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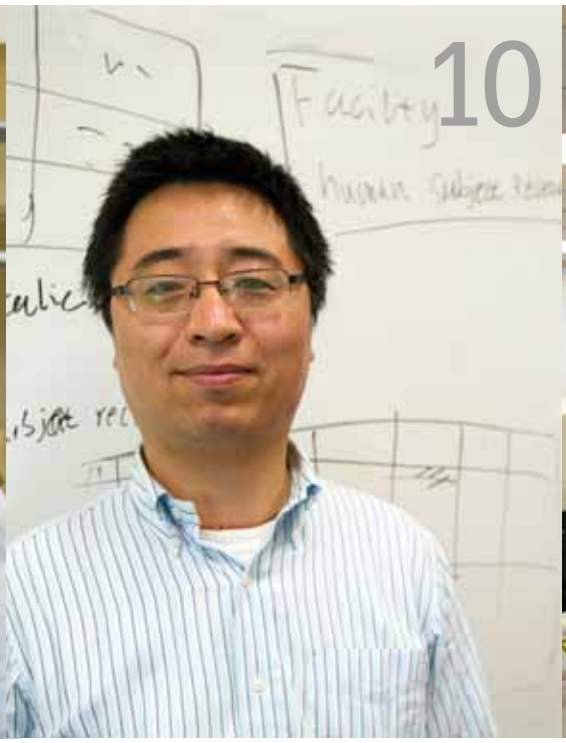


# Contents



ENGINEERING

*innovating our economic future*

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**ON THE COVER:** Allie Hayford of Cape Neddick, Maine, has interned three summers at Pratt & Whitney's North Berwick, Maine, facility. This summer, she was an engineering structures intern involved in engine testing. She is among the 80 percent of UMaine engineering students who participate in internships and co-ops as part of their academic experience. A related story is on page 14.

IT'S AN EXCITING TIME to be an engineering student at the University of Maine, and even more so to be an engineering graduate working in Maine and throughout the world. Students are studying renewable energy to innovate practical solutions to our energy challenges, including biofuels and offshore wind, as well as robotics, biomedicine and nanomaterials. Our students work with world-class research facilities, including the nation's first Cellulose Nanofiber Pilot Plant and the nation's first offshore floating wind platform. Future plans include a pioneering offshore wind-wave generating system.

The pathway from being an engineering student to an employee often includes at least one internship or co-op experience to help him or her along the way. At UMaine, we've been fortunate to have upward of 80 percent of our engineering students expand their knowledge, networking and team-building skills through internships and co-ops at top companies in Maine and beyond. We are very grateful for the opportunities that these companies provide our students. These solid internship experiences are part of the UMaine engineering brand, resulting in high demand for our graduates, with 97 percent reporting full-time employment or being full-time graduate students within six months of earning their bachelor's degree. In this issue, we take a deeper look at the students, faculty, alumni and employers who make our co-op and intern programs work.

Finally, we are proud to report record enrollment again this year, with more than 500 new students coming to UMaine Engineering. However, even further growth is needed so that Maine can reach the national average for per capita graduation of engineers.

As we continue to grow engineering enrollment and make pioneering advances through our research, it is critical that the university and the state of Maine invest in the faculty and facilities that are needed to meet the increased demands for engineering graduates and new products for businesses in Maine and the nation.

Dana N. Humphrey
Dean, College of Engineering

# Reverse technology

## Studies of smarter transportation could help drive improvements in pedestrian safety

TODAY'S AUTOMOBILES have gadgets once only found in James Bond's vehicles and the Batmobile, including a rear-facing camera and remote-controlled driving.

A University of Maine engineer says such technology can make transportation safer for both drivers and pedestrians, particularly children and the elderly.

**Each year, about 300 people in the United States die after being struck by vehicles traveling in reverse, according to the Insurance Institute for Highway Safety.**

Per Garder, a professor of civil and environmental engineering who has studied and promoted pedestrian safety, roundabouts and highway rumble strips, is now researching how to improve pedestrian safety using Intelligent Transportation Systems (ITS). ITS devices utilize communication technologies inside vehicles, from vehicle to vehicle, and between automobiles and infrastructure.

During his fall 2012 sabbatical at VTT Technical Research Centre of Finland, Garder conducted a case study on backup warning systems that alert drivers when pedestrians, children and objects are behind their automobiles.

It's a timely study. Each year, about 300 people in the United States die after being struck by vehicles traveling in reverse, according to the Insurance Institute for Highway Safety. In Maine, such a tragedy occurred in March when a father backing up a plow truck hit his 6-year-old son playing in the driveway. The boy later died.

According to kidsandcars.org, each week two people die and more than 50 — mostly children younger than 5 and adults older than 70 — are injured in accidents involving vehicles traveling in reverse. In about 70 percent of the crashes, the drivers are related to the people they hit.

While reverse sensor technology has been standard in motor vehicles in some countries for about a decade, that's not yet the case in the U.S. In February 2013, though, the National Highway Traffic Safety Administration mandated all U.S. automobiles have a rear-view camera by 2014.

The case study done by Garder, Lars Leden and Anna Schirokoff indicates if all vehicles had backup warning systems, these types of crashes would decrease from 60 percent to 80 percent.

**"It's clear we need to offer an acceptable level of convenience, efficiency, comfort, safety and security to pedestrians, but it is less clear if society will prioritize resources toward this."** Per Garder

In the study, traffic experts from several countries, as well as Finnish taxi drivers who operate vehicles with backup warning systems, and engineering students at Aalto University in Finland, were told that nationwide there would be 100 crashes involving vehicles without backup warning systems in three different scenarios.

With a backup warning system, the groups concluded approximately 40 percent of crashes would occur in the same situations.

In a second round of estimates, when participants received additional information about the system, the engineering students estimated 20 percent of crashes would occur. This estimated 80 percent improvement would translate into a reduction of fatalities in the U.S. from 300 to around 60 per year.

Garder says the research team will compare its case study data with actual crash data.

The researchers' findings are detailed in a draft paper, "Methodology to Assess ITS systems: Case Study Backup Systems."

Garder also recently conducted a study that asked experts whether additional ITS could be utilized so cities would be safer for child pedestrians.

In order to have a more sustainable society and a healthier populace, Garder says children need to be able to safely walk in cities, rather than be routinely bused or chauffeured.

Experts surveyed by Garder and the research team of Leden, Schirokoff, Hector Monterde-i-Bort, Charlotta Johansson and Socrates Babas, ranked 15 city transportation problems related to child pedestrians. Then they prioritized ITS services that might remedy the situations.

Among the 15 problems ranked in terms of importance: No. 2 was drivers not yielding to pedestrians in crosswalks; and No. 8 was operators not seeing children while driving in reverse.

Experts cited emerging use of in-pavement flashing lights that alert drivers they are approaching a crosswalk with people in it. Garder also pointed to Volvo's S60 model with pedestrian protection with auto brake. When traveling 19 mph or slower, the vehicle comes to a complete stop — without the driver using the brake — when a pedestrian is in the roadway in front of the car. Since 2011, Volvo has offered the system as part of its optional package in the United States.

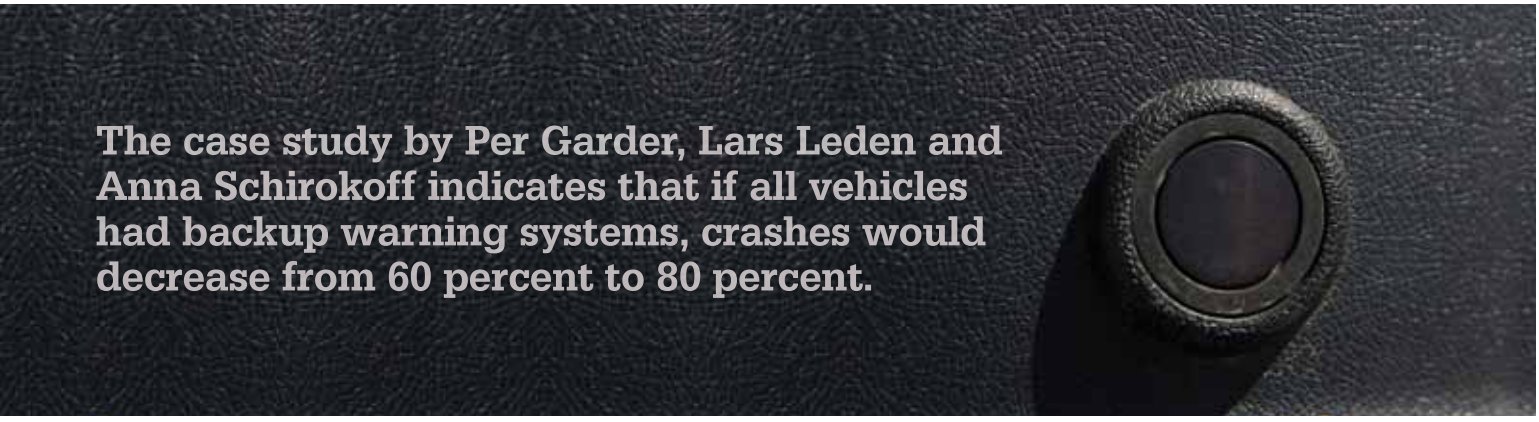
As for difficulty seeing children when driving in reverse, experts suggested a backup camera with sound alarm. Garder says the camera and alarm together are much more effective than each one is separately.

Experts added that children's safety shouldn't be dependent on technological devices. They said motor-vehicle operators should be fully accountable for their driving and not believe technology will bail them out if they drive distracted. They also said technological devices should not be substitutes for parental responsibility of child pedestrians.

"It's clear we need to offer an acceptable level of convenience, efficiency, comfort, safety and security to pedestrians, but it is less clear if society will prioritize resources toward this," Garder and his team wrote.

"Is ITS the solution to creating a safe city environment for children?" is the title of the draft paper. ■

**The case study by Per Garder, Lars Leden and Anna Schirokoff indicates that if all vehicles had backup warning systems, crashes would decrease from 60 percent to 80 percent.**



Backup sensor on a recent model Volvo

**Ph.D. student serves as VolturnUS design manager**

# Floating concrete ideas

GROWING UP in Cooper, Maine, Anthony Viselli worked in his father's masonry business, learning how to create and build with concrete. He became interested in the design aspect of construction and at the University of Maine, earned his bachelor's degree in civil engineering in 2006 and master's in 2008.

Viselli is now pursuing his Ph.D., and working as a full-time research engineer at UMaine's Advanced Structures and Composites Center. He is the lead design engineer at the center for a novel floating offshore wind turbine platform called VolturnUS, which combines a concrete hull with a composite tower. The design was demonstrated at one-eighth scale this spring off Castine, Maine, and Viselli is now leading efforts to design a full-scale offshore wind turbine.

"I worked for my father for years, working with concrete, and now I'm designing floating concrete hulls. It has been a full circle," he says.

The smaller-scale turbine, VolturnUS 1:8, developed by the UMaine-led DeepCwind Consortium, was launched in Brewer at the end of May and deployed off Castine in June. It is the first grid-connected offshore wind turbine to be deployed in the Americas.

Viselli is responsible for leading his team in the design of a cost-effective hull and tower to support the turbine, all of which must be able to endure extreme conditions off Maine's coast, including hurricane winds, large waves and icing.

"We work together to make that happen," says Viselli, noting that the team involves UMaine researchers and students, and more than two dozen companies, including Cianbro, a major partner in the project. "It involves the concrete hull, the composite tower, the anchoring systems, the soil conditions, wind/wave environment, instrumentation and the turbine itself. All those pieces have to be integrated and accounted for. We have an exceptional team here pulling together all these pieces."

Viselli says the research at the center is focused on designing floating platform systems for harnessing the resources that exist far offshore Maine and beyond.

Waters off the coast of Maine offer some of the best wind on the continent for producing energy. But placing a turbine offshore requires floating the device because of the water's depth. The floating offshore wind turbine is cutting-edge technology and being researched by only a handful of groups in the world. He says the university-led team is laying the groundwork for a possible commercial endeavor.

"We have a great resource offshore Maine and there's exists a huge market to sell that electricity down the coast," Viselli says. "Maine is close to huge population centers such as Boston, New York and New Jersey, which are expected to have increased demand for renewable energy sources in the future."

In addition to business opportunities, Viselli says Maine has the potential to capture this energy to help reduce the state's dependency on fossil fuels. Home heating systems and vehicles could transition in the future to take advantage of the steady offshore wind resource at competitive prices.

The one-eighth scale turbine deployed in June is paving the way for a full-scale unit now being designed. The goal is to eventually create an 84-turbine, 500-megawatt wind farm. ■

**"The construction of these units will be one of the largest construction projects taken on in this region. Each structure is enormous. The floating platform is over 120 feet tall, the tower is over 300 feet tall, and the turbine blades are each bigger than the wingspan of a Boeing 747."**

Anthony Viselli

# Devising devices

## An interdisciplinary approach to creating nanotechnology to improve biomedical applications

ROSEMARY SMITH originally enrolled in art classes in college, but was soon drawn to bioengineering. Today, the professor of electrical and computer engineering at the University of Maine regularly taps into her creative side to design and build analytical microinstruments.

Scientists use Smith's micro devices for a variety of applications — from biomedical to environmental to aeronautic. Improving public health is a priority for Smith, who is excited that two current research projects utilizing devices she built may help move medical science forward.

Scott Collins, a chemistry professor at UMaine, Greg Cox, associate professor at Jackson Laboratory, and Smith are leading one project researching neural stem cell differentiation.

The National Science Foundation (NSF) is funding the study that examines how these cells are triggered by specific chemicals to develop into motor neurons.

Smith and Collins have designed and built a "cells on chips" device, in which cells are exposed to various chemical combinations.

A similar microinstrument is being utilized in a toxicology research project that explores how mammalian cells are impacted by environmental toxins.

"We know what the lethal dose of arsenic is," she says. "But what about if it's present in combination with mercury? In Maine, we have naturally occurring arsenic, radon and mercury. What if they're all present in a home in levels that are considered to be safe independently? If they're all present together, are the levels still safe?"

The devices allow for simultaneous and parallel experimentation, and help speed up what can be tedious, time-consuming medical research, she says.

Smith began microfabricating devices at the University of Utah, where she earned her master's and doctorate in bioengineering. Her adviser, an electrochemist specializing in chemical sensing, tasked Smith with making the field-effect transistor-based devices for his other students to use in their experiments.

She and Collins also helped design the clean room micro/nanofabrication facility at the University of Maine. "It was a nice opportunity to put together a facility with a wide variety of capabilities," she says. "This facility is extremely flexible."

These days, semiconductor manufacturing methods are only some of the tools, which are part of an ever-growing toolbox to manipulate and create instruments at the nanoscale.

**It's difficult to predict beyond evolutionary technology — the regular progression of technological improvement — what discoveries might be on the nanotechnological horizon. What impacts us the most is revolutionary technology — disruptions that move us by leaps and bounds.** Rosemary Smith

It's difficult to predict beyond evolutionary technology — the regular progression of technological improvement — what discoveries might be on the nanotechnological horizon, Smith says. What impacts us the most is revolutionary technol-

ogy — disruptions that move us by leaps and bounds. That's the exciting part, she says — never knowing what's coming.

Consider, she says, in the late 1800s, that a New Yorker estimated that by 1930, manure from horses used for transportation would pile up to third-story windows in Manhattan.

Then automobiles were invented.

Or, she says, consider how the invention of computers has changed nearly everything.

"Scientific discovery is really exciting," Smith says. "It's what keeps me interested in research in a mix of disciplines."

As associate editor of the *Journal of Biomedical Microdevices*, Smith is up to date with other scientists' exciting discoveries as well. And she's adamant that budding future scientists become familiar with nanotechnology. To help ensure that, she obtained an NSF Nanotechnology in Undergraduate Education (NUE) grant to strengthen nanotechnology education at UMaine, as well as introduce it to area youth, from pre-K through high school.

At UMaine, basic concepts, applications and implications of nanoscale science and engineering are now introduced to all first-year engineering students. In addition, a College of Engineering minor in nanotechnology and an upper-level course in nanoscience have been added.

Outreach activities focus on increasing high school girls' interest in engineering careers with projects that apply nanotechnology to biomedicine and energy.

And Michael Mason, associate professor in chemical and biological engineering and a co-principal investigator on the NUE grant, regularly presents nanotechnology concepts to elementary and middle school students at Center Drive School in Orrington.

It's a logical introduction, Smith says, considering nanotechnology is part of their everyday lives — from sunscreen to lightweight, rugged bike frames and tennis racquets. ■

**Scientists use Rosemary Smith's micro devices for a variety of applications — from biomedical to environmental to aeronautic. Improving public health is a priority for Smith.**

**Research in quantum dot-based magnetic materials could lead to new nanotechnology applications**

# Attracting attention

ATOMIC MICROSCOPES are needed these days to see the trails that researchers blaze on the nanoscale science frontier. Robert Meulenberg, University of Maine assistant professor of physics, studies magnetism at the nanoscale level. With a $371,000 National Science Foundation grant, he's exploring how manipulating surface chemistry can produce unique magnetic properties in quantum dots.

His nanomagnetism research could lead to new uses for nanotechnology — building structures with atomic-level control. Meulenberg is searching for a breakthrough in quantum dot-based magnetic materials that might result in novel magneto-optical devices based on ultraviolet lasers.

**Robert Meulenberg is searching for a breakthrough in quantum dot-based magnetic materials that might result in novel magneto-optical devices based on ultraviolet lasers.**

At left: Ph.D. candidate Joshua Wright

For instance, he says, quantum dot-based magnetic materials could act as magnetic storage platforms (hard drives in computers) or as qubits (encoded information) in a quantum-computing device.

"A lack of comprehensive knowledge about magnetic behavior is often a major limitation in utilizing nanomaterials to their full potential," Meulenberg says.

UV lasers, which generate invisible light wavelengths, are commonly used for corrective eye surgery, dental procedures and electronics manufacturing.

Meulenberg, who is also a cooperating assistant professor of chemistry, conducts his research in the university's Laboratory of Surface Science and Technology (LASST), an interdisciplinary research center that brings together researchers from physics, chemistry, electrical and computer engineering, and chemical and biological engineering.

He frequently uses the $600,000 SQUID (Superconducting Quantum Interference Device) magnetometer for his research. The device, obtained with a NSF grant he wrote, is cooled with liquid helium and measures extremely small magnetic fields.

**"A lack of comprehensive knowledge about magnetic behavior is often a major limitation in utilizing nanomaterials to their full potential."** Robert Meulenberg

Meulenberg has been interested in nanoscience research since he was introduced to it in graduate school. "I enjoy trying to understand what happens to materials when you make them so small that you cannot even see them," he says. "It is the world of applied quantum mechanics, where those theoretical ideas learned in class actually take place."

Meulenberg is also excited about the research of UMaine students, including physics doctoral candidate Joshua Wright from Bavaria, Germany, and Ellsworth, Maine.

Wright's research, says Meulenberg, has added another knob at the nanoscale level to tune electrical properties of materials. Wright calls his discovery the orbital hybridization theory.

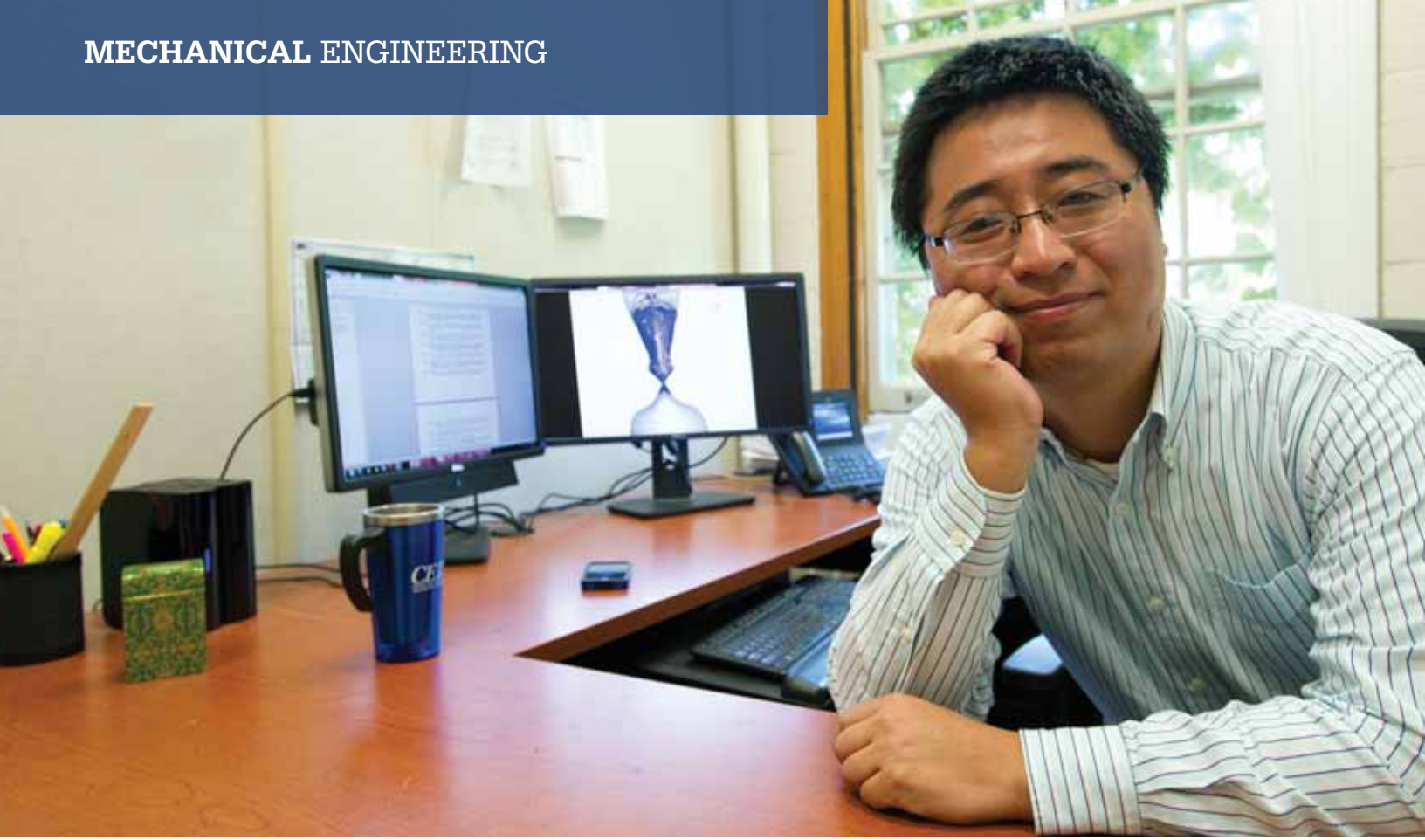
Wright's research involves chemical doping — a different variety from the chemical doping investigated in connection with Le Tour de France racers and Major League Baseball sluggers. Wright introduces chemical defects or impurities to pure materials to alter their properties, including copper to cadmium selenide, a semiconducting material. By adjusting the amount of copper added to a substance, Wright can determine the amount of energy required to make the substance conductive.

Wright has gone to Canadian Light Source Inc., Canada's national synchrotron research facility, and the Brazilian Synchrotron Light Laboratory to conduct his research, which was recently published in *Applied Physics Letters*.

After earning his doctorate at UMaine, Wright is considering postdoctoral research and work at a synchrotron facility.

Meulenberg also hails the efforts of junior Stuart Lawson of Wilton, Maine, who is majoring in physics and mathematics.

The graduate of Mt. Blue High School in Farmington, Maine, tests magnetic properties of dried film coatings of nanoparticles. The research, Lawson says, could yield benefits in the medical field, including cancer treatment. ■



# Biological flow

## Computational modeling of fluid dynamics hopes to advance human phonation research

WHEN IT COMES to the biology of the human body, Xudong Zheng doesn't think of flesh, bones, blood and organs. His mind immediately goes to a slew of fluid mechanics examples in action. Every biological flow in the body — from how the heart pumps blood to how voices are produced — fascinates Zheng, an assistant professor of mechanical engineering at the University of Maine. He hopes to use computer simulations to study how the human body works through the application of fluid dynamics.

One of Zheng's main research areas focuses on human phonation — voice production inside the larynx that results from a complex biomechanical relationship between glottal aerodynamics and vocal fold vibrations. He uses computer simulation of the fluid dynamics of human phonation to model both glottal aerodynamics and vocal-fold deformation and vibration, which can be challenging.

"We're talking about flow, solids and acoustics coupled together. It's very difficult to study those types of problems because everything is very complex," Zheng says. "It's not just fluid dynamics, but also solid dynamics."

As a child, Zheng had an interest in aerospace engineering and aspired to be the first astronaut in China. While studying thermal power engineering at the Beijing University of Aeronautics and Astronautics, he was introduced to fluid dynamics while working on a jet engine. In his Ph.D. research in mechanical engineering at George Washington University, Zheng renewed his interest in fluid dynamics

— this time in relation to human voice production.

"It's totally different but it has the same fluid dynamics," he says. "I started with rocket science and moved to biomedical science, but everything is related by fluid dynamics."

Zheng began studying human phonation in 2005 when Rajat Mittal, his adviser at George Washington University, received funding from the National Institute on Deafness and Other Communication Disorders (NIDCD) for a four-year project on human phonation.

According to NIDCD, 7.5 million people suffer from a voice disorder each year in the United States, and voice production research could lead to better healthcare and benefits for those affected.

The aim of the project was to improve the effectiveness of vocal cord implant surgeries by using a computerized simulation tailored for each patient.

People with vocal cord paralysis require an implant to correct the damaged cord and repair the voice. However, there is no one-size-fits-all implant for human vocal cords.

During the implant surgery, the patient is kept awake. The surgeon makes an incision in the patient's neck, inserts an implant onto the vocal cord, then asks the patient to match the surgeon's tone of voice to determine if the size or shape of the implant needs to be adjusted. The implant is removed, reshaped and re-inserted until the tones match. This constant stress on the vocal cords causes swelling that can skew results and be painful for patients, Zheng says.

"We're trying to build a high-fidelity computational model because we want simulation to predict for each person what kind of shape or size could be used for this type of surgery," Zheng says.

When the researchers began their study, there was no high-fidelity fluid simulation computer tool available, so Zheng and his team started from scratch.

"We didn't have enough tools or computational power when we started," Zheng says. "We waited seven years to finally do this."

By importing a CT scan into a computer program that uses biomedical imaging software, the researchers can create a geometrical reconstruction of the patient's vocal folds. The larynx model is then fed into the researchers' physics models, which includes tissues, fluids and acoustics to create a patient-specific simulation of human phonation.

Past human phonation research, especially collegiate studies, was too simplified due to the multiphysics nature and highly complex geometry of human airways, Zheng says. These studies on both fluid and solid mechanics advanced the understanding of human phonation, but lacked information related to the nonlinear coupling of the glottal flow and vocal fold tissue.

Zheng's team believes they have created the first flow-structure interaction modeling of human phonation in a patient-specific larynx model. This model allows the effects of geometry on vocal fold vibrations and glottal flow to be extensively examined for the first time, Zheng says.

In June, Zheng and his team successfully completed their first simulation on a patient's larynx. Working with doctors at Eastern Maine Medical Center in Bangor, Zheng hopes to soon complete a full computational model on 10 patients. Researchers would measure the flow, acoustics and vocal fold vibration of the patients and use them to validate the computer simulation that could be used for voice disease diagnosis and surgical planning.

**"It's important for fluid mechanics to finally merge into clinical applications."** Xudong Zheng

Zheng's team believes they are almost at the stage where they can apply these techniques in a clinical setting.

"It's important for fluid mechanics to finally merge into clinical applications," he says.

In the past decade, the understanding of human phonation has been enhanced by technological advances and new experimental techniques. Zheng hopes the computer simulation tool can be used with CT scans or MRIs for treatment and further understanding of all biomedical problems, including phonation, coronary flows and aneurysms.

"Using this model, we can also study other fundamental human phonation problems that have gone unanswered for a long time," he says. ■

# Five questions for Dick Hill

## The importance of a wet sock and other reflections

RICHARD C. HILL joined the College of Engineering faculty in 1946 with a degree in mechanical engineering from Syracuse University, four years of industrial experience in steam and gas turbine design with General Electric, and a passion for being "academically responsible and socially useful." In his nearly half-century of service to UMaine, he helped establish the rigorous academic inquiry and excellence of the College of Engineering, provided economic development leadership through the university's Department of Industrial Cooperation and contributed exceptional expertise at all levels of government. The people of Maine know him for his vast knowledge of energy-related topics that he enthusiastically shared for years via print and broadcast media.

**Professor Emeritus of Mechanical Engineering Dick Hill is as well known for his 46 years in the classroom and laboratory as he is for his public outreach efforts that tapped his expertise in energy.**

**How did you leave your mark on UMaine engineering?**

In my career at the university, I did a great deal of problem solving — from working with Maine Yankee and the State Fire Marshal's Office to testing fire extinguishers, and writing the exams for oil and solid fuel burner technicians. We were deeply immersed in the workaday world of the state of Maine. Then the federal government poured a great deal of money into engineering education after discovering that engineering is really a clumsy, old science (in the age of Sputnik), and they started graduate programs. About this time, grants and contracts also began to flow into the university. For two or three years, I handled the contractual paperwork. And I served as dean for two years.

**What was your favorite topic to teach — and why?**

I mean this seriously: watching a sock dry on the clothesline. You have several things going on. The air is in contact with the sock. Because of the evaporation of the water on the sock, the sock gets cold. The air contacting the sock gets cold and as it does, it increases humidity and the amount of moisture absorbed in the sock. That decreases the amount of heat transfer. At the same time, capillary action is pulling the moisture back up the sock again. So you can look and pinch the sock to see if it is drying from the top down or from the bottom up. You can match this heat transfer rate, the diffusion of water from the sock into the atmosphere, the temperature gradient of the boundary layer between the air and the sock, and see what effect this is having on the rate at which a sock dries.

This interest of mine has given rise to a lot of work that I've done. In the laboratory, I spent a lot of effort on this whole arena of understanding moisture migration in the atmosphere and the active condensation, mildew, etc. I built a lot of apparatuses so we could saturate the atmosphere and determine the dew point. I was very interested in that as a teaching device.

Similarly, I'm also very interested in the frost that appears on the windows. Why does frost appear the way it does? What is the physical phenomenon that differentiates frost from ice? That's a subject of interest to me because I've been an expert witness in several cases having to do with how this moisture migration causes mold and I have been hired to do this kind of research for attorneys. That entire idea of interaction between atmospheric moisture with its substrates is something that is of great interest to me.

**What's your favorite story about a student project gone awry?**

The present generation won't believe this at all, but one of the things we did was run a big coal-fired burner — a 200-horsepower boiler — that burned several hundred pounds

**"In my career at the university, I did a great deal of problem solving."**

of coal per hour. We ran it for 24 hours. Some students were assigned to measure the Orsat apparatus — the $CO_2$ in the stack. Some would weigh coal, some would shovel coal and some would measure the amount of steam power generated per hour. As the data emerged over 24 hours, the students would be putting down pounds of coal per hour, pounds of steam per hour, stack temperature, carbon dioxide concentration, etc.

One of the things the students had to do was fill a wheelbarrow with coal and weigh it. Another group of students shoveled the coal into the boiler. The faculty eventually noticed that the efficiency was not as good as it had been in the previous years. The $CO_2$ looked all right. Stack temperature seemed reasonable, as did pounds of steam per hour. We couldn't figure out what was causing the inefficiency. It turned out that those weighing the coal didn't subtract the weight of the wheelbarrow. Once we got that straightened out, everything proceeded reasonably.

**Advice to today's engineering faculty?**

Take field trips, be involved in the world.

**Advice to the next generation of engineering students?**

People with a liberal education can look at the world and see "connection" not discernible to others. The life of an engineer is also enriched by the ability to make connections. Why doesn't the hydrant burst as water freezes in the winter? The bricks in Little Hall have an essentially random color distribution, except around windows. Why is that? That discomfort when sitting by a window in the winter: outdoor air leakage, convection or radiation? To the engineer, the world is full of enriching experiences — like being able to distinguish between a Monet and a Manet. ■

Francie Foehrenbach earned a scholarship to UMaine and is now gaining hands-on training at Woodard & Curran.

# Being there

## Engineering students, alumni mentors know the difference internships and co-ops make in academic and professional careers

GROWING UP in Saco, Maine, Francie Foehrenbach was determined to figure out how things worked.

"I loved to build stuff and there was no toy that I hadn't ripped apart," says Foehrenbach, now a senior mechanical engineering major at the University of Maine.

She's resolutely pursued her interests and strengths. Foehrenbach learned AutoCAD (software application for computer-aided design and drafting) at vocational school and, prior to her senior year at Thornton Academy, she attended Consider Engineering — UMaine's Pulp & Paper Foundation's free four-day summer program on campus.

Foehrenbach earned a scholarship to UMaine and is now gaining hands-on training at Woodard & Curran, a 700-employee engineering, science and operations company that specializes in projects for municipalities, industries, colleges, real estate companies, and food and beverage manufacturers.

"It is the best experience you can have and the knowledge gained far surpasses any theoretical knowledge taught in a lecture," she says of the internship, which has led to a full-time engineering job at Woodard & Curran next summer.

**"Given how many companies come back year after year for more interns, they clearly like UMaine graduates."** Dana Humphrey

Dana Humphrey, dean of the College of Engineering, says a key priority of the College of Engineering is to connect students with meaningful internships.

"This allows students to apply their engineering skills in the real world and to 'test drive' a company to see if they would like to make their career there," Humphrey says. "Moreover, the companies get to 'test drive' our students.

"Given how many companies come back year after year for more interns, they clearly like UMaine graduates," Humphrey says. "Companies report that they have 80 percent long-term retention of UMaine engineers who started as interns. This is clearly a win-win for our students and employers."

And a lot of UMaine students are getting in on the action. In the UMaine College of Engineering, upward of 80 percent of undergraduates are involved in internships and co-ops as part of their academic experience.

UMaine senior Christopher Cronin is part of that 80 percent. He works a few cubicles away from Foehrenbach in Woodard & Curran's fifth-floor office overlooking downtown Bangor.

"Meeting other engineers, whether they have one year of experience or 30, is extremely helpful because I am able to learn something new every time," says Cronin, a civil engineering major and construction management minor.

The Canton, Maine, native has participated in a number of projects at Woodard & Curran, including sizing storm water pipes, working on erosion control plans, calling state agencies and assisting with the renovation of a building.

Sarah Lingley, a 2010 UMaine graduate who mentored Cronin last summer at Woodard & Curran, agrees with Humphrey that internships are beneficial for all involved. She interned two summers at Woodard & Curran before joining the firm full time after she graduated.

"The best way to get a job is for someone to remember your face (and) name," she says.

Internships give students "a chance to explore different areas of civil engineering to see if they have a preference that they would like to specialize in," says Lingley, who designs, does cost estimates, develops bid documents and oversees construction. "And maybe most important, it provides them with an invaluable networking opportunity."

**Matthew Edwards**

## Experiencing engineering

MATTHEW EDWARDS was involved in diverse electrical and computer engineering internships throughout his undergraduate and graduate student years at the University of Maine. Internships offer innumerable opportunities, he says. And perspective.

"Academics are very different than the industrial working world," says Edwards, a recent graduate working as a software engineer with Kepware Technologies in Portland, Maine. "Internships give you the opportunity to understand the value of what you're learning, and the chance to interact day-to-day with colleagues and bosses. You also get a lot of good feedback, and the results have tangible, real effects.

"The experience is what you end up remembering, and what you learn is more valuable than the money given."

Edwards, from Glenburn, Maine, majored in electrical engineering and was a teaching assistant in seven engineering classes. He also helped in the microelectronics lab and, in his first semester of graduate school, led the robotics laboratory.

Edwards was a member of the University Volunteer Ambulance Corps and UMaine's Senior Skulls honor society. And he sang bass in a number of campus groups, including University Singers.

After his first year at UMaine, Edwards spent the summer as a project engineering intern with Sappi Fine Paper in Skowhegan, Maine. He worked with more than a dozen project engineers responsible for installing machines and process oversight.

"It was overwhelming in a good way," he says. "I was handed way more responsibility than I expected, including responsibilities for projects that cost $10,000 and helping with million-dollar projects. It was great. I loved it. It gave me an idea of what's expected of me on graduation — the responsibilities of engineering in the future."

In his next project, funded as part of a National Science Foundation Research Experience for Undergraduates program, Edwards worked with UMaine climate scientist Sean Birkel in the Climate Change Institute. Edwards assisted with coding the Climate Reanalyzer, (cci-reanalyzer.org) an online software program used for visualizing climate and weather forecast models. His key contributions included porting MATLAB scripts to C, and developing an HTML/PHP interface template.

In 2011, Edwards received his undergraduate degree and launched his graduate research focused on a power industry-related project involving intense computation and streamed data of synchrophasors.

In summer 2012, Edwards was in Dayton, Ohio, for an internship with LexisNexis Special Services Inc. As a software design intern for the 10-week stint, Edwards focused on big data and visualization of identity resolution designed to understand the relationships between people.

"This built on my prior skills, but there also were specific subsets I used," Edwards says of his third internship. "You leave understanding much more about a specific process. Then, in another internship, you drill down in another direction," learning even more.

Mentors benefit, says the Machias native, because in addition to getting help with their workload, they share knowledge they've amassed with interns who are eager to learn.

"It really makes the mentors reflect on how much they have learned since school," says Lingley. "Also, in my experience, interns have open minds as they have not necessarily been taught how to do everything yet, and when allowed the opportunity, can find better ways to execute tasks than the sometimes old-fashioned way things are typically done."

And, Lingley says, internships are a marketing tool for companies seeking to hire the best and brightest prospects. "If the students have a great internship, they talk about it at school, and nothing is better than word-of-mouth marketing," she says.

"It takes time and effort to make an internship valuable, but it is worth it for both parties in the end. The intern I mentored worked out so well that he came back again this year."

Nathan McLaughlin, Cronin's mentor this summer, is glad Cronin returned. "Chris is a good example of the quality product UMaine produces," says McLaughlin, a 1998 UMaine graduate from Old Town. "We're lucky to have him. He's going to be a great engineer."

Internships give companies the chance to "test drive potential new hires," says Cindy Daigle, a 1997 UMaine grad and process engineer at Texas Instruments in South Portland. "The program also builds bridges between schools and industry, allowing two-way continuous improvement of curriculums," says Daigle, who majored in chemical engineering.

**Woodard & Curran engineer Nathan McLaughlin, left, reviews plans with University of Maine senior Christopher Cronin, an intern at the firm's Bangor, Maine, office.**

**Lacie Kennedy, left, a 2002 University of Maine graduate and plasma etch process engineer at Texas Instruments in South Portland, listens as 2013 UMaine graduate David Hart talks about his previous internship at TI, where he was recently hired as a test engineer.**

# Rooted in Maine — and soaring

WADE MAYNARD, who grew up in Washburn, Maine, and Terence Tyler, a native of Phillips, Maine, get a boost when they see aircraft streaking across the sky. The University of Maine graduates know the engines they manufacture at Pratt & Whitney are powering the flight.

As business unit manager at the North Berwick, Maine, facility for the global aerospace manufacturer, Maynard is responsible for all metrics, including safety, quality control, customer delivery and satisfaction, incorporation of new products, cost reduction and budgeting.

As a design engineer of components for high-pressure turbine engines, Tyler, a 2005 alumnus with a degree in mechanical engineering technology, works on innovative products and cutting-edge technology.

Thomas Clark, design engineer in Pratt & Whitney's Turbine Module Center, also grew up in Maine. He graduated from UMaine in 2012 with a degree in mechanical engineering and a minor in mathematics.

"In my roughly one year at Pratt & Whitney, I have created new designs of turbine cooling tangential injectors and rear bearing compartments, improved existing military turbine vanes through engineering changes and optimized existing designs using analytical software," he says.

"I also appreciate my responsibility, even as a relatively new employee, to make critical design changes and provide engineering inputs on the next-gen military Adaptive Engine Technology Development (AETD) program for both turbine and mechanical systems components."

Maynard, a 2000 graduate, returns to his alma mater to recruit for Pratt & Whitney. When he evaluates the resumes of candidates, he notes whether they have internship experience.

"Employers like to see that students are taking their career choice seriously and are making an effort to learn more about it through real-world experience," he says.

The bottom line, says Maynard, is that real-world experience sets students up for a full-time job. "I think co-ops/internships should be mandatory. All of the high school students I talk to ask me about what they need to do to secure a good job," he says. "My first suggestion is to start internships early and get as many meaningful assignments as possible before graduation."

That's why Allie Hayford of Cape Neddick, Maine, has interned three summers at Pratt & Whitney. The UMaine mechanical engineering senior plans to pursue a career in the aerospace industry and earn a master's degree in mechanical engineering.

The York High School graduate's first two internships at Pratt & Whitney were in the manufacturing department. This summer, she was an engineering structures intern.

"I have had many opportunities to get exposure to new environments, and apply knowledge and be challenged in many different subjects, ranging from chemistry to mechanical vibrations," she says.

"My work has focused primarily around the PW1100G-JM geared turbofan engine currently in development for the Airbus A320 NEO aircraft. I have contributed to airfoil design and processing strain gage measurements from these airfoils taken during engine testing."


Wade Maynard


Terrence Tyler


Thomas Clark


Allie Hayford

Students, she says, see how textbook learning applies in the real world and can be motivated to take specialty classes when they return to school. "It's also a chance to start building a professional network," says the Madawaska native.

Lacie Kennedy interned at National Semiconductor (now Texas Instruments) when she was majoring in chemical engineering at UMaine. Since graduating in 2002, Kennedy has worked as a plasma etch process engineer at Texas Instruments, a global semiconductor design and manufacturing company.

"Having internships during college helped confirm that I had made the right choice in my major, and also really improved my confidence level for entering the workforce after graduation," she says. "I knew that I'd be able to get to work right away and make a contribution to the company because I already had a lot of training behind me."

And, she says, nothing tops being around other engineers. The College of Engineering felt like one big family," says the graduate of Deering High School.

"It was helpful living on an engineering floor in my dorm the first two years because I was around people who understood my workload, and it was easy to work on projects together and form study groups. Eleven years later, most of my closest friends are people I met at UMaine in engineering classes."

Kennedy says a similar sense of cooperation exists with her co-workers. "You might not think of engineering as being a very social job, but at a 24-7 manufacturing facility, it is. We constantly have to work with other engineers, manufacturing technicians and equipment technicians in order to solve problems," she says.

"My group, in particular, has a wonderful camaraderie

**"Having internships during college helped confirm that I had made the right choice in my major, and also really improved my confidence level for entering the workforce after graduation."** Lacie Kennedy

and we help each other out every single day. TI really promotes teamwork across sites, so I've had the chance to work with groups from Texas, Japan and Europe."

Each year, UMaine's Engineering Job Fair affords students an ideal opportunity to make connections with firms seeking interns and employees. In 2012, more than 900 UMaine students and nearly 80 companies attended the event. The fair's popularity has increased exponentially since the inaugural fair in 2000 when 83 students and 13 employers participated.

"Many of the employers who participate in the Engineering Job Fair are alumni of the University of Maine and they enjoy returning to Orono to recruit new talent for their organizations," says Patty Counihan, director of the UMaine Career Center.

"In fact, we now have participating employers who lined up their first jobs with their companies as a result of attending the Engineering Job Fair when they were UMaine students. Their participation has gone full circle, from being a job-seeking student to being a hiring manager or recruiter for their company."

David Hart, a 2013 UMaine graduate and a full-time test engineer at Texas Instruments, says attending the Engineering Job Fair was instrumental for him to secure an internship, then a dream job.

"Fall semester junior year, I was taking Electronics I, which was my first in-depth course in semiconductor fundamentals," says Hart. "I enjoyed the material, which began to interest me in the semiconductor industry."

At the Engineering Job Fair, the Portland, Maine, resident met Kim Millick, a former Texas Instruments human resources manager. Hart handed her his resume, an interview followed during a school break and he was hired for an internship that summer.

"An internship is a great opportunity for you to get your foot in the door with a company. It may also help you figure out what you do and don't like, as well as where you may want to work in the future," says Hart.

"Interning was a great opportunity for me to become familiar with technical things and people I am now working with in my full-time job. It also helped me understand how a large company works, which made the transition into my full-time job that much easier."

The 2013 Engineering Job Fair is in October at the New Balance Student Recreation Center. ■

James Knapp

## Getting the right fit key for Knapp, Pratt & Whitney

A PRECISION FIT is imperative for Pratt & Whitney, a worldwide leader in the design, manufacture and service of engines for military and commercial aircraft. University of Maine graduate James Knapp, a design engineering manager at the company's facility in North Berwick, Maine, relishes that responsibility.

"I have a dozen design engineers working for me and I'm responsible for ensuring their solutions are technically viable and affordable. We provide cradle-to-grave service in the aviation industry for various gas turbine hardware components," says Knapp, adding that service ranges from initiating concepts through developing repairs.

His favorite part of the job is finding talented engineers who are a good match with the company. "I like recruiting and finding employees that are highly motivated, energetic and technically savvy," he says. "My job is to make sure they are put in the right job and have the proper tools to be successful. I enjoy empowering people."

Toward that end, Knapp's group has hired 11 UMaine graduates in the last three years to work in the company's engineering center in North Berwick. The center, says Knapp, has grown from approximately 30 in 1996 to more than 120 today. The North Berwick facility employs approximately 1,300 people; worldwide 33,000 work at Pratt & Whitney, serving 11,000 clients.

Knapp says UMaine students have what it takes to be working with game-changing technologies for the company whose engines power a quarter of the world's commercial passenger fleet and 29 armed forces.

"I find they're very well prepared for their jobs," Knapp says. "They've learned engineering theory really well and they have a willingness to do what it takes to get the job done."

Internships, Knapp says, are valuable, in that they bridge the theory that students learn in class with real-world applications of designing jet engine hardware. "The hope is that they enjoy their time with us and decide to pursue a career in the industry," he says.

The 1992 graduate of Mt. Abram Regional High School was motivated to pursue a career in the industry because of his interest in movement. "I always wanted to get into transportation — automobiles, planes, trains — things that convert fuel to power and power to motion," he says. "UMaine was the obvious choice. It's an in-state school with a great reputation."

As a student, Knapp appreciated hands-on learning in mechanical engineering labs as well as the size of UMaine. "It was as big as you wanted it to be and as small as you wanted it to be," he says. "There were lots of opportunities and yet you got to know most everyone in your classes."

# Researching undergrads

## New fellowships fund the explorations of six engineers of tomorrow

SIX STUDENTS FROM the University of Maine's College of Engineering have been awarded Center for Undergraduate Research Fellowships for 2012–13.

The fellowships were developed to enhance and increase undergraduate student involvement in faculty-supervised research, and are supported through a PRE-VUE grant awarded by the University of Maine's President's Office. Each fellowship provides a $1,000 award for the student, and up to $1,000 in more funding, if needed, to cover costs associated with the project.

The students' research areas involve a variety of engineering topics — from studying extreme rainfall and climate change to optimizing power conversion for wave energy converter systems.

**Center for Undergraduate Research Fellowships awarded to six engineering students support work that ranges from studying extreme rainfall and climate change to optimizing power conversion for wave energy converter systems.**

### MICHELLE BEAUCHEMIN

**Graphene potential:** A sophomore in engineering physics with a concentration in electrical and computer engineering, Beauchemin is researching a graphene-based electrochemical sensor. Her research focuses on graphene's electrical characterization and its potential for use in single-molecule sensors. Graphene is a single-layer graphite — a hexagonal lattice of carbon atoms — and has properties of high conductivity and strength that give it potential in the area of electronics. Beauchemin has produced graphene, and hopes to identify it optically and electrically. She plans to test its possibility as a sensor for nanopore DNA encoding research by her adviser, electrical and computer engineering professor Rosemary Smith.

**Building skills:** Beauchemin says the fellowship has given her the opportunity to work in a lab with faculty she admires, and has helped strengthen her research and laboratory skills. "I work in the Laboratory for Surface Science and Technology (LASST) in Barrows, and there is a lot of intimidating equipment there, but Dr. Smith has been there to answer all my questions and assist me when needed," Beauchemin says. "There are times at which I feel less experienced than the graduate students I work with, but I feel lucky to begin building my skills as an undergrad, so when I go to grad school, I will be well-prepared for research."

**Engineering Expo:** Beauchemin, from Saco, Maine, cites UMaine's annual Engineering Expo in Gorham and Orono as the springboards for deciding to study engineering at UMaine. "It is a great display of the diversity of programs at the school and is a great way to get children interested in science and engineering," she says. "I have always loved math and science, and engineering is a great way to apply my interests."

**Future plans:** Graduate school for electrical engineering is in sight for Beauchemin, who is interested in solid state physics and semiconductors. She hopes to work in the field of semiconductors.

### MICHAEL DANDY

**Extreme rainfall:** A sophomore in civil and environmental engineering, Dandy is working on climate change adaptation for his research project, "Extreme Rainfall in a Changing Climate: Developing New Methodologies to Inform Infrastructure Design." He is analyzing past extreme precipitation and hurricane data for the East Coast, and is writing computer programs to help predict future extreme flood events to inform better infrastructure design.

**Challenging himself:** The Los Angeles, Calif., native chose

Michelle Beauchemin

Michael Dandy

engineering because he has always excelled at math and likes a challenge. "I enjoy challenging myself with course material that interests me," says Dandy, noting that he chose UMaine for its reputation as an engineering school.

**Pursuing research:** Dandy says the fellowship gives him the opportunity to pursue research in the field that he finds most interesting. "It is very interesting to observe the entire process involved, and see everyone's input toward a project," says Dandy, who works with civil and environmental engineering professor Shaleen Jain. Dandy has presented his research at the National Council for Undergraduate Research Conference in LaCrosse, Wis., and published a research article.

**Graduate school:** Dandy plans to study water resource engineering or hydrology in graduate school.

**KYLE NOLAN**

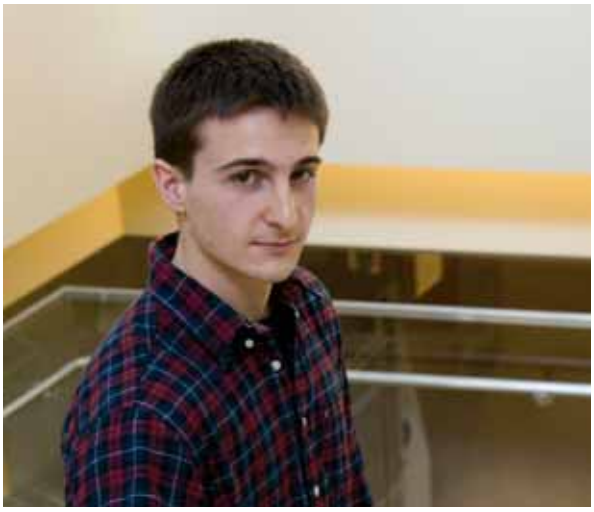
**Genetic sequencing:** A sophomore in electrical and computer engineering and student in the Honors College, Nolan has been working on a nanopore gene sequencing project in the Microinstruments and Systems Laboratory. "Our objective is to translocate single-stranded DNA through a nanopore and electrically identify individual nucleotides as they pass through," Nolan says. "If we could fine-tune the process well enough, it has potential to replace traditional methods of genetic sequencing, as it is a faster and cheaper alternative to current commercial approaches." Nolan says the bulk of his research has been in "optimizing the recipe we use to make the carbon nanoelectrodes for our electrical measurements."

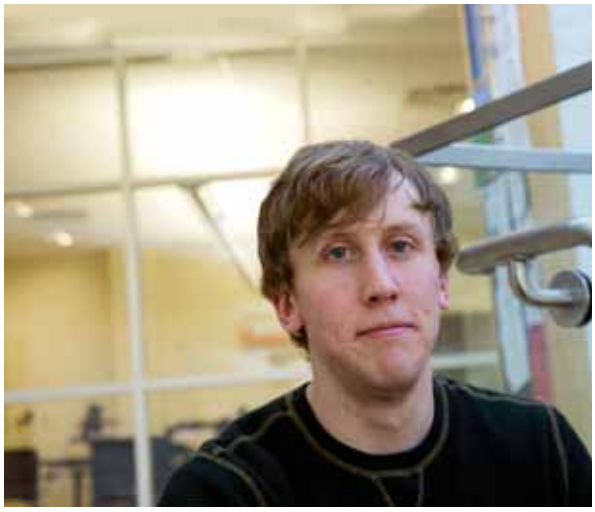
**Invaluable asset:** Nolan, from Camden, Maine, says he did not imagine that he would have this kind of opportunity to do research as an undergraduate. "I was excited to earn a lab position here at the university, pleased with the cutting-edge facilities and meaningful projects, and thrilled to subsequently receive a research fellowship," he says. "It has been an invaluable asset to my research, and I greatly appreciate the opportunity." He says research has been "an enjoyable, meaningful way to work during the summer and supplement coursework during the academic year."

**Combining strengths:** When deciding where to attend college, Nolan knew he wanted a school with a solid curriculum and scholarship opportunities. "With UMaine's renowned engineering program, merit scholarships and research positions, it offers a great balance between quality education, professional opportunity and affordability," Nolan says. Nolan views engineering as a chance to learn interesting, dynamic material while combining his strengths. "It is a discipline where I can combine my natural creativity with my knack for science and mathematics, and the way engineering continues to be shaped by — and to evolve with — the modern world, ensures that it stays relevant and integral to our society," he says.

**Role models:** Nolan says his research would not have been possible without the guidance of Institute for Molecular Biophysics research engineer Justin Millis and Professor of Electrical and Computer Engineering Rosemary Smith. "Justin has shown me the ropes in the clean room and consistently provided great project advice," Nolan says. "Rosemary always manages to find the time and the patience, despite her busy schedule, to sit down with me and explain the answers to all of my questions."

**Continuing education:** Nolan says he plans to attend graduate school after completing his undergraduate studies. "I strive





**Kyle Nolan**
**Anthony Nuzzo**

to become the best engineer I can be, and after graduate school will probably look to move into industry," he says. Nolan says he is interested by both the electrical and computer aspects of his major, but sees himself leaning toward computer engineering.

**ANTHONY NUZZO**

**Power conversion:** A senior in electrical engineering, Nuzzo is working on optimizing power conversion for wave energy converter (WEC) systems. He has been designing printed circuit boards that will be used with a mechanical prototype WEC designed by the Mechanical Engineering Department. Nuzzo's work, which involves converting DC power to AC power using an inverter he designed, will help convert power produced by WEC, as well as control it to optimize system performance. The research is an example of multiple departments at UMaine working together to find new methods for harnessing renewable energy resources, Nuzzo says.

**Practical experience:** The fellowship has helped Nuzzo gain practical experience in the power electronics field. The Litchfield, Maine, native says, through the fellowship, he has been able to develop significant skills in printed circuit board design that are essential for his engineering work.

**Early fascination:** Nuzzo says he chose to study engineering because he has always been interested in building. "I've known since I was young that I wanted to study electrical engineering because it would allow me to understand how all my toys — that I took apart — worked," Nuzzo says. Nuzzo has since become interested in renewable energy and he sees electrical engineering as a key to innovation in that area. He chose to study at UMaine because of its "well-regarded engineering program and its financial benefits for Maine residents."

**Difficult but rewarding:** Nuzzo, who has been working with electrical and computer engineering professor Nathan Weise, says research as an undergraduate is a fun, different type of work than what you do in the classroom. "Working on research between classes can be difficult but also rewarding," Nuzzo says. "I enjoyed working closely with my professor and learning the tricks of the trade rather than working problems from a book."

**Working in the field:** After graduation, Nuzzo says he will be working full time at Pika Energy, a start-up company in Gorham, Maine, where he interned last summer and learned about inverter design.

**BIPUSH OSTI**

**Improving usability:** Osti, a junior in computer engineering from Kathmandu, Nepal, is researching alternative ways to interact with visualizations walls. Visualization walls are made up of many monitors that act as a single monitor and are usually used to display scientific data. Osti's research mainly involves using Microsoft's Kinect to find alternative input devices in place of a mouse or keyboard. "Since the total screen size of visualization walls is big, using a keyboard or mouse would mean that the user would have to stay close to the screen and would not be able to see much because of the size of the wall," Osti says. "This creates a need for a different kind of input device that allows users to easily navigate the huge screen as would a mouse in a single-monitor screen." Osti says the plan is to build a wireless device for users to navigate the walls.

**Bipush Osti**

**Carolyn Pugliano**

**Solving problems:** Osti says he has long been interested in computer programming and creating things that would solve problems. He transferred to UMaine from a Tennessee school during his first year because of the College of Engineering's well-known academic programs. "I felt that I would get more opportunities and greater exposure here," Osti says.

**Valuable experience:** Osti, who has been working with electrical and computer engineering professor Bruce Segee, says the fellowship has allowed him to learn a lot beyond the classroom through research as an undergraduate.

**Implementing knowledge:** Osti is undecided about his plans after graduation. "I would love to work on something interdisciplinary that requires implementing my knowledge of engineering in a different field like medicine or chemistry," he says.

**CAROLYN PUGLIANO**

**Detecting explosives:** A junior in electrical engineering from Nashua, N.H., Pugliano is researching the optimization of a lateral field excited (LFE) sensor that she hopes will be able to detect peroxide-based explosives. "An LFE sensor is basically a wafer of AT-cut quartz crystal with electrodes deposited on one side, leaving the other side of the crystal bare," she says. "The electrodes excite the crystal's transverse shear mode with an electric field. Using equipment like a network analyzer, the crystal's response can be measured. The response can be affected by the environment, such as gases and liquids that come in contact with the bare surface. This indicates that the LFE device may be sensitive enough to detect the gases emitted by dangerous chemicals." Pugliano also is working to find a new method for measuring the LFE device's response.

**Strength to persevere:** "The fellowship means that other people believe in me and my research, which is encouraging," she says. "While research can be exciting, it can also be frustrating. When I am frustrated, I remember that there are other people who have faith in me, and it gives me strength to persevere."

**No place like UMaine:** The Electrical and Computer Engineering Department is what drew Pugliano. "I visited several places and none of them really compared to UMaine," she says. "UMaine has a lot of great opportunities, a beautiful campus and an impressive College of Engineering."

**Real-world applications:** Pugliano chose engineering because it's a challenging yet rewarding field that gives her the opportunity to solve real problems and improve the lives of others. "Also, I can't say no to those big engineering paychecks," she says, adding that undergraduate research "isn't just about getting paid, it's about applying knowledge from the classroom to real-world problems."

**Helping hand:** Pugliano says she has been working closely with her adviser, electrical and computer engineering professor John Vetelino. "I started doing research for him in summer 2012 in the National Science Foundation Research Experiences for Undergraduates (NSF-REU) program," she says. "Dr. Vetelino has been a wonderful adviser and has given me many opportunities."

**Teaching others:** After graduation, Pugliano plans to gain experience by working with companies before returning to school to obtain her doctorate in electrical engineering. Her long-term goal is to become a professor. ■

# Team sport

**"I feel very strongly that we are supposed to learn something from every person that we meet. I could be doing a much better job at this, but I have really been inspired by some wonderful people since 1985."**

Calen Colby

CALEN COLBY graduated from the University of Maine with bachelor's and master's degrees in civil engineering in 1985 and 1991, respectively. He spent the first part of his career overhauling SSN-594 and -637 class nuclear attack submarines. For 15 years, Colby worked for a national contractor designing power plants, and then was in project management in the paper industry in the United States and Europe. In 2008, he and his wife Sarah founded Colby Company Engineering, a Portland, Maine-based firm specializing in structural, mechanical, electrical and civil engineering.

**Biggest challenges in your field?**

Getting things built — roads, buildings or other things — is a team sport. There is little room for ego in a profession that purports to have the public's safety as its primary mission. The best projects I've worked on were the ones on which the team truly collaborated to create a great end product. I would like to see more collaborative efforts and more acknowledgement of the entire team that makes a good project come to life. In addition, it's important to remember that good design still requires a certain amount of time to complete correctly; it is worth writing twice. The challenge in this area of our profession is to make sure that we make the time.

**Why UMaine?**

I applied for "early decision" at MIT and visited three other colleges, but as soon as I arrived at Orono, I knew it was going to be great. Take a look at the companies that come to UMaine to interview graduating students. When I graduated, the Los Angeles County Highway Department came every year; they said that Maine engineers have a much better work ethic than they have found elsewhere. If you know where Los Angeles is, you'll quickly recognize that there are a lot of solid engineering schools in "elsewhere." If that alone does not convince you, you'll be very amazed and very impressed by the professors, curriculum and research.

**What kinds of research were you involved in as a UMaine student?**

My graduate work was a study of Maine's first integral abutment bridge. I performed a detailed structural analysis of the bridge, located on State Route 201 in the Forks, and then I designed a data acquisition system to collect data in support of the computer model. My undergraduate research consisted of skateboarding in the stairwells of Hancock Hall and one attempt of the roof of Alfond Arena. This research remains undocumented except for one photo in the yearbook.

**While in Orono, I spent too much time:**

Freshman year: skateboarding; result: academic probation. Sophomore year: running NCAA cross-country; result: academic probation. Junior year: studying; result: Dean's List. Senior year: studying; result: Dean's List, Chi Epsilon, Civil Engineering Senior of the Year (1985), President of ASCE Student Chapter, first place in Concrete Canoe Race.

**Class that nearly did you in?**

In graduate school, I nearly failed Advanced Structural Dynamics. This means you don't get to come back (no more free college). I nailed the final preliminary examination. Professor Mohammed Elgaaly announced to the entire class as he was handing back the corrected exams that he had been worried about me flunking out. Like most folks, I prefer my humiliation in a more private setting.

**How does UMaine still influence you?**

The ability to solve problems of almost any magnitude sets this education apart from anything I have experienced. UMaine taught me to never stop learning. I visit the campus almost every year at least twice and I am always inspired by the research being done. ■

**Collaboration key to alumnus Calen Colby's success**

# Managing energy

## Training stresses environmental and cost efficiency around the globe

SCOTT DUNNING is no stranger to the bright lights of the Las Vegas strip. And the pumps that power the majestic water fountains. And the casinos' air conditioning and ventilation systems.

As an energy management expert, Dunning isn't trying to dim the glitz and glamour, just make it as environmentally and economically efficient as possible.

"As technology has changed, there's a need not only for engineers but also technicians and workers on the floor to be trained to spot where there are opportunities to save energy," says Dunning, director of the University of Maine School of Engineering Technology and one of six instructors in the Association of Energy Engineers (AEE) training for certified energy managers. "For instance, in the economic downturn, revenue for the Las Vegas casinos has been down and they're looking to increase income by decreasing cost. The AEE course for building technicians trains them to recognize where to reduce energy costs."

For the past 12 years, Dunning has provided AEE energy management training the world over, teaching short courses — many of which he's developed for AEE — from Tokyo and Hong Kong to Milan, Dubai and throughout the United States. Whether training maintenance personnel or professionals in commercial and industrial energy auditing, the key is managing energy costs. That involves investments in energy-efficient equipment and following operation and maintenance best practices.

**"Energy management is a practical engineering discipline. A manufacturer may be an expert in making that product, but isn't necessarily an expert in using energy, and may be using more energy than needed."** Scott Dunning

"Energy management is a practical engineering discipline. A manufacturer may be an expert in making that product, but isn't necessarily an expert in using energy, and may be using more energy than needed," says Dunning.

Power systems optimization and the application of energy-efficient technologies to industry have been Dunning's focus since joining the College of Engineering faculty in 1991. He is an electrical engineer by training, earning his bachelor's, master's and Ph.D. from UMaine.

In 1993, Dunning led the Industrial Assessment Center at UMaine, an energy analysis and diagnostic initiative funded by a $1.4 million, seven-year grant from U.S. Department of Energy. The center performed annual energy audits for 25 Maine companies — small and medium size manufacturers such as sawmills and tanneries with energy bills ranging from $100,000 to $1.7 million a year — in an effort to help them reduce energy costs, improve productivity and minimize waste.

Working closely with these manufacturing companies gave Dunning and other UMaine engineers insights into how to also help improve efficiencies with better production tools and prototype development. That was the impetus for UMaine's Advanced Manufacturing Center, which opened in 2002 and moved to a new facility in 2004, built with the support of a research and development bond approved by Maine voters in 2002.

Dunning was the founding executive director of the Advanced Manufacturing Center, serving until 2007. Then he again turned his attention to energy management, this


**As an energy management expert, Dunning isn't trying to dim the glitz and glamour, just make it as environmentally and economically efficient as possible.**

Photo by Nikki Villoria

time in training professionals in the field and producing educational materials.

He developed his first short course in 2001 as part of a certified energy manager program sponsored by AEE. His role in training evolved from serving as an instructor to developing curricula content and, ultimately, to chairing AEE's testing committee that oversees the four-hour certification exam that culminates 36 hours of energy management instruction.

Dunning has developed five AEE certification courses for energy managers; building energy and sustainably technicians; masters-level and international energy auditors; and government operators of high-performance building. He also has written three books, including co-authoring the most recent edition of *Plant Engineers & Managers Guide to Energy Conservation.*

In Maine, Dunning does commercial energy audits for the Efficiency Maine Trust, and this spring he led an AEE technical meeting of natural gas distributors statewide to talk about the future of the industry.

"Technology changes and we have to continually update material to keep up," says Dunning of the training he develops. "In 2001, LED lighting didn't exist much; today, it's the lighting of choice for energy efficiency. We have to keep the courses relevant, continually introducing new material. Currently, we're investigating different testing equipment and what works best."

From Dunning's perspective, energy management is not just efficiency in production, or effective heating and cooling. Efficiency begins with an understanding of what energy costs — even the labor to replace a lightbulb.

"People come to energy management because it can save them money, but it's really about doing the right thing for our future," Dunning says. "We can save energy without changing convenience or lifestyle, using energy in the most optimal, efficient way." ■

# Value added

## The potential of problem solving is realized in product development

MOST RESEARCH LABS are meticulously clean and monitored. That's why University of Maine Chemical and Biological Engineering Professor David Neivandt has two of them. One is a high-end, high-tech laser lab for model cellular membrane work. Then there's his "dirty lab," a cramped room with almost no free counter space, full of computers and noisy equipment coated with a dusty film where he "can play with lignin and lobster shells."

In his research, the professor of chemical and bioengineering focuses on the determination of the interfacial orientation and conformation of protein and lipid species, including transport across cell membranes; and the gelation, dispersion and phase separation of natural and synthetic polymeric species. He's also the newly named director of UMaine Graduate School of Biomedical Science and Engineering.

Neivandt's work with protein transport aims to shed light on how cell membranes interact with certain proteins. Understanding the process could lead to the design of therapeutics that could control diseases, such as cancer and Alzheimer's, he says.

And then there are the myriad of side projects, including lobster shell golf balls, clam shell hatcheries for lobster larvae, and curricula design for UMaine and area middle schools.

Neivandt, who earned his B.S. and Ph.D. in chemistry from the University of Melbourne in Australia, realized after earning his degrees and working in the field that solving real-life problems was his passion. That's when he turned his sights to engineering.

"I think that if I had stayed in pure science, I would have eventually gotten frustrated," he says. "So a lot of the work I do is product development.

**Undergraduate student Haylea Ledoux collaborates on research with professor David Neivandt.**

**"A lot of the work that I do is product development. I think that's really where the fun is. You can take a real problem and tackle it, to generate a solution that potentially has utility."** David Neivandt

"I think that's really where the fun is. You can take a real problem and tackle it, to generate a solution that potentially has utility."

Many of his projects have crossed the bounds between scientific areas. Doing a lot of work with the university's Forests Bioproducts Research Institute (FBRI) "marries the realms of chemical engineering with bioengineering," Neivandt says. Most recently, Neivandt has been developing a means of converting lignin into highly valuable carbon nanofibers.

The technology is patent pending and was the subject of a June 2012 article in *Nano Letters*, a monthly peer-reviewed scientific journal published by the American Chemical Society.

**David Neivandt has developed a means of converting lignin into highly valuable carbon nanofibers. The patent-pending technology involves rapidly freezing the lignin using liquid nitrogen at -196 C. Pictured with the technology is Ph.D candidate Alexander Demers.**

Lignin, a complex chemical compound, is about 30 percent of a tree that comes into a mill and typically is extracted in the papermaking process and then burnt for its energy content. Through Neivandt's method, a stream of lignin, worth a few cents per pound in energy value, can be converted to carbon nanofibers, worth anywhere from a couple hundred to a couple thousand dollars per pound.

"We go from maybe 4 cents to $1,000, which sounds great, but of course the process itself costs money," he says. "But nonetheless, we go from a raw material with very little value to a product that has extremely high value."

The unique green process takes a solution of lignin in water and freezes it rapidly, forming ice.

"What many people don't appreciate is the faster you freeze water, the smaller the ice crystals you make," Neivandt says. "So what we do is freeze the lignin solution at an extremely high rate, which forms very small ice crystals and the lignin that's in the solution phase separates around the ice crystals."

If the lignin is frozen fast enough and the ice crystals are small enough, the templated lignin structure has nanoscale dimensions. Removal of the ice crystals frees the lignin nanofibers, which may be carbonized in a furnace.

"It's a process that takes a natural material that's normally burnt and produces a very high value-added material, and does so in a green manner," Neivandt says.

To freeze the lignin at such a fast rate, liquid nitrogen at a temperature of -196 C is delivered inside a small steel drum, cooling the drum to the same temperature. A water solution containing lignin is placed in a pressurized vessel and fired through needles onto the drum; the solution freezes in 0.01 seconds, making the cooling rate about 10,000 degrees Celsius per second and forming tiny ice crystals.

"The way we do it — no pun intended — is kind of cool," Neivandt jokes.

The steel drum is hollow, allowing liquid nitrogen to spill into a reservoir in which the drum sits. The drum is constantly rotating in the bath of liquid nitrogen, picking up a film, so when the lignin hits the liquid nitrogen film, it vaporizes some of the nitrogen and releases a ribbon off the drum.

"If you didn't (have the drum rotating in liquid nitrogen), it would be like sticking your fingertips on a steel surface at -196 C," Neivandt says. "So if we don't have that, we basically weld the lignin to the drum. By employing the liquid nitrogen film, we release the ribbon."

The current process is not specific to lignin; any water-soluble polymer would work, Neivandt says.

Neivandt thinks the process can be easily scaled, and he and his research team are currently working on increasing the freezing temperature to eliminate the use of expensive liquid nitrogen. They are also looking into modifying the method and believe it could have uses other than for nanofiber production. ■


## Floating LIDAR System collecting data in Gulf of Maine

WITH FUNDING from the Maine Technology Institute and the U.S. Department of Energy, the University of Maine's Advanced Structures and Composites Center is leading the effort to enable cost-effective measurements hub-height winds in deepwater where fixed-based towers are not feasible. The UMaine Composites Center's buoy-based floating LIDAR system is collecting hub-height wind and other metocean measurements in the Gulf of Maine.

In October 2012, UMaine's Composites Center, NRG Systems Inc., AWS Truepower LLC, UMaine's Physical Oceanography Group and Leosphere SAS established a research and development partnership to gather deepwater metocean data in the gulf. UMaine has designed a floating system to house a modified WINDCUBE® v2 Offshore LIDAR Remote Sensor.

The floating system, which incorporates a proven LIDAR system that detects wind conditions using laser technology up to 200 meters above the ocean surface, is based on buoy technology developed and tested by UMaine's Physical Oceanography Group over the past decade in the Gulf of Maine and abroad. AWS Truepower and UMaine will conduct a campaign to validate the data collected by the floating system.

The buoy was deployed alongside UMaine's VolturnUS 1:8 floating offshore wind turbine in June off the coast of Castine, Maine.

## Hutto named outstanding employee

DWANE HUTTO, Forest Bioproducts Research Institute (FBRI) project manager, is the recipient of a 2013 Outstanding Professional Employee Award, presented by the University of Maine Professional Employees Advisory Council. Hutto oversees FBRI's administrative functions, coordinates project work and collaborates with the institute's executive director to ensure the efficiency of operations. He joined FBRI in 2008 after working for three years in UMaine's Process Development Center as pulping group leader.

## Electrons from North America's first offshore wind turbine flow into U.S. grid

VOLTURNUS 1:8, a 65-foot-tall offshore wind turbine prototype, was connected to the Central Maine Power Company June 13, making it the first grid-connected offshore wind turbine in the Americas. The turbine, sited off the coast of Castine, Maine, is 1:8th the scale of a 6-megawatt (MW), 423-foot rotor diameter design.

VolturnUS technology is the culmination of more than five years of collaborative research and development conducted by the University of Maine-led DeepCwind Consortium. DeepCwind research is a unique public-private partnership funded by the U.S. Department of Energy (DOE), the National Science Foundation-Partners for Innovation, Maine Technology Institute, the state of Maine, the University of Maine, Maine Maritime Academy, Cianbro and more than 30 other industry partners.

VolturnUS 1:8 was launched in Brewer May 31 by UMaine's Advanced Structures and Composites Center and its partners. The event was hosted by Cianbro.

Data acquired during the 2013 deployments off Castine will be used to optimize the design of UMaine's patent-pending VolturnUS system. The program goal is to reduce the cost of offshore wind to compete with other forms of electricity generation without subsidies.

The UMaine Advanced Structures and Composites Center has partnered with industry leaders to invest in a 12-MW pilot farm. The deployments this summer will de-risk UMaine's VolturnUS technology in preparation for connecting the first full-scale unit to the grid in 2016.

Maine has 156 gigawatts (GW) of offshore wind capacity within 50 miles of its shores and a plan to deploy 5 GW of offshore wind by 2030. The 5 GW plan could potentially attract $20 billion of private investment to the state, creating thousands of jobs.

Last year, the UMaine Composites Center-led DeepCwind Consortium was awarded the first phase of a potential $93.2 million DOE deepwater offshore wind demonstration project. The consortium of industry leaders and national laboratories was one of five awardees selected from more than 70 competing proposals.

In this initial phase, each project received as much as $4 million to complete the engineering, design and permitting phase of this award. At the end of this year, DOE will select up to three of these projects for follow-on phases that focus on siting, construction and installation, and aim to achieve commercial operation by 2017. These projects will receive nearly $47 million each over four years, subject to Congressional appropriations.

**VolturnUS 1:8 was launched in Brewer May 31 by UMaine's Advanced Structures and Composites Center and its partners.**

## 2013 Outstanding Graduates

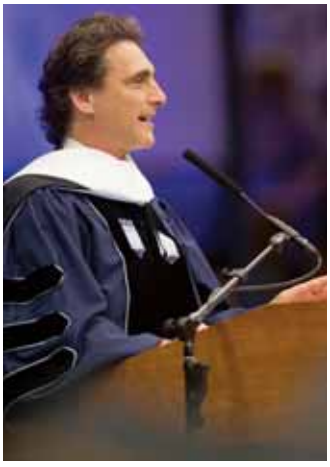
**MOLLY SEGEE**
MECHANICAL ENGINEERING

Molly Segee of Old Town, Maine, was the Outstanding Graduating Student in the College of Engineering. She majored in mechanical engineering with a minor in robotics. She is a member of Tau Beta Pi and Pi Tau Sigma, and collaborated with professor Michael Peterson in the Racing Surfaces Testing Laboratory. She was a member of the Black Bear Robotics Club and played French horn in Symphonic Band. She plans to pursue a master's degree in aerospace engineering.

**ANIN MASKAY**
ELECTRICAL ENGINEERING

Anin Maskay of Kathmandu, Nepal, was the Outstanding Graduating International Student in the College of Engineering. The electrical engineering major served as president of UMaine's International Student Association in 2012. For three years, he was involved in wireless sensing research in UMaine's NASA lunar habitat and in the Wireless Sensor Networks Laboratory on campus, collaborating with professor Ali Abedi. Maskay plans to pursue graduate school.

## Engineering alum receives honorary degree



UNIVERSITY OF MAINE alumnus Lawrence Bender, the producer of films that have won a total of six Academy Awards®, received an honorary Doctor of Humane Letters degree and shared remarks during Commencement ceremonies May 11. Bender graduated in 1979 with a degree in civil engineering. His successful career as a producer and activist spans two decades. His films, which include such noteworthy projects as "Inglourious Basterds," "Pulp Fiction" and "Good Will Hunting," have been honored with 29 Academy Award® nominations, including three for Best Picture, and have won six.

## Making waves

THE UNIVERSITY OF Maine, Maine Maritime Academy, Sandia National Laboratories and the National Renewable Energy Laboratory (NREL) were awarded a nearly $984,000 energy grant from the National Science Foundation for the creation of a new wind and wave generating system.

$W^2$ will be a unique, multidirectional system that will consist of a rotating open-jet wind tunnel positioned over a deep-wave basin that will be designed to work together. Using a programmable directional wave maker, wave and wind conditions similar to those in the Gulf of Maine and beyond will be simulated.

This type of system is not available anywhere else in the country.

The wind-wave basin test facility will be located in an annex to the Advanced Structures and Composites Center. The facility can be used to develop new concepts and standards for floating structures, particularly those requiring wind and wave interaction, such as offshore floating wind turbines.

The system also has the potential to create better understanding of wave and wind effects in the ocean that can help researchers develop new methods of capturing renewable energy, optimize the performance of existing renewable energy devices and construct future offshore infrastructures, according to a press release issued by U.S. Senators Susan Collins and Angus King.

Krish Thiagarajan, the University of Maine's Alston D. and Ada Lee Correll Presidential Chair in Energy and mechanical engineering professor, is the principal investigator of the project. Co-principal investigators include UMaine engineering professors Habib Dagher, Andrew Goupee and Qingping Zou, as well as Maine Maritime Academy professor Richard Kimball.

## Nation's first cellulose nanofiber pilot plant opens at UMaine

A RIBBON CUTTING ceremony in April marked the opening of the nation's first cellulose nanofiber pilot plant in the University of Maine's Process Development Center, which is observing its 25th anniversary.

The Cellulose Nanofiber Pilot Plant, funded by a $1.5 million grant from the U.S. Forest Service, manufactures cellulose nanofibers (CNF), a wood-based reinforcing material that is increasingly of interest to researchers worldwide in the development of high-value materials. Last year, UMaine and the Forest Products Laboratory 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 development of new generations of high-performance wood-based materials.

UMaine is in a consortium with the Forest Products Lab, six other universities and numerous industrial partners pursuing research using CNF. Nanomaterial is used in automobile components, paint and coating additives, composites and filtration media.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College of Engineering
5796 AMC, Room 200
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**More than 30 UMaine engineering alumni work at Texas Instruments in South Portland, Maine.**

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