPUTER, AND MECHANICAL ENGINEERING

ON THE 40TH ANNIVERSARY of humans landing on the moon, the next generation of lunar technology was delivered to the University of Maine via two tractor trailer trucks carrying about 14,000 pounds of cargo — parts of an inflatable habitat 42 feet wide, 10 feet tall. This fall, faculty and students will begin assembling the structure, which is expected to someday provide a lunar home base for astronauts as they explore the moon, Mars and Venus. In the next three years, UMaine electrical and mechanical engineering researchers will equip the lunar habitat with wireless sensors to provide continuous monitoring of the structure's soundness and safety. An inflatable habitat is set to be installed on the moon by NASA astronauts in 2020. The structure now on campus is the only one of its kind in the world. The sensor project, led by Ali Abedi, assistant professor of electrical and computer engineering, is funded primarily by a nearly $2 million grant from NASA. This past July, UMaine also received $2.2 million from the Maine Technology Institute to purchase equipment that will be used in this research, as well as other projects on campus.

New dual-degree program

THE UNIVERSITY OF MAINE and the University of Maine, Farmington, are collaborating to offer a five-year dual-degree program resulting in liberal arts and engineering degrees. Beginning this fall, students can spend three years pursuing a bachelor of arts degree at Farmington, then attend UMaine for two years of study toward a bachelor of science degree in engineering. They would graduate with a UMF degree in environmental sciences and a UMaine degree in any one of several engineering tracks. UMaine College of Engineering Associate Dean Chet Rock says combining engineering and liberal arts programs is becoming more popular as engineers recognize the need for greater exposure to humanities, along with their technical skills. The College of Engineering's first 3+2 program was established with Bowdoin College last year.

Silvia Nittel's research, funded by NASA, the National Spatial-Intelligence Agency and a National Science Foundation Early CAREER award, focuses on extending database technology to support stationary and mobile sensor networks, especially geosensor networks.

SPATIAL INFORMATION SCIENCE AND ENGINEERING

Geosensor potential

THE LATEST IN SMALL-SCALE GEOSENSOR network technology has the potential to serve as an "environmental microscope," significantly improving how we detect, monitor and react to environmental changes on the planet — from a volcanic eruption or air pollution to those phenomena that, up to now, have been too difficult to observe or measure, according to a University of Maine spatial information science engineer.

"Today, the domain of geosciences is at the brink of a new wave of technology: ubiquitous wireless communication networks, including long- and short-range communication technology and intelligent sensor platforms deployed in an untethered way performing localized and collaborative data processing," says associate professor Silvia Nittel, writing in the July issue of the journal *Sensors.* "This leads to a fundamental paradigm shift in how we can sense, monitor and track dynamic phenomena in real time in the environment."

In her paper, Nittel explores how geosensor networks — specialized applications of wireless sensor networks — have the potential to provide a view of environmental processes at a spatiotemporal resolution like never before. A plethora of applications is possible with advanced technology platforms that are increasingly lightweight and portable, and able to deliver real-time data.

WHILE UNIVERSITY OF MAINE engineering students are involved in many areas of alternative energy research and efficiency technologies on campus, one mechanical engineering course in particular provides one-of-a-kind, hands-on experience as part of senior design projects. Michael Peterson, who teaches the course, urges students to take on projects that have real-world application potential. James LaBrecque, a local inventor who has been a consultant and adviser to the Mechanical Engineering Department since the mid-'80s, supervises the technological innovation.

One of the ongoing initiatives is to create and improve residential and commercial heat pump technology that can lower the energy cost in Maine homes and businesses, and some of UMaine's buildings.

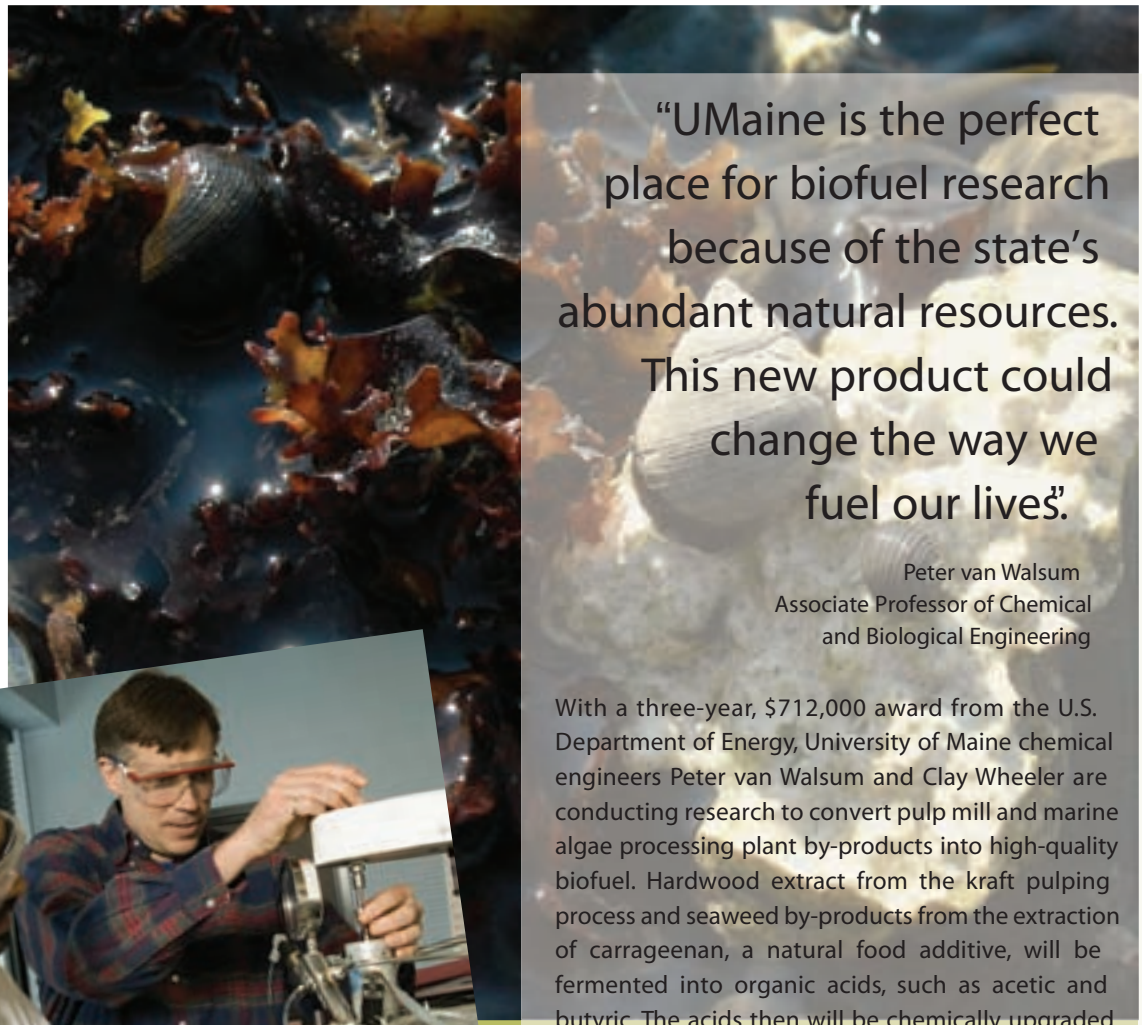
Energy-efficient heat pumps move rather than generate heat, producing many units of heat for each unit of electricity used.

A heat pump installed in March at the Engineering Science Building on campus is expected to save the university $125,000 annually in oil costs, while only adding $25,000 a year to UMaine's electricity bill. Money for the $200,000 project came from the University of Maine Foundation's Green Loan Fund, which lends money to the university for projects designed to reduce energy consumption and improve campus sustainability.

A second generation unit built by students is scheduled for installation and testing this fall at a supermarket in Farmington, Maine. The unit, the first of its type, will recover heat from the store's new refrigeration technology, built earlier this year at UMaine's Advanced Manufacturing Center.

MECHANICAL ENGINEERING

Pumping heat



"UMaine is the perfect place for biofuel research because of the state's abundant natural resources. This new product could change the way we fuel our lives."

Peter van Walsum
Associate Professor of Chemical and Biological Engineering

Photos by Linda Healy and Michael Mardosa

With a three-year, $712,000 award from the U.S. Department of Energy, University of Maine chemical engineers Peter van Walsum and Clay Wheeler are conducting research to convert pulp mill and marine algae processing plant by-products into high-quality biofuel. Hardwood extract from the kraft pulping process and seaweed by-products from the extraction of carrageenan, a natural food additive, will be fermented into organic acids, such as acetic and butyric. The acids then will be chemically upgraded into fuel alcohols, such as ethanol and butanol. Industrial collaborators in the project include Old Town Fuel and Fiber, a nearby kraft pulp mill in Old Town, Maine, and FMC BioPolymer in Rockland, Maine, the only seaweed carrageenan manufacturer in North America.*Chondrus crispus*, the seaweed known as Irish moss, is a source of carrageenan.

DISCOVERING what's next

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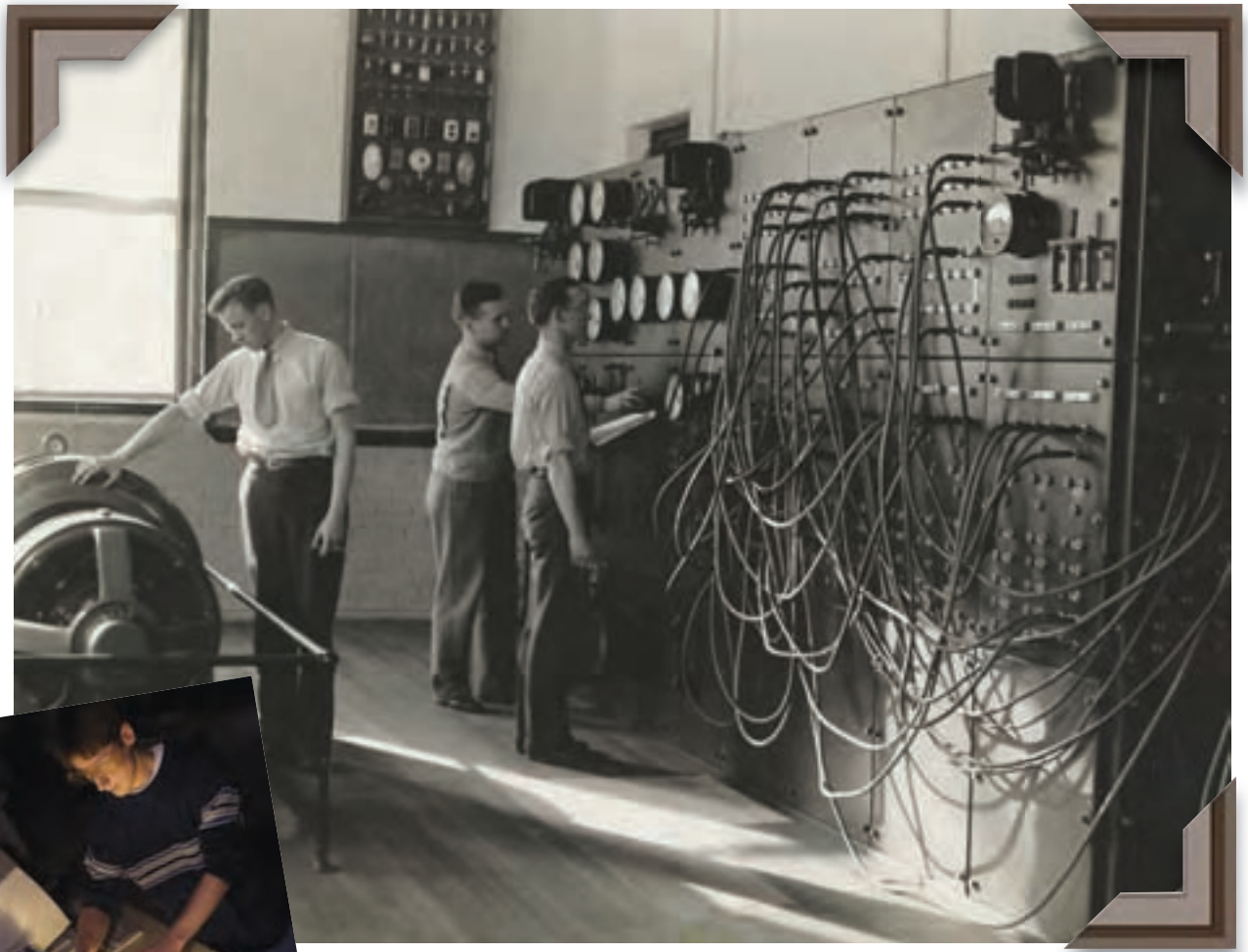

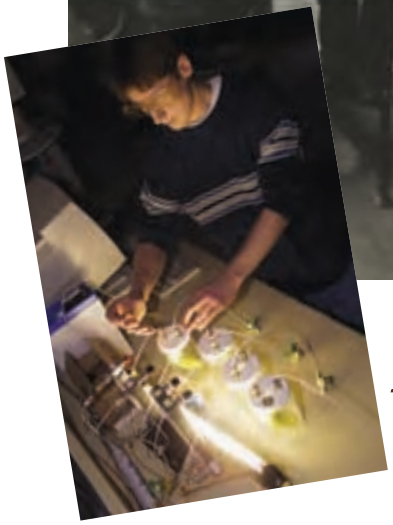

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