FALL 2018

# ENGINEERING SOLUTIONS

A PUBLICATION OF THE FRANCIS COLLEGE OF ENGINEERING

UMASS LOWELL

## ENGINEERING FOR THE ENVIRONMENT

*Helping to Preserve Our Planet for Future Generations*

**Dear Alumni, Colleagues and Friends,**

It is hard to believe that five years have passed since I joined the Francis College of Engineering at UMass Lowell. We published our first issue of Engineering Solutions that fall of 2013 to inform you of the groundbreaking research and high-impact work of our students, faculty and alumni.

Our college has changed significantly since that inaugural issue—an 80 percent increase in bachelor's degrees awarded, a 40 percent increase in graduate degrees awarded, a 25 percent increase in full-time faculty and more than doubling our research expenditures. Against the backdrop of rapid change and growth, our drive to solve the pressing problems of today and tomorrow while serving as an economic engine for the commonwealth and beyond has not wavered, as highlighted in the pages of this magazine. We are proud to share the stories of how our students, faculty and alumni are impacting the world. We hope you enjoy reading about them, for we have more work to do and many more stories to tell!

This issue of Engineering Solutions focuses on our work on sustainability and our environment. The problems we face in these areas, such as access to clean water and air, the need for reliable, clean energy and transportation and the desire to reduce and reuse waste, grow more urgent and challenging each day. These problems also require solutions from many disciplines, and thus the issue features work from a variety of departments, including chemical engineering (creating eco-friendly fertilizer from lobster shell waste), civil and environmental engineering (filtering water as well as increasing biogas fuel production from wastewater sludge); mechanical engineering (storing solar energy efficiently); and plastics engineering (recycling plastic waste).

We also highlight a new undergraduate degree program launched this fall in environmental engineering. The U.S. Bureau of Labor Statistics states that "environmental engineers use the principles of engineering, soil science, biology and chemistry to develop solutions to environmental problems. They are involved in efforts to improve recycling, waste disposal, public health and water and air pollution control." This description emphasizes the interdisciplinary nature of the field. Graduates will be prepared to work in pollution prevention and remediation and help solve global environmental challenges related to climate change. The first class of 17 students started in the major this fall.

As always, please feel free to contact me (Joseph_Hartman@uml.edu, 978-934-2576 or via LinkedIn) if you have a story to share or would like to partner with the Francis College of Engineering. I look forward to hearing from you.

Sincerely,

Joseph C. Hartman, Ph.D., P.E.
Dean, Francis College of Engineering
University of Massachusetts Lowell

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## IN THIS ISSUE



**ON THE COVER**

The amount of fresh water on earth is limited, and its quality is under constant pressure. According to the World Health Organization, in 2015, about 2.1 billion people worldwide lack access to safe water. UML researchers are tackling a number of important issues—such as identifying contaminants in water, providing methods to filter the water and planning for cleaner water in the future—to help preserve the safety and quality of water for drinking and domestic use.


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**Editor:** Edwin L. Aguirre
**Designer:** Paul Shilale

**Contributing Writers:**
Karen Angelo, Geoffrey Douglas, Nichole Moreau, David Perry, Katharine Webster

**Copy Editor:** Don St. John


# UML LAUNCHES FIRST PUBLIC ENVIRONMENTAL ENGINEERING BACHELOR'S PROGRAM IN MASSACHUSETTS

BY **KAREN ANGELO**

First-year engineering student Adriyanna Albert is passionate about preserving natural resources and wants a career where she can make a difference in protecting the environment. That's why she enrolled in the Francis College of Engineering's new bachelor of science in environmental engineering program.

"Due to my love of the environment, I decided that I wanted a major and a career that was meaningful," says Albert, a 2018 Lowell High School graduate who was among the first group of students to begin the program when it launched in September. The program will prepare students like Albert for jobs in which they'll address some of the world's most pressing problems, from protecting water and air quality to figuring out how to remediate hazardous waste sites.

The program, the first and only public undergraduate degree program of its kind in the state, is taught by faculty who are top-notch researchers in their fields.

"Undergraduate students have opportunities to participate in cutting-edge research alongside graduate students and faculty members," says Prof. Pradeep Kurup, chair of the Civil and Environmental Engineering Department, whose own research expertise includes intelligent sensing of organic and inorganic contaminants in soil, water and air.

**"Undergraduate students have opportunities to participate in cutting-edge research alongside graduate students and faculty members."**

Prof. Clifford Bruell, senior director of the Environmental Engineering B.S. program, led the effort to develop the new degree.

"By applying engineering principles, soil science, biology and chemistry to protect water, soil and air, environmental engineers develop solutions that make an impact on people's lives," Bruell says. "When clean water is flowing, we all take it for granted, but when something goes wrong, most likely the person who will fix the problem is an environmental engineer."

Working with Bruell and Kurup on the proposal was Prof. Xiaoqi (Jackie) Zhang and Asst. Prof. Sheree Pagsuyoin.

Bruell says job opportunities in environmental engineering are on the rise due to population growth around the world, particularly in areas where people are living with limited resources. In the United States, environmental engineering jobs are expected to grow 8 percent between 2016 and 2026, according to the U.S. Bureau of Labor Statistics.

"Private companies, municipalities and government organizations need environmental engineers to solve complex problems related to water treatment, waste disposal and air pollution prevention to improve public health," Bruell says. "They also solve environmental challenges related to climate change."

For Albert, the degree will help prepare her to address those challenges.

"This career path is important to me because I understand that we're harming the earth," she says. "There are countries that lack clean water and even areas of our own country that have been introduced to varied types of pollutants. Everyone needs clean water and land to survive; therefore, my job will always be needed."

In addition to foundation courses in writing, math and sciences, the program will include classes in energy and sustainability; groundwater hydrogeology and remediation; biological processes in environmental engineering; air quality; and solid waste engineering. During their final semester, seniors will complete an in-depth capstone design project that solves an environmental problem.

Examples of possible projects include teams of students producing a conceptual design of the components in a biological wastewater treatment plant or designing a groundwater remediation system to clean an aquifer contaminated by a leaking underground storage tank.

Students in the program will gain professional experience through the university's longstanding partnerships with numerous national and local environmental engineering firms.

Students are expected to find internships, co-op placements and job opportunities with Massachusetts environmental firms such as CDM Smith, Weston & Sampson, Woodard & Curran, Tighe & Bond, Kleinfelder, Stantec and GZA GeoEnvironmental Inc. and others. Possible public sector employers in the area include the U.S. Environmental Protection Agency Region 1, the U.S. Army Corps of Engineers and the Massachusetts Department of Environmental Protection. UML

**Photo above: Civil and environmental engineering graduate student Connor Sullivan collects and tests water samples from a site in Massachusetts where groundwater has been contaminated with heavy metals.**

# UML RESEARCHERS CLEAR A PATH TO CLEAN WATER

## GOAL IS TO MAKE SAFE WATER ACCESSIBLE TO EVERYONE

BY EDWIN L. AGUIRRE

A young girl collects untreated water from a river near her village in Ethiopia. It's a task that many people in Africa and elsewhere in the world must endure every day so their families can have water for drinking, cooking and washing.





While working on her thesis in the central Philippines in 2004, Sheree Pagsuyoin watched villagers walk for miles to collect water for drinking, cooking and washing. Those living in more remote areas had to wait for water to be delivered via indigenous dugout canoes called "bancas." Although access to clean drinking water has since improved significantly in this Southeast Asian nation, there is still a lot of work to do to deliver reliable and safe water to a greater number of people, says Pagsuyoin, now an assistant professor in UMass Lowell's Civil and Environmental Engineering Department.

That's why she decided to dedicate her life to researching ways to improve access to safe, clean water.

"I want to contribute to solving this universal problem," says Pagsuyoin, who has a master's degree in environmental engineering from the University of the Philippines, Diliman, and a doctorate in civil and environmental engineering from the University of Virginia.

"Water problems don't recognize political or geographic boundaries; a problem in one area impacts another in many ways," she notes.

In fact, in 2010, the U.N. General Assembly recognized access to safe, clean water and sanitation as a basic human right.

But according to the World Health Organization, in 2015, at least 2 billion people worldwide used drinking water sources contaminated with human waste, which can transmit infectious diseases such as cholera, dysentery, hepatitis A, typhoid and polio. Drinking contaminated water is estimated to cause more than 500,000 deaths, mainly of children, due to diarrhea each year. In addition, waterborne parasites, toxic chemicals and radiological hazards pose serious threats to drinking water.

In response, Pagsuyoin, along with teams of other faculty researchers from the Francis College of Engineering—led by Prof. Pradeep Kurup and Asst. Prof. Onur Apul of civil and environmental engineering and Asst. Prof. Ertan Agar of mechanical engineering—have embarked on projects that combine sustainability with cutting-edge technology to address these problems and help provide people with clean, easily accessible water.

Pagsuyoin is exploring the use of the seeds of Moringa oleifera, a fast-growing, drought-resistant tree widely cultivated in the tropical and subtropical regions of Africa, Asia and Latin America, for treating drinking water. Agar, Apul and Pagsuyoin are also designing an electrochemical system for removing harmful contaminants from water, while Kurup has developed an electronic "tongue" that can detect traces of toxic heavy metals in groundwater and soil that can cause physiological and neurological disorders.

"It is hard to overstate the importance of this work. Access to clean water is a fundamental need for all. These projects are critical to safeguarding this precious resource," says Dean Joseph Hartman of the Francis College of Engineering. "I'm proud that our faculty, students and staff are tackling such an important problem and are helping improve the lives of people all over the world."

### A Sustainable, Eco-friendly Way of Disinfecting Water

In many parts of the world, untreated water from streams, rivers, ponds, lakes and the ground are the primary sources of drinking water, particularly in low-income regions, according to Pagsuyoin. "In these communities, the need for a low-cost, readily accessible water treatment method is especially critical in reducing incidences of waterborne diseases," she says.

Pagsuyoin collaborated with researchers from De La Salle University in Manila, the Philippines, and George Washington University in Washington, D.C., to investigate the use of crushed moringa seeds for treating and disinfecting contaminated water via adsorption.

"Moringa seeds are known to contain proteins that have antibacterial and coagulant properties," she says. "One tree will produce enough seeds to purify about 6,000 liters [1,600 gallons] of water. They are as effective as alum, and can reduce hardness and arsenic in water."

However, the seeds also contain soluble organic matter that are released into the treated water and can serve as food for pathogenic microorganisms, causing them to regrow.

"The downside is that water treated by powdered moringa seeds cannot be stored for long periods of time," notes Pagsuyoin.

To address this issue, researchers tested carbon-based adsorbent materials—activated charcoal, rice husk ash and ceramic beads—that would bind the seed protein tightly onto the materials' surfaces and keep the unwanted organics from being released into the water.

"We observed the highest adsorption capacity with activated charcoal, followed by rice husk ash and then ceramics," says Pagsuyoin. The team also used a nonpathogenic form of E. coli bacteria to show that the immobilized seed protein still retained its antibacterial property.

"The seed protein/carbon adsorbent combination can be used as a filter medium for creating a low-cost, portable biofilter," says Pagsuyoin. This application is still under development.

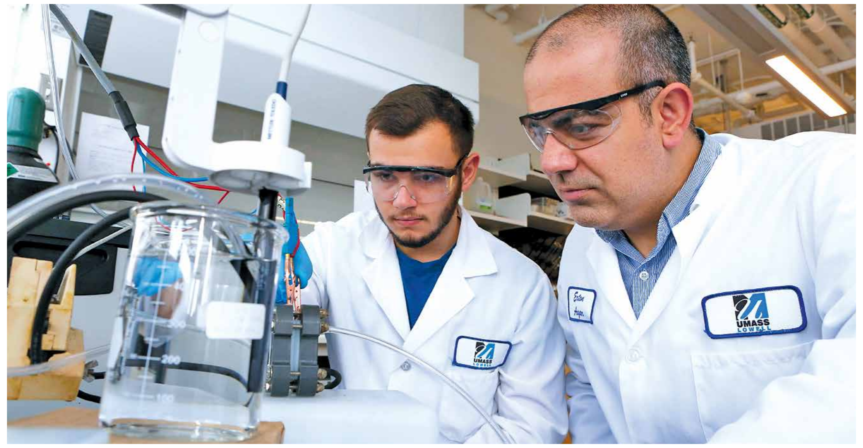
Pagsuyoin and graduate student Akarapan Rojjanapinun are currently investigating other low-cost adsorbent membranes for removing trace pollutants in drinking water. These projects are in collaboration with Prof. Hongwei Sun of mechanical engineering and Earl Ada, Ph.D., of the university's Materials Characterization Laboratory.

### Very Persistent Chemicals

Americans enjoy one of the cleanest, safest and most reliable supplies of drinking water in the world. Yet traces of contaminants can still lurk in tap water from public water systems. These can range from microorganisms to disinfectants and disinfection byproducts, inorganic and organic chemicals and radionuclides.

*Continued*

**Photo above: Civil and environmental engineering Asst. Prof. Sheree Pagsuyoin, right, and Ph.D. student Akarapan Rojjanapinun use liquid chromatography tandem mass spectrometry to analyze water samples for traces of organic pollutants.**
**Photo top right: The seeds from the Moringa oleifera tree contain proteins that can be used to clarify drinking water and kill harmful microorganisms.**



**"If successful, our proposed system will provide access to clean, safe and secure water resources and help establish a healthy ecosystem."**

**Photo top: Mechanical engineering Asst. Prof. Ertan Agar, right, and chemical engineering undergraduate student Joseph Egitto carry out a capacitive deionization (CDI) experiment to test the effectiveness of their method in removing bromide from water flowing through the CDI cell.**

**Photo right: Civil and environmental engineering Prof. Pradeep Kurup, left, and geotechnical engineering Ph.D. student Susom Dutta examine a prototype of the electronic "tongue" probe at the Geoenvironmental Monitoring Laboratory at the Olney Science Center on North Campus. The probe is designed to penetrate sediments to detect traces of toxic heavy metals in soils and groundwater.**

Two man-made chemicals used in manufacturing industries, called perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), have recently attracted significant interest because of their increasing and widespread detection in the country's water supply. These compounds have been used for decades in many industrial applications and commercial products, such as firefighting foams, flame-retardant and nonstick coatings, stain- and water-repellent fabrics, cleaning products, metal coatings, additives, surfactants and food packaging materials.

"Both chemicals are very persistent in the environment and in the human body—meaning they don't break down and they can accumulate over time. The bioaccumulation and toxicity of these compounds can potentially lead to adverse health effects," says Agar.

To date, several water treatment technologies, including photochemical oxidation, ultraviolet irradiation, adsorption and coagulation, have been developed to remove PFOS and PFOA in drinking water. "However, the effectiveness of these systems in eliminating the environmental and health risks has not reached a satisfactory level," notes Agar.

This has motivated Agar, Apul and Pagsuyoin to develop a high-capacity, high-efficiency "capacitive deionization," or CDI, system that would selectively remove PFOS and PFOA from water. This low-energy desalination method uses porous carbon electrodes to capture and remove salt from flowing saline water.

"Our project is currently in its very early stage," says Agar, who directs the university's Electrochemical Energy Systems and Transport Laboratory. He and his co-researchers recently received a $10,000 seed grant from UMass Lowell to support their project. Assisting them in the lab are incoming chemical engineering juniors Joseph Egitto and Jana Latayan of UML and UMass Amherst, respectively.

In the first part of the project, the team will design and develop a CDI setup for removing ordinary table salt (sodium chloride) from brackish water. Then they will attempt to remove bromide (a salt containing negatively charged bromine ions) from water, which will be used as a technology benchmark to accurately assess the feasibility of their proposal. In the final part, the knowledge obtained from earlier experiments will be applied to develop an electrochemical water treatment technology for the effective removal of PFOS and PFOA from natural surface water sources.

"If successful, our proposed system will provide access to clean, safe and secure water resources and help establish a healthy ecosystem," says Agar.

### A TASTE FOR SENSING DANGER

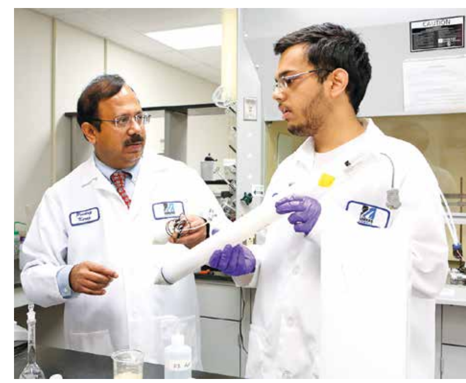
Kurup, who chairs the Department of Civil and Environmental Engineering, cites the recent water crisis in Flint, Mich., as an example of how even developed countries can face problems with water contamination.

The problem in Flint was caused by insufficient corrosion treatment of the water supply, which allowed lead to leach from lead water pipes into the city's drinking water, exposing more than 100,000 residents to the neurotoxin.

"Flint's drinking water had levels of lead hundreds of times higher than the EPA limit," Kurup says.

Waste products from mining and industrial manufacturing as well as heavy use of pesticides have resulted in the accumulation of heavy metals in surface water, groundwater and soils in many cities and farms across the country. Long-term exposure to these pollutants through direct contact or the food supply has been linked to health problems involving the skin, kidneys and liver as well as the gastrointestinal tract and central nervous system.

To address the problem, Kurup and geotechnical engineering Ph.D. students Connor Sullivan and Susom Dutta will use the electronic tongue to rapidly test and analyze traces of heavy metals on-site and in real time. The E-tongue uses arrays of highly sensitive microelectrode sensors coupled with artificial intelligence to "taste" water and soil samples and to detect—and identify—any heavy metals present, such as arsenic, cadmium, copper, chromium, iron, lead, manganese, mercury, nickel, selenium, thallium and zinc.



Research and development of the E-tongue has been supported with grants from the National Science Foundation totaling nearly $740,000.

"The E-tongue will be simpler, faster, safer and more cost-effective compared with the traditional methods," says Kurup. "It should cut the cost associated with field sampling and lab analysis by more than 50 percent."

He says the E-tongue will limit the exposure of lab personnel to contaminated soil and water by avoiding the need for drilling and collecting samples. Since site investigators will get the test results more quickly, they can provide regulatory agencies with critical information needed for taking appropriate actions, such as issuing drinking-water advisories in a timely manner.

The technology can also be expanded to detect other types of toxins, making this approach applicable to such fields as biotechnology, pharmaceuticals and medical diagnostics, food and agricultural inspections, environmental monitoring, law enforcement and homeland security, he says.

Kurup has formed AquaTerrene, a spinoff company that is working to commercialize the E-tongue technology. The company is located in the UMass Lowell Innovation Hub in downtown Lowell.

"The university is currently exploring a licensing opportunity with a major environmental engineering company," he says. "Our group is also working with the Army to develop a handheld E-tongue to allow soldiers to test water quality in the field." UML





**In New England, seafood companies process millions of pounds of lobster meat every year for the domestic and overseas markets.**

# STUDENTS' ECO-FRIENDLY FERTILIZER WINS EPA AWARD

*Raw Material Is Derived from Seafood Shell Waste*

BY **EDWIN L. AGUIRRE**

The U.S. Environmental Protection Agency (EPA) has awarded a group of UMass Lowell student researchers a "P3" grant to develop an innovative technology that would turn seafood waste into fertilizer. The funding is part of the EPA's annual national student design competition for sustainability that focuses on three P's – People, Prosperity and the Planet.

The UML group is among 31 teams from 30 colleges and universities across the country recognized by the EPA for their work in designing environmental solutions that will help improve quality of life, promote economic development and protect the environment. Each team will receive $15,000 under Phase I of the competition, and the researchers will use the funds to prove their concepts and to further test the technical and economic feasibility of their designs.

UMass Lowell won funding for its proposal to create safer, effective and nontoxic fertilizer from an abundant resource—in this case, the shell waste produced by processing crustaceans such as crabs, lobsters and shrimp. The group will develop a hydrothermal process to make chitin, a natural sugary substance derived from the hard outer shells of crustaceans, and turn it into renewable fertilizer.

Members of the team include chemical engineering Ph.D. students Melisa Nallar and Peng Yu, biology senior William Bizilj, chemical engineering sophomores Nicholas Teanglia and Olivia Gauntlett and mechanical engineering sophomore Jonathan Aguilar.

"Winning the EPA grant gives us an opportunity to achieve our environmental goals and apply our classroom knowledge to a real-world problem," says Nallar. "Our research is very important, because it is a pathway to the future we want for all."

"The P3 award allows us to not only develop innovative technologies to simultaneously promote economic growth and global sustainability, but also to create a platform for students from different backgrounds to work together as a team," says chemical engineering Asst. Prof. Hsi-Wu Wong, who is advising the students on the project. "I believe this is the best way to stimulate creative ideas."

### A 'GREENER' APPROACH TO FERTILIZING

In New England, the lobster industry is a multimillion-dollar enterprise, with companies processing millions of pounds of lobster meat every year for the domestic and overseas markets.

According to the UML team, shell waste presents a significant economic and environmental challenge for the local processing businesses due to the cost and carbon footprint associated with transporting the waste to a landfill. At the same time, the use of petroleum-derived chemical fertilizers by farmers can be costly and can have adverse environmental impact due to the potential nitrate contamination of groundwater and the large amount of energy needed to produce ammonia, a key ingredient in making synthetic fertilizers.

Wong and his students hope that their hydrothermal reactor system can be used to address these issues and convert crustacean shell waste into high-value, nitrogen-rich "biochar" soil enhancer for agricultural applications.

"Our goal is to improve the lives and advance the economy of seafood processors and agricultural farmers by introducing a new source of revenue based on shell-derived fertilizers, as well as to help preserve the environment by reducing landfill and energy consumption," Wong says.

This year's P3 award winners showcased their projects at the National Sustainable Design Expo, held in April during the USA Science and Engineering Festival in Washington, D.C.

The other P3 winners include teams from Cornell University, Georgia Tech, Purdue University, the University of California Davis and UC Riverside, the University of Texas, Arlington and the University of Washington. Their projects range from harnessing solar power to disinfect drinking water to using beetle larvae to break down Styrofoam and organic waste.

The teams will be eligible to submit proposals for Phase II funding—with each grant worth up to $75,000. The EPA's ultimate goal is to bring the technologies into the marketplace. UML

**Inset above: Members of UMass Lowell's P3 team include, from left, Peng Yu, William Bizilj, Jonathan Aguilar, Nicholas Tenaglia, Olivia Gauntlett, Melisa Nallar and Asst. Prof. Hsi-Wu Wong.**

Biogas Production

The Deer Island Wastewater Treatment Plant on Boston Harbor features a dozen 130-foot-tall, egg-shaped digester tanks where anaerobic bacteria break down the sludge's organic matter and convert it to methane gas and other byproducts.

# BREAKTHROUGH INVENTION WILL INCREASE BIOGAS FUEL PRODUCTION FROM WASTEWATER SLUDGE

## Nanotechnology-based Treatment to Produce More Clean Energy, Less Landfill Waste

BY EDWIN L. AGUIRRE

Each year, the United States produces more than 12 million tons of sludge—the thick mixture of solid and liquid matter left over from processing wastewater and raw sewage in treatment plants. And it costs taxpayers roughly $2 billion annually to safely handle, treat and dispose of the unwanted byproduct.

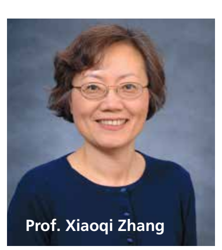
Massachusetts alone produces 620,000 tons of sludge every year and uses up to 10 million watt hours of energy to process the waste.

"There is a lot of wastewater sludge in the country, and it is very expensive to deal with it," says Asst. Prof. Onur G. Apul of the Department of Civil and Environmental Engineering.

According to Apul, only half of the sludge gets converted to biogas fuel (mainly methane); the rest is disposed of in incinerators and landfills.

Apul and a team of UML researchers have invented a more environmentally friendly, efficient and potentially revenue-generating alternative. They have developed a single-step thermal treatment technique that increases biogas production by up to 300 percent while reducing the amount of residual sludge that goes into landfills by 20 to 30 percent.

"The technology—which uses microwave radiation together with nanofiber additives—is new, and we applied for a patent for it this year through the university's Office of Technology Commercialization," says Apul. "We can contribute to clean-energy production and also help treatment plants to discharge less waste because more sludge can now be converted to biogas."



Prof. Xiaoqi Zhang

Aside from Apul, the research team includes Prof. Xiaoqi (Jackie) Zhang of the Department of Civil and Environmental Engineering, Ph.D. student Arsalan Khalid (see page 12) and undergraduate student Ritchie LaFaille.

The project, which is funded with a one-year, $65,000 grant from the Massachusetts Clean Energy Center's Catalyst Program, is a collaboration with the Lowell Regional Wastewater Utility, which serves the city of Lowell as well as the surrounding towns of Chelmsford, Dracut, Tewksbury and Tyngsboro.

"Using our technology, a city with a population of 75,000, for example, would save about $210,000 a year in sludge transportation and disposal, as well as earn an additional $74,000 a year from biogas revenue," says Apul.

### AN INNOVATIVE SOLUTION

In a treatment plant, the wastewater is first treated with biological methods, using aerobic microorganisms in a process called activated sludge. Gravity then separates water from the waste sludge, and the water is disinfected to kill any pathogens. The treated, clean water is typically discharged to a nearby river or lake.

The sludge is sent for further processing into a digester, a huge tank where anaerobic bacteria break down the sludge's organic matter and convert it to methane. About half of the sludge produced is digested by the bacteria, and the remaining sludge goes to a landfill.

The researchers' method calls for heating the sludge with microwave radiation (similar to what is used in kitchen microwaves) before it goes to the digester. The radiation breaks down the cell walls of microbes, making them more soluble in water and decreasing clumping of the cells. The hydrolyzed sludge then goes to the digester.

To make the process more efficient, the team adds carbon-based dielectric (nonconducting) nanofibers to the sludge, dramatically speeding up the microwave heating. The high temperature increases the sludge's concentration of soluble organic compounds that get converted to methane in the digester.

"Aside from improving the digester's methane production by three times, our method offers other advantages, including low-energy requirement and safe and easy-to-deploy microwave irradiation, and no additional chemicals are needed," says Apul.

He says the microwave-nanofiber treatment method may reach, and even surpass, the efficiencies of other commercial techniques that are currently used to hydrolyze sludge—with ultrasound, ozone, alkaline/acid chemicals and thermal (non-microwave) treatment, among others.

### REVENUE-MAKING POTENTIAL

At treatment plants, the methane produced is captured and used to heat the digesters and keep the tanks at the appropriate temperature. Any excess methane is usually burned off into the atmosphere.

The high-tech Deer Island Wastewater Treatment Plant on Boston Harbor, operated by the Massachusetts Water Resources Authority (MWRA), does not burn off surplus methane, according to Apul. "This one-of-a-kind facility in the state has a system where excess methane is piped to boilers to heat buildings onsite and generate about 3 million watts of electricity via steam turbine generators," he says. "This saves the MWRA approximately $15 million annually in heating and electricity costs."

The team's vision is to turn the business of wastewater treatment into a self-sustaining, and even profit-making, enterprise by selling the surplus methane-generated electricity to the local power grid. Aside from municipal sewage treatment plants, other sources of sludge that contain high organic carbon include the sugar industry, manure from farms, agricultural discharges and the food-waste industry.

"There is a huge revenue potential for our microwave-nanofiber treatment method," says Apul. "Depending on the market needs and technology readiness, our team can start a spinoff company or license the technology to an existing microwave application company." UML

**Photo left: Civil and environmental engineering Asst. Prof. Onur G. Apul, left, and undergraduate student Ritchie LaFaille prepare to heat a sample of carbon-based nanofibers in a 2,100-watt research-grade microwave oven.**


Plastics engineering Assoc. Prof. Meg Sobkowicz-Kline, right, and former undergraduate student Jennifer Dinh characterize mixed plastic flakes for recycling.

Image: Joson Images





BY KATHARINE WEBSTER

# UML PROFESSOR WORKS TO INCREASE PLASTICS RECYCLING

When it comes to recycling, getting people to participate is just the first challenge. Turning that recyclable waste into high-quality products is a much bigger problem.

Assoc. Prof. Meg Sobkowicz-Kline of the Department of Plastics Engineering is tackling that challenge as the university's representative to the REMADE (Reducing Embodied Energy And Decreasing Emissions) Institute.

"We're trying to increase the recyclability of plastic waste streams," Sobkowicz-Kline says.

The REMADE Institute was created two years ago under the Manufacturing USA initiative, which brings together universities, corporations and government agencies on research projects that involve innovation in manufacturing.

REMADE recently awarded its first round of grants, including $200,000 to Sobkowicz-Kline and researchers from Michigan State University, the National Renewable Energy Laboratory, the American Chemistry Council and Unilever. They plan to study whether layered films, like those used for packaging food, can be separated into their component materials for recycling, or whether chemical processing and high-speed extrusion can turn some of the films into recycled products, such as adhesives and coatings.

Improvements in plastics recycling are especially urgent because China banned nearly all imports of recyclable plastics at the beginning of the year, saying the blocks of crushed bottles and containers from other countries were too often contaminated with other undesirable materials, such as Styrofoam and plastic grocery bags.

The U.S. sends about one-third of its recyclable materials overseas, and China was the biggest consumer before Jan. 1. So now American companies are scrambling to find other markets—and increase the U.S. market, too. In the meantime, some of the plastics Americans put in their recycling bins have effectively become garbage, notes Sobkowicz-Kline.

"We're starting to landfill our recyclables in this country," she says. "There's nowhere else for them to go."

Sobkowicz-Kline is an expert in plastics manufacturing processes, especially high-speed extrusion. Much of her previous research involves bioplastics—polymers made from natural materials that are biodegradable. Among other projects, she is working on biodegradable plastics for the agriculture industry.

Now she wants to see if high-speed extrusion will conquer two of the biggest problems in plastics recycling: mixed materials and contamination.

Some plastics are easy to recycle because they're made of a single material that can be melted down and re-formed, she explains. Plastic soda bottles and milk jugs, labeled with a "1" or "2" inside the recycling symbol, are examples of high-quality recyclables.

"In plastics, our paradigm has been: Collect it, melt it down and reuse it," Sobkowicz-Kline says.

Other plastics are compounds made by mixing materials. Still others are layered, often with paper or foil, like the food wrappings used for many grocery products. These are nearly impossible to recycle using current technology.

Finally, there's the problem that China complained of: contamination. Even the best-quality plastics are difficult to recycle if they're not thoroughly sorted and other materials end up in the mix.

Sobkowicz-Kline says high-speed extrusion may keep some mixed materials together or reduce the impact of contamination, compared to the standard extrusion process now used by most manufacturers. High-speed extrusion also uses less electricity, reducing emissions from fossil fuels and reducing energy costs for manufacturers, she says. That's key to getting industries to adopt it.

Outside of REMADE, Sobkowicz-Kline and plastics engineering Asst. Prof. Javier Vera-Sorroche have obtained an $18,000 grant from the Health Care Packaging Recycling Council for a test project to see if they can apply high-speed extrusion to recycling the plastic wrap that hospitals and medical offices use to keep medical instruments sterile. The wrap never touches patients, but the amount of waste generated is enormous, since virtually every instrument is covered in plastic that's discarded after each procedure and patient.

"Medical packaging holds a lot of promise," Sobkowicz-Kline says. "It's a very clean waste stream."

Sobkowicz-Kline says she is looking for more partners in industry, as well as UMass Lowell researchers, to come up with proposals for REMADE that meet the institute's goal: reducing the waste stream by recycling more materials using energy-efficient methods. REMADE isn't limited to plastics—the institute is also seeking proposals for better recycling of metals, electronic waste and fibers.

"This is a huge opportunity," she says. "Anybody can apply for this."

To learn more about issues in plastics recycling, visit Sobkowicz-Kline's educational website, **www.plasticsfacts.com**. UML

Photo top right: Former Ph.D. student Azadeh Farahanchi uses a Technovel twin-screw extruder in the university's plastics processing laboratory.

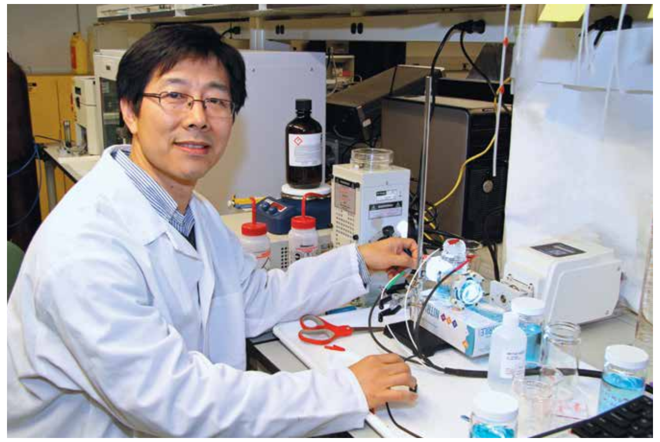
# PROFESSOR TO CREATE AN ALL-DAY SOLAR CELL

*Invention Will Provide Electricity Day and Night*





BY EDWIN L. AGUIRRE



Solar energy is the cleanest, safest and most abundant renewable source of energy available. And solar cells, also called photovoltaic (PV) cells, can convert this free and unlimited radiant energy from the sun directly into electricity to power our lights, electronics and household appliances. But how do you harness solar energy at night or when it's cloudy? The most common solution is to store the electricity generated by the solar cells in rechargeable batteries for later use.

Mechanical engineering Assoc. Prof. Fuqiang Liu thinks he can make solar energy more attractive to homeowners and businesses by simplifying the energy generation/storage process, improving its efficiency and reducing cost. His solution? An all-day solar cell that generates and stores electricity simultaneously during the day. This allows it to power lights for up to five hours at night, without the need for an external storage battery.

"Our portable, compact all-day solar cell relies on a dual-function electrode that generates and stores electricity at the same time," says Liu. "This eliminates the need for expensive rechargeable batteries used in conventional PV systems, which steeply increase the dollar-per-watt price of the electricity produced. Our proposed solution will significantly reduce both the capital and operating costs as well as improve the system's safety and reliability."

To provide electricity under darkness for longer than five hours, more materials (i.e., larger PV panels) can be used with the solar cell, he says.

Because of the cell's unique electron-storage mechanism, the electrons' storage (charge) and release (discharge) can be automatically triggered by ambient light condition.

"Under darkness or low-intensity light conditions, discharge occurs automatically without the need for smart switches or controllers, as one sees in conventional PV systems," notes Liu. "This maintenance-free feature of the all-day solar cell would be useful in the electrification of remote rural areas."

Liu anticipates a 50 percent reduction in cost compared to traditional PV systems. For example, for a 5-kilowatt solar system, he estimates that a homeowner will save more than $9,000 in installation with the all-day solar cell system compared to a traditional PV system. If successful, he plans to collaborate with public agencies and private industry to expand and scale up the capability of the technology and bring it to market.

**"As renewable energy sources become more prevalent, the ability to store solar energy can provide a sustainable solution to the world's growing energy shortage."**

Liu's work is funded with a five-year, $416,000 "CAREER" award from the National Science Foundation (NSF). This highly competitive annual program recognizes the nation's best young university faculty-scholars "who most effectively integrate research and education within the context of the mission of their organization."

Liu also received a one-year, $50,000 grant from the NSF to explore the commercial potential of his new solar cell.

Last year, the Massachusetts Clean Energy Center awarded Liu $65,000 through its Catalyst Program, which enables early-stage researchers to develop promising products and technologies in the fields of clean energy and clean water and help bring them to the marketplace.

"Our efforts to reduce Massachusetts' greenhouse gas emissions are reliant upon the technology advancements and hard work of our entrepreneurs," says state Energy and Environmental Affairs Secretary Matthew Beaton. "This funding provides crucial resources to young companies and promising ideas, supporting clean-tech innovation and job creation in the commonwealth."

## ROUND-THE-CLOCK ENERGY

Liu calls his all-day solar cell an "all-vanadium photo-electrochemical storage cell."

"Unlike conventional rechargeable batteries, which convert solar energy first into electricity and then store this electricity into chemical energy for later use, our all-vanadium photo-electrochemical storage cell stores solar energy directly in the form of chemical energy, increasing its efficiency and capacity," he says. "At night, the stored energy is converted to electricity using a flow battery."

Liu's findings have been published in peer-reviewed publications, including ACS Catalysis, Scientific Reports, Electrochimica Acta, Journal of Materials Chemistry A, Journal of Power Sources, Materials Research Bulletin, Nano Energy and Electrochemistry Communications.

Assisting him with the lab research are postdoctoral associate Zi Wei and Ph.D. students Husain Almakrami and Guanzhou Lin. Liu is also collaborating with UMass Lowell mechanical engineering Asst. Prof. Ertan Agar as well as Prof. Krishnan Rajeshwar of the University of Texas at Arlington.

"As renewable energy sources become more prevalent, the ability to store solar energy can provide a sustainable solution to the world's growing energy shortage. Our research, if successful, can effectively change the way we utilize the inexhaustible energy from the sun," says Liu. UML

**Photo above: Mechanical engineering Assoc. Prof. Fuqiang Liu conducts research at the Electrochemical Energy Laboratory in Falmouth Hall on North Campus.**

BY **DAVID PERRY**

# ARSALAN KHALID: GETTING THE LEAD OUT

*On paper, the challenge of DifferenceMaker can seem simple.*
*Step one: Think of a problem.*
*Step two: Make something that solves the problem.*
*In between, it's anything but easy.*

That's what Ph.D. student Arsalan Khalid discovered quickly when he decided to address the problem of poisoned drinking water in America's cities. The solution he and research partner Lewis Rowles created—the Lead Ex-Filter, which uses nanotechnology to remove lead from the water distribution system—could help cities like Flint, Mich., which famously faced drinking water laced with lead that was leaching from old water pipes.

The pair's idea snagged them $4,500 in the "Contribution to a Healthier Lifestyle" category in the spring DifferenceMaker Idea Challenge. Houses built before 1997 use lead service pipes for their water distribution, and as the pipes corrode over time, explains Khalid, "lead gets into our drinking water."

"The lead water crisis in Flint was one of the cases which brought attention to the serious issue of lead poisoning by drinking water, but Flint was not the only case," he says. "Recently, lead was detected in samples from Chicago as well."

Here is how their solution works: Lead-Ex Filter packs into a deployable cartridge a fibrous, nanocomposite material that has a high "adsorption affinity" for lead, says Khalid. The cartridge is installed near the sink or faucet. "As water passes through the Lead Ex-Filter, lead is removed from the contaminated water by attaching to the surface of the filter material without any significant reduction in water flow," he says.

It can be used "for any kind of household application," says Khalid. Once the filter material is developed, it can have multiple applications—for use with a pitcher, under the sink or faucet-mounted. It'll even work with whole-house filters.

Khalid says commercially available lead filters use activated charcoal and are relatively inefficient. Other filters that use reverse osmosis are expensive and energy-consuming.

"Our lab-made filters will use a fibrous structure made by mixing polymer and nanomaterials, then spinning the solution under high electric voltage. It is called the electrospinning process," he says.

The polymer/nanocomposite material is strong and removes lead, and its fibrous structure allows filtration without significant loss in water pressure.

It will also contain "a special nanomaterial with enhanced adsorption affinity for lead," which will bind lead molecules to the surface of the nanomaterial, says Khalid. "The unique thing about this concept is that each filter can be specially designed for each geographic location and the particular contaminants found there, through the blend of polymers and nanomaterial."

It's too early to know the cost, but Khalid expects it to be "cheap or comparable to the available market filter."

### A DISCIPLINED AND ORGANIZED RESEARCHER

Khalid, a research and teaching assistant in the Department of Civil and Environmental Engineering, is a Ph.D. candidate in civil engineering. He earned a master's degree in chemical engineering from King Fahd University of Petroleum & Minerals in Saudi Arabia and a bachelor's degree in polymer and petrochemical engineering from NED University of Engineering & Technology in Pakistan. He arrived at UMass Lowell in September 2017, and works as a research assistant with Onur Apul, assistant professor of civil and environmental engineering.

Apul calls Khalid a dedicated researcher. "He is disciplined and organized, and he takes his job seriously," says Apul.

And with lead bleeding into the water supply, seriousness is a good fit.

"There is a dire need to come up with an innovative idea to solve the ongoing crisis without having to replace the whole piping infrastructure and spending billions of dollars," says Khalid, whose partner Rowles is a Ph.D. candidate in civil and environmental engineering at the University of Texas at Austin.

The $4,500 Idea Challenge money "is a seed grant for us to work in our labs, producing filter materials and preparing a prototype," he says.

Khalid came to UMass Lowell because it offers "lots of opportunities for graduate students if you are passionate about research work. Active student clubs and organizations are a great source for releasing mental stress and ways to remain motivated during graduate studies."

He plans to make clean water his life's work.

"I always get excited when I see my research work in the lab is directly leading to societal or technological benefit for mankind," he says. "I aim to pursue an active R&D career after I complete my Ph.D., so I can apply my research skill and expertise in solving practical water challenges." UML

**Civil engineering Ph.D. student Arsalan Khalid presents the lead filter project that he and research partner Lewis Rowles had developed to the panel of judges during the spring DifferenceMaker Idea Challenge.**





BY **DAVID PERRY**

# UML WORKS TO ATTRACT WOMEN TO STEM MAJORS

For their senior capstone project, 2018 mechanical engineering graduates Katie Elwell and Benjamin Tran turned a rolling cart into a portable classroom and made their way to Girls Inc. of Lowell to show how renewable energy works.

The lesson? Science is fun. The audience? Ages 9 to 13, female and—they hope—impressionable.

Among the lessons offered were the workings of de-icing, wind turbines and solar panels. But more importantly, Elwell and Tran were there to convey the message that STEM disciplines—science, technology, engineering and math—are for girls.

"I think a lot of them feel like they're not supposed to do well at STEM, that it's not cool to like math or science," says Elwell. "I'm 22 now, but when I was growing up, it was still definitely a thing. I feel like what we did at Girls Inc. helped reinforce that STEM is open to them and it's something they can do."

The outreach at Girls Inc., which serves girls from ages 5 to 18, is part of a multifaceted effort at UMass Lowell to increase the ranks of young women studying STEM-related disciplines.

Elwell and Tran presented their capstone project to Girls Inc. officials and UML professors.

Pam Larocque, Girls Inc.'s program coordinator, taught the organization's staff how to present the mobile station to the girls. The cart was a gift to the agency, so the lesson will continue as new girls join.

Joseph Hartman, dean of the Francis College of Engineering, says that whether they're starting companies, running service learning trips or leading campus organizations, women in engineering at UMass Lowell thrive.

"The fact of the matter is that women do great in engineering at Lowell," Hartman says.

The shortage of women in STEM-related professions is well-documented. According to the U.S. Department of Commerce, women filled 47 percent of all jobs in this country in 2015, but held only 24 percent of STEM jobs.

"This is why we started our Future Engineers High School Summer Camp a few years ago," says Hartman. "The same idea applies to what Katie and Benjamin did—get students, especially girls, excited about engineering. Show how engineers solve problems and make peoples' lives better. If girls see that engineers help society as much as nurses, doctors and teachers, maybe we can get more to pursue engineering careers."

One of the camp sessions—the weeklong Engineering for Sustainability—is for girls only. Campers live on campus, do hands-on projects and enjoy access to 3-D printing and CNC machining labs, as well as meet with DifferenceMaker teams to develop a business pitch for the product they create.

And a new program helps build support for incoming female engineering students on campus. This past summer, 24 first-year women students in engineering participated in a new six-week, six-credit RAMP program. The camp focused on computer skills, calculus and problem-solving in each engineering discipline, while also connecting students with women faculty—and each other. Assoc. Dean Kavitha Chandra, the program's architect, says she hopes to improve retention of women students by building up their confidence and providing a support network.

### SETTING THE RECORD STRAIGHT

Projects like Elwell and Tran's are a step in reaching girls before they hear the myths: Science and math are for boys. Smart girls aren't popular.

"When I was growing up, I was encouraged to do well in math and science," says Elwell, who is pursuing a master's degree at UML. "A lot of times, when girls are young, they can do well at math and science and then just lose interest in it."

Elwell believes the lesson she and Tran brought to Girls Inc. resonated with the young students.

"They seemed to really like it. A lot of the girls may not have ever met someone like me from STEM before," she says.

Girls Inc.'s Larocque says the organization has "a robust STEM program that we integrate into what we do on a daily basis."

Still, there's the "sociological component—girls taking science and math who are told they are for boys, that it's not feminine to like them. It certainly isn't that it's too hard for them ... So it isn't that they can't do it, but they lose interest."

Larocque often brings role models to meet the girls. She says Girls Inc.'s frequent collaboration with UMass Lowell, from the engineering department to M2D2 and an internship program at the university's MakerSpace, is "very positive for everyone."

Linda Barrington, the service-learning coordinator for the Francis College of Engineering, says Larocque "really gets it. She is interested in having the girls learn that different STEM careers are useful. So if a student goes in and meets them, they might end up saying, 'OK, that could be an older version of me. That could be my future.'"

Maybe they're choosing between becoming a hairdresser or an engineer.

"I might say, well, if they're both equal in your mind, you might consider going for chemical engineer," says Barrington. "It's a really well-paying career, they can do great things and we could use more women in the field."

Elwell and Tran's capstone project was partially funded by a National Science Foundation grant for solar energy research awarded to mechanical engineering Asst. Prof. Juan Pablo Trelles.

"The earlier you bring kids into STEM careers, the easier it is to reach them," says Trelles. "Expressing to them specific scientific concepts helps to motivate them. The things on that cart, the girls could see and relate to."

He says seeing role models like Katie Elwell is important: "The idea for them is to think, 'These are people just like me.'" UML

BY **GEOFFREY DOUGLAS**

# FROM SCHENECTADY TO FRANCE: FOR 32 YEARS, AN ENERGY AMBASSADOR

*John Lavelle ’83 Leads GE’s Offshore Wind Energy Business*

“You’re killing your career,” John Lavelle ’83 remembers friends telling him in 1986, when he accepted a post in his early days with General Electric to go to Schenectady, N.Y., to overhaul turbines and trouble-shoot problems. The role was “a lot like a mechanic,” he says.

He was three years out of ULowell with a bachelor’s degree in mechanical engineering, and had spent all three of those years working on company projects in small industrial cities like Lynn, Mass., and Rotterdam, N.Y. It must have seemed that he’d put in his time—that he’d earned his way to something bigger.

But looking back, Lavelle says, he’s pretty sure he made the right choice: “I got to see things, early on, from the customers’ perspective. That was critical for me later. I learned a ton those two years in Schenectady.”

The company must have seen it that way, too. For most of the 32 years since, Lavelle’s GE postings have been far more ambitious and way farther afield: China, Indonesia, Singapore and France, interspersed with periods in Atlanta and Houston. Moving across much of Asia through the 1990s, he managed the company’s energy interests first in Taiwan, then in all of China—where he opened new offices throughout the country, expanding GE’s presence severalfold—and finally in Southeast Asia, where he had the same success.

During his posting in Atlanta as general manager of global marketing for GE Energy Services, beginning in 2000, that sector’s business increased from $2 billion to $7 billion in the space of six years. Then, from 2008 to 2012, as vice president of global projects operation for GE Energy, he managed a $75 billion portfolio of customer sites, building power plants in every major country in the world.

There was some high adventure along the way. In China in the early ’90s, where the ghost of Mao Zedong still loomed large and the country was only four years removed from the Tiananmen Square student protests, Lavelle learned to conduct business in a rapidly changing economy. In Jakarta from ’95 to ’98, he had to work within a system ruled by rampant corruption. All of it, he says today, was “a definite eye-opener for a 30-something, blonde-haired, blue-eyed guy from Holyoke, Massachusetts.”

Always, though, the one big constant was movement: a family that kept growing—his wife, Lisa, and four kids born in different countries—and a job that wouldn’t stay put.

“Taiwan, Jakarta, Singapore, always somewhere else. I’m gone 200 days a year.” He wishes sometimes it could be different, but with customers in every major country in the world, there’s not much chance of that: “I’ve got to be able to say to them, ‘I’m where you need me to be.’ That’s the only way it’ll work.”

Outside of his instincts on customer service, Lavelle says, there may be no factor more key to his success than the years he spent at ULowell. “Some of the best engineers in the world come to GE—from Stanford, MIT, Caltech, all over,” he says. “But with the training I had at ULowell and the knowledge it gave me, I never for a minute felt I couldn’t hold my own with the best of them.”

Lavelle is based today in Nantes, France (though you’ll rarely find him there, or anywhere else, he says, “for much more than three days at a time”), facing what seems his most ambitious challenge yet. As CEO since 2016 of GE Renewable Energy’s Offshore Wind business, he leads the company’s mission to parlay a $400 million investment into the deployment of the world’s largest and most powerful offshore wind turbine: the Haliade-X 12 MW, which rises 260 meters above sea level, roughly four-fifths the height of the Eiffel Tower. One Haliade-X 12 MW turbine, with its three 107-meter-long blades, would be capable of providing clean power to up to 16,000 European homes.

The key question, of course, is whether the world is ready for it. John Lavelle believes it is.

“It’s going to be a long-cycle project,” he concedes, but change is definitely coming—and offshore wind is the fastest-growing renewable technology out there. “It’s grown five times larger in just the past 20 years and will increase another five times by 2030.”

Coal as an energy source, he says, “is definitely on the decline. Nuclear, too. Look at what’s happened with China. Over the past four years or so, there’s been a noticeable change in the environment there—less coal, more wind, more solar. It’s picking up every year. No one would have predicted this pace of change, but it’s happening.” UML

**Photo facing page: John Lavelle ’83 points to one of three Haliade 150-6MW offshore wind turbines that GE had installed as part of the Fujian Xinghua Gulf demo project in China.**






**“Offshore wind is the fastest-growing renewable technology out there. It’s grown five times larger in just the past 20 years and will increase another five times by 2030.”**

Image: GE Renewable Energy


"Because we are a women-owned firm, talented female engineers come looking for us."

# ENGINEERING SUCCESS

BY **NICHOLE MOREAU**

*At Nitsch Engineering, Chairman and CEO Lisa Brothers '84 prioritizes both the bottom line and the workplace culture*

Nitsch Engineering is not your average civil engineering firm. Then again, Chairman and CEO Lisa (Girard) Brothers '84 is not your average civil engineer.

In 1989, when founding principal Judy Nitsch launched the firm, it was one of the few of its kind run by women. When Brothers heard that Nitsch was planning to start her own firm, she told her, "Not without me!" What began as a startup has grown into a well-respected company that works on some of the most challenging and exciting projects in the state and across the country.

Brothers began her engineering career working for the Massachusetts Department of Public Works (now MassDOT), where she was the first female engineer assigned to construction. She moved into the private sector after three years, working for two small engineering companies before becoming the first employee at Nitsch Engineering in 1990. As vice president and chief operating officer of the company from 1993–2010, Brothers managed the day-to-day operations of the business.

Since becoming CEO of Nitsch Engineering in 2011 (and chairman in 2016), Brothers has led Nitsch's strategic growth from an $8.8 million company with one office to a $17.5 million firm with four offices—three in Massachusetts and one in Washington, D.C.

Nitsch Engineering provides civil, structural and transportation engineering, land surveying, planning, and green infrastructure consulting to clients in 20 states and five countries. Last fall, the company was recognized as one of the Top Women-Led Businesses in Massachusetts by the Commonwealth Institute and The Boston Globe Magazine.

"At Nitsch, 38 percent of our technical people are female," Brothers says. "The industry norm is 12 percent. Because we are a women-owned firm, talented female engineers come looking for us."

The company is also recognized for its exceptional work culture, and has made the Globe's "Top Places to Work" list for the past three years. Brothers says she takes great pride in running a business with a reputation for doing excellent work and being an excellent place to work. Today, Nitsch Engineering has 107 employees—22 of them UMass graduates.

"We find that UMass graduates are really hard workers," says Brothers. "They come in ready to roll up their sleeves—and because they are trained well, they integrate easily into the workforce."

Brothers is a strong proponent of UML's mission of accessibility, because she herself benefitted from it.

"You get a very high-quality engineering education at UMass Lowell, without putting yourself into debt for a large portion of your life," she says. "I worked two jobs to pay for my education, and the fact that I was able to afford the tuition while working part-time jobs was key. The education was top-notch. I had other friends in engineering programs at different schools, and I always felt that I was getting a deeper level of practical engineering experience—we didn't just learn theory."

In addition to her civil engineering degree, Brothers earned a master's degree in business from Northeastern University in 1991. She frequently returns to the UML campus, as a member of the Francis College of Engineering's Industrial Advisory Board and the Center for Women and Work Advisory Board. She is also a generous supporter of the university.

Brothers lives with her husband, Thomas, in Wilmington, Mass. Their daughter, Colleen, graduated from the University of New Hampshire, while their son, Ryan, followed his mother to UML. Brothers' sister, Loretta Girard Doughty '88, is also a UML engineering alumna.

Given her three-plus decades of experience, Brothers says she would give today's students three pieces of advice as they embark on their careers:

"First, you have to be passionate about what you do in life. Second, surround yourself with people who have different skill sets than you have. And last, remember that there is nothing like creating something you are proud of." UML



## FACULTY SUCCESSES

■ Asst. Prof. **Seung Woo Son** (electrical and computer engineering) was awarded a National Science Foundation (NSF) CAREER award for his research, "Reliable and efficient data encoding for extreme-scale simulation and analysis."

■ Prof. **Christopher Niezrecki**, chair of the Department of Mechanical Engineering, was named by the University of Massachusetts as this year's Roy J. Zuckerberg Endowed Leadership Chair.

■ **Hongwei Sun** (mechanical engineering), **Seongkyu Yoon** (chemical engineering) and **Hengyong Yu** (electrical and computer engineering) have been promoted to full professor.

■ **Brian Buchholz** and **Laura Punnett**, joining from the Zuckerberg College of Health Sciences, have been named professors of biomedical engineering.

■ **Juan Pablo Trelles** has been promoted to associate professor of mechanical engineering.

■ **Paul DeStefano** (civil and environmental engineering) and **Daniel Sullivan** (mechanical engineering) have been promoted to associate teaching professors.

■ A team of UMass Medical School physicians and Asst. Prof. **Gulden Camci-Unal** (chemical engineering) won a one-year, $15,000 grant in a recent Medical Device Innovation Competition sponsored by the Massachusetts Medical Device Development Center (M2D2) for developing a postoperative hybrid dressing for skin-graft donor sites.

■ The National Heart, Lung and Blood Institute of the U.S. National Institutes of Health has awarded a five-year, $7.9 million grant to the UMass Medical School in partnership with M2D2 under the leadership of Prof. **Stephen McCarthy** (biomedical engineering) to establish the Center for Advancing Point of Care in Heart, Lung, Blood and Sleep Diseases.

## STUDENT SUCCESSES

■ **Deborah Fowler** '18 (mechanical engineering) and **Erin Shaughnessey** '18 (chemical engineering) each won a 2018 NSF Graduate Research Fellowship award. Fowler is pursuing her Ph.D. in mechanical engineering at UMass Lowell; Shaughnessey is pursuing her Ph.D. in biomedical engineering at Tufts University.

■ **Melisa Nallar, Peng Yu, Nicholas Tenaglia** and **Olivia Gauntlett** (chemical engineering), **Jonathan Aguilar** (mechanical engineering) and **William Bizilj** (biology) won a $15,000 grant from the U.S. Environmental Protection Agency for their proposal to develop "green fertilizers from crustacean shell waste." The team is advised by Asst. Prof. **Hsi-Wu Wong** (chemical engineering). See page 5.

■ **Stephen Halas**, **Travis Kessler** and **Ciro Origi Rohr** (electrical and computer engineering), together with **Chunlong Huang** and **John Wheeler** (mechanical engineering), won first place in the 2018 Student Utility Bot Competition, sponsored by Symbotic. The team, which developed a "utility bot" to clean in an automated warehouse, was advised by Asst. Prof. **Yan Gu** (mechanical engineering) and Prof. **Yan Luo** (electrical and computer engineering).

■ The American Society of Civil Engineers (ASCE) has awarded the UML ASCE Student Chapter a letter of recognition for community service for the second year in a row. Assoc. Teaching Prof. **Edward Hajduk** (civil and environmental engineering) serves as the chapter's faculty advisor.

■ The Fellowship Board of Tau Beta Pi has awarded a scholarship to **Michael Doane** (chemical engineering) for academic year 2018–19.

■ **Nischay Kodihalli Shivaprakash** (plastics engineering) was awarded a student chapter scholarship from the Rubber Division of the American Chemical Society.

■ The summer internship work of biomedical engineering student **Aisling McEleney** at Draper Lab on developing a cellphone app-guided blimp was featured on newsedge.com.

## NEW RESEARCH AWARDS

■ Profs. **Craig Armiento** and **Alkim Akyurtlu** (both electrical and computer engineering) were awarded a grant by the Air Force Research Laboratory (AFRL) for their research on "low profile arrays" with Raytheon Company.

■ Assoc. Prof. **Joel Therrien** (electrical and computer engineering) and **Akyurtlu** were awarded a grant by the Army Research Laboratory for their study on "graphene-metal candidates for high-permeability areas."

■ Prof. **James Sherwood** (mechanical engineering) was awarded a grant by the Army Research Laboratory for his research on the "characterization and application of temperature-dependent material properties of thermoplastic lamina for the modeling of composite helmet forming."

■ Assoc. Prof. **Glenn Sundberg** (mechanical engineering) was awarded a grant by the Army Research Laboratory for his study on "additive manufacturing process development using cold spray technology" with H. F. Webster Engineering Services, Inc.

■ Assoc. Prof. **Christopher Hansen** (mechanical engineering) was awarded a grant by the Army's Small Business Innovation Research (SBIR) program for his work on "reusable modules for patient simulators" with Triton Systems, Inc.

■ **Armiento** and **Akyurtlu** were awarded a grant by the Army's SBIR program for their work on "printed materials with embedded electronics and radio frequency components" with SI2 Technologies.

■ **Camci-Unal** was awarded a grant by the Army Medical Research and Materiel Command's Small Business Technology Transfer (STTR) program for her research on a "low-cost diagnostic platform for biochemical and biomarker rapid detection and assay system" with Triton Systems, Inc.

■ Prof. **Xuejun Lu** and Assoc. Prof. **Hualiang Zhang** (both electrical and computer engineering) and Asst. Prof. **Wei Guo** (physics) were awarded a grant by the Army through AFFOA (Advanced Functional Fabrics of America) for their study on "flexible electronics for Li-Fi hat."

■ **Lu, Zhang** and **Guo** were also awarded a grant by AFRL for their work on "acquisition of a nanosecond ultra-broadly tunable mid-IR laser system for time-resolved investigation of the nonlinear interaction of MIR plasmonics and low-dimensional material systems."

■ Asst. Prof. **Zhu Mao** and Prof. **Peter Avitabile** (both mechanical engineering) were awarded a grant by the U.S. Department of Defense for their work on "image processing and motion magnification for dynamics identification of launch missile systems" with Dynetics, Inc.

■ **Avitabile** was awarded a grant by the U.S. Department of Energy for his research on "fixture design and damage potential" with Honeywell International, Inc.

■ **Wong** and Prof. **Zhiyong Gu** (chemical engineering) were awarded a grant by the NSF for their study on "catalytic reaction coupling of bio-oil hydrodeoxygenation and alkane dehydrogenation."

■ **Luo** was awarded an NSF grant for his research on "embedded machine vision for accurate gait analyses and body movement measurements."

■ Assoc. Prof. **Chronis Stamatiadis**, Asst. Prof. **Danjue Chen** and Assoc. Prof. **Yuanchang Xie** (all civil and environmental engineering) were awarded a grant by the Massachusetts Department of Transportation (MassDOT) for their research on "evaluation and enhancement of MassDOT traveler information programs."

■ **Chen** and **Xie** were awarded grants by the Federal Highway Administration for their work on "the application of unmanned aerial systems in surface transportation" and by MassDOT for their study on "traffic flow improvements: quantifying the influential regions and long-term benefits."

■ **Chen**, **Xie** and Assoc. Prof. **Jill Lohmeier** (education) were awarded a grant by MassDOT for their work on "greenhouse gas reduction strategy analysis."

■ **McCarthy** was awarded a grant by the U.S. Department of Health and Human Services for his work on a "product accelerator for health security at the Massachusetts Medical Device Development Center."

■ Assoc. Prof. **Sukesh Aghara** (chemical engineering) was awarded a grant by the Nuclear Regulatory Commission for his work on the "enhancement of nuclear engineering and health physics at UMass Lowell."

■ Asst. Prof. **Joyita Dutta** (electrical and computer engineering) was awarded a grant by the American Physical Society for her study on "joint segmentation of multi-channel biomedical images via graph cuts."

■ Asst. Prof. **Onur Apul** and Prof. **Xiaoqi (Jackie) Zhang** (both civil and environmental engineering) were awarded funding from the Massachusetts Clean Energy Center (MassCEC) Catalyst Program for their invention on "increasing biogas production from wastewater residual sludge by a novel single-step thermal pretreatment method." See page 6.

■ Assoc. Prof. **Stephen Johnston** (plastics engineering) was awarded a grant by the Army Natick Soldier Research, Development and Engineering Center for his work on "advanced materials and processes for improving soldier protection."

■ Asst. Prof. **Marianna Maiaru**, Assoc. Prof. **Fuqiang Liu** and Asst. Prof. **Scott Stapleton** (all mechanical engineering) and Assoc. Prof. **Tibor Beke** (mathematical sciences) were awarded a grant by the NSF for their research on "microstructural quantification and virtual reconstruction of polymer matrix composites within the Integrated Computational Materials Engineering (ICME) approach."

■ Asst. Prof. **Alireza Amirkhizi** (mechanical engineering) was awarded a grant by the NSF for his study on "accurate determination of acoustic wave sources using periodic microstructured materials."

## UNIVERSITY AND COLLEGE NOTES

■ Chemical engineering alumnus **Robert S. Ward '71**, who is president and CEO of California-based ExThera Medical Corp., has been elected a member of the National Academy of Engineering for his accomplishments in the development and commercialization of biomedical devices and prosthetic implants.

■ The U.S. Department of Transportation has awarded a $2.5 million grant to a consortium of institutions—including UMass Lowell, the University of Maine, the University of Connecticut, the University of Rhode Island and Western New England University—to create a Transportation Infrastructure Durability Center to research ways to extend the life of New England's roads and bridges. Assoc. Prof. **Tzuyang Yu** (civil and environmental engineering) is leading the UML effort.

■ The Center for Science of Heterogeneous Additive Printing of 3D Materials (SHAP3D), led by Prof. **Joey Mead** (plastics engineering) at UMass Lowell and in partnership with the University of Connecticut and Georgia Institute of Technology, received a Phase I Center Award from the NSF Industry/University Cooperative Research Center program.

■ UMass Lowell has launched a bachelor of science degree program in environmental engineering (through the Department of Civil and Environmental Engineering; see page 1) and a minor in aerospace engineering (through the Department of Mechanical Engineering) this fall.

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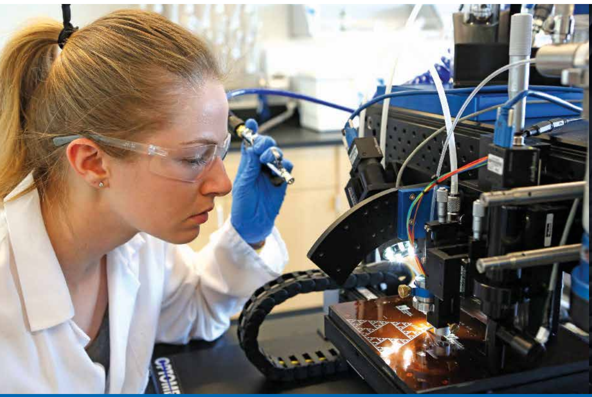

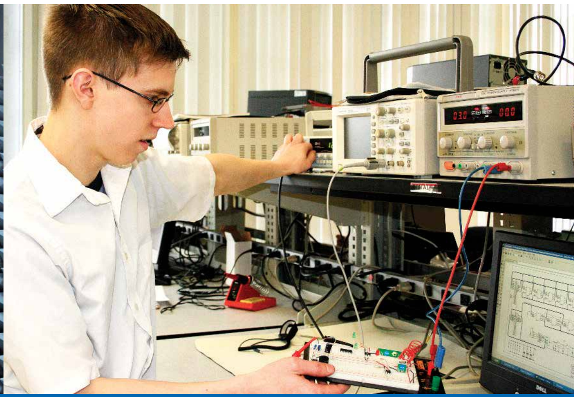

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**Save the Date!**

**Francis College of Engineering Alumni Night and Hockey Game**

UMass Lowell River Hawks
vs. Merrimack College
Friday, Feb. 22, 2019
Game starts at 7:15 p.m.,
Tsongas Center at UMass Lowell

RSVP: Alumni_Office@uml.edu; 978-934-3140

**Contact Information**

*For College information:*

Joseph C. Hartman, Ph.D., P.E.
Dean, Francis College of Engineering
Joseph_Hartman@uml.edu
978-934-2576

*For sponsorships and partnering:*

Sally Washburn
Director of Development, University Advancement
Sally_Washburn@uml.edu
978-934-4821