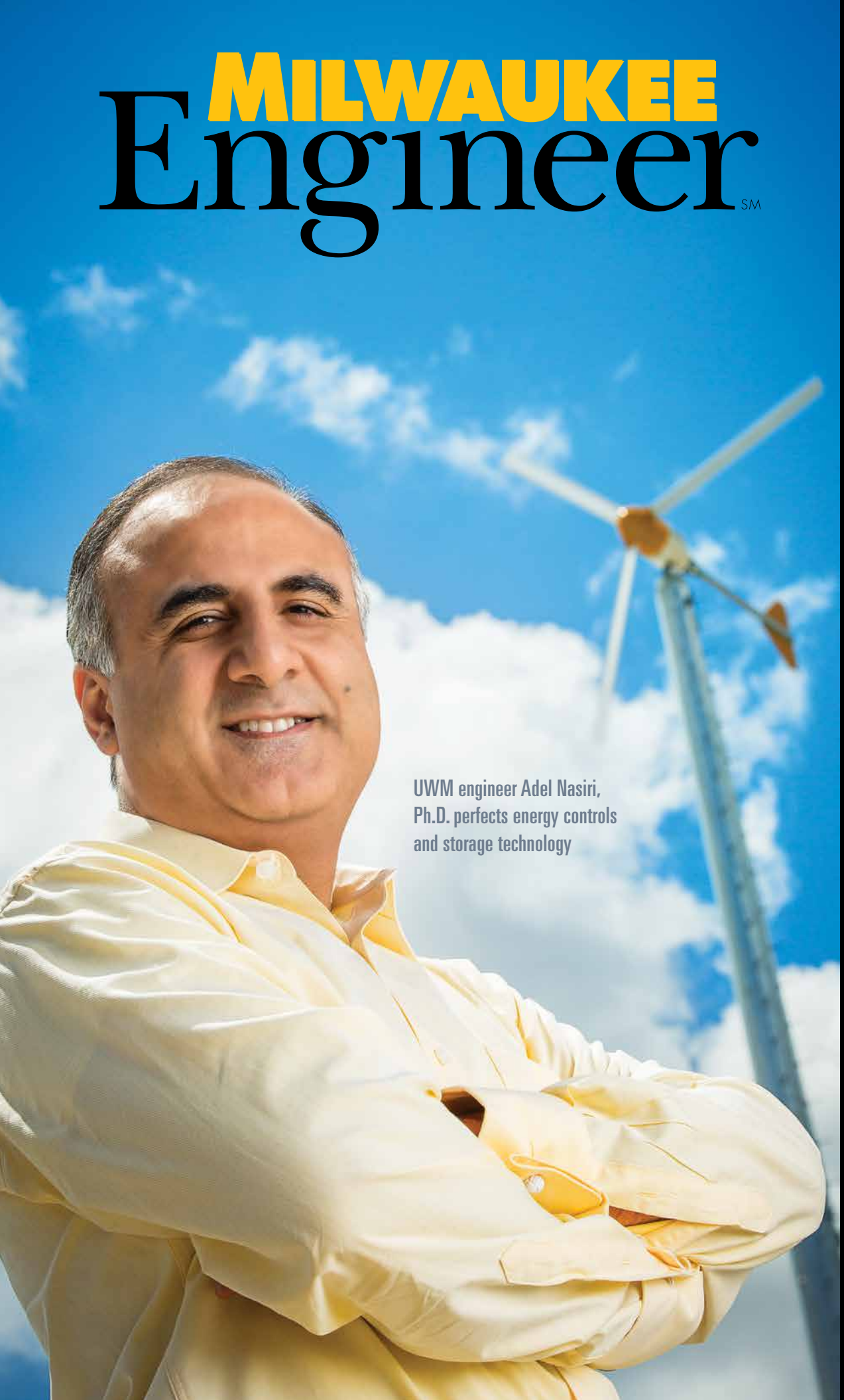
MILWAUKEE Engineer℠



UWM engineer Adel Nasiri, Ph.D. perfects energy controls and storage technology

FALL 2014

UNIVERSITY of WISCONSIN
UWMILWAUKEE
College of Engineering & Applied Science

MILWAUKEE Engineer

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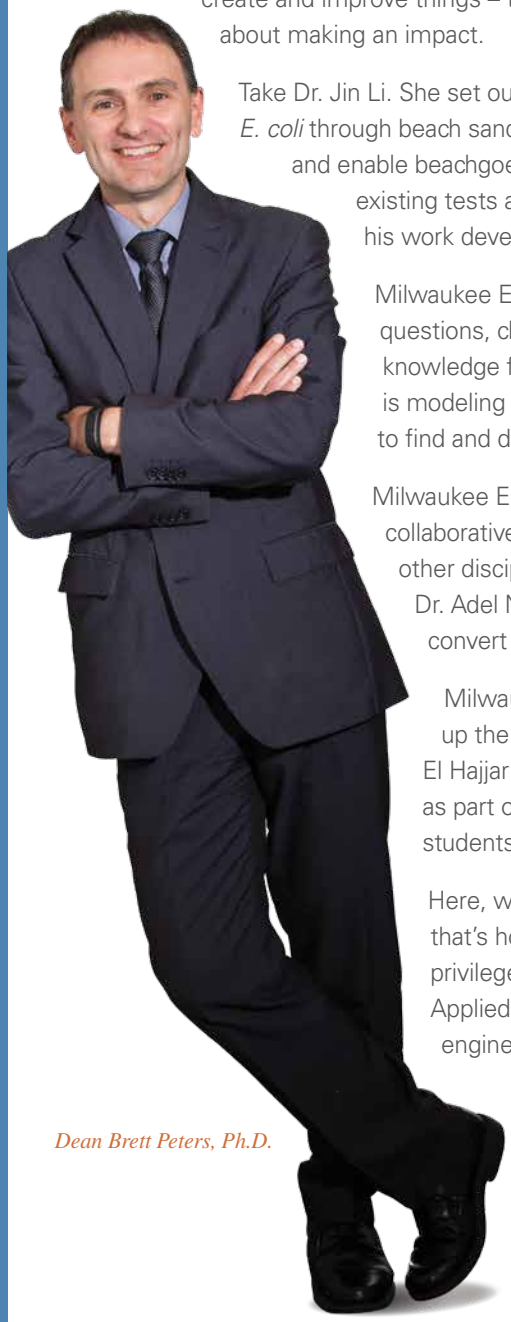
College of Engineering & Applied Science

What is a Milwaukee Engineer?

As the academic year begins and we welcome new students and faculty members to UWM Engineering & Applied Science defining what makes a Milwaukee Engineer is timely.

While Milwaukee Engineers have roots at UWM, being a Milwaukee Engineer is less about our campus and more about what drives us to change the world.

Milwaukee Engineers have a thirst for knowledge and discovery matched with a drive to create and improve things – to make people's lives better. Our applied research is about making an impact.



Dean Brett Peters, Ph.D.

Take Dr. Jin Li. She set out to improve public safety by understanding the path of *E. coli* through beach sand (p. 8). Her work stands to improve water filtration systems and enable beachgoers to be warned of dangerous *E. coli* presence sooner than existing tests allow. Likewise, Dr. Junhong Chen is improving lives through his work developing sensors to help manage medical conditions (p. 6).

Milwaukee Engineers have the tenacity and courage to ask tough questions, challenge assumptions and integrate knowledge – even knowledge from uncommon places. Take a look at how Dr. Ryo Amano is modeling wind turbine blades after whale fins and bird wings (p. 10) to find and deliver solutions to real-world problems.

Milwaukee Engineers are tempered by industry experience. They are collaborative engaging students, industry partners and colleagues from other disciplines to identify, understand and solve problems - like Dr. Adel Nasiri and his team who are reimagining how we can convert and distribute electrical energy (p. 2).

Milwaukee Engineers want to expand their knowledge and bring up the next generation of Milwaukee Engineers. Step into Dr. Rani El Hajjar's classroom where students are working on a 3D printer as part of NASA's 2015 X-Hab Academic Innovation Challenge. The students' goal is to enable parts to be manufactured in space (p. 14).

Here, we lead with research, while education is our foundation — that's how Milwaukee Engineers seek to change the world. I'm privileged to serve as Dean of UWM's College of Engineering & Applied Science. It's an honor to lead a team of creative, inquisitive engineers who are driven to change the world and to cultivate bright minds of future engineers.

I'm Brett Peters, and I'm proud to be a Milwaukee Engineer. ●

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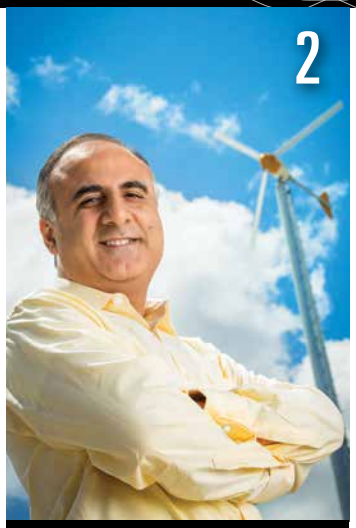
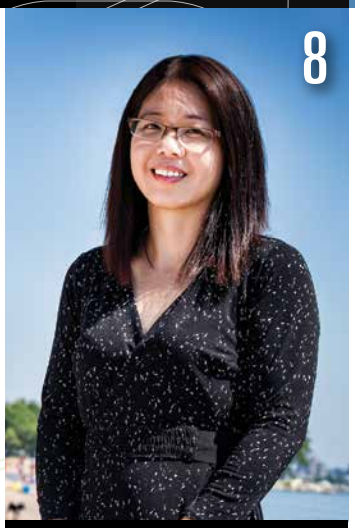


Adel Nasiri, Ph.D.

Junhong Chen, Ph.D.



Jin Li, Ph.D.

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UWM engineer collaborates with industry

The infrastructure that supports the way we access electricity is on the brink of revolutionary change equivalent to the leap from landline to cell phones in the telecommunications industry.

Recent advances are making energy sources like natural gas, solar cells and even wind turbines more cost-efficient. The remaining hurdle is making these sources that generate and distribute energy in different ways compatible with the nation's electrical grid.

"The region has a large footprint in energy, power and control. The size and growth of that sector makes it the North American center for the field."

— Alan Perlstein, executive director and CEO of M-WERC

That is the goal of Adel Nasiri, professor of electrical engineering, whose lab is developing a microgrid testbed – the most complex in the state — that will demonstrate his research on new energy control and storage methods.

The grid infrastructure is designed to use power dispatched from sources like power plants that can adjust their output to match user demand. Output is not as adjustable with other energy sources.

"By adding multiple other sources, we will need to 'smooth out' the intermittent power that each generates," says Nasiri, "in order to keep the output-demand in balance."

Wind turbines, for example, generate electricity only when the wind is blowing. But in most places, the wind blows more often at night when demand for electricity is low. Nasiri's patented technology allows energy generated when the demand is low to be stored and then released when the demand is high.

Energy islands

Microgids can function in two ways. They are able to trade power from integrated sources and provide supporting services to the electrical grid; they can also serve as free-standing power sources that provide uninterrupted service to a limited surrounding area.

They could serve as "energy islands" for local areas during power outages or could be a way to power small villages in developing countries when the service isn't available or reliable. For now, microgrids are still experimental.

Nasiri is addressing the remaining challenges that are keeping microgrids from entry into a market that is projected to produce revenues of $3 billion by 2017.

A 100-foot-high, 10-kilowatt wind turbine recently was erected outside the University Services & Research Building near Capitol Drive and Port Washington Road, the first piece of UWM's microgrid system. When completed later this year, the system will combine power generated from wind, solar, natural gas and batteries.

Nasiri's project is one industry leaders are watching closely because of the number of sources it is integrating.

The work will facilitate the use of more renewable energy sources, a goal of many of the projects Nasiri directs at the Center for Sustainable Electrical Energy Systems in the College of Engineering & Applied Science *(see sidebar, page 3)*.

to develop energy islands

The epicenter of the field

Perfecting microgrid technology would strengthen an industry cluster that already exists in the Midwest.

"The region has a large footprint in energy, power and control (EPC)," says Alan Perlstein, executive director and CEO of the Midwest Energy Research Consortium (M-WERC). "The size and growth of that sector makes it the North American center for the field."

In Wisconsin the EPC sector is the number one economic driver, according to a survey conducted by Wisconsin Economic Development Corporation.

Continued on page 4

Adel Nasiri, professor of electrical engineering, is working to bring reliable distributed energy systems called microgrids to the marketplace.

Growing sustainable energy systems

Yi Wang, a graduate student in the Nasiri lab, is tasked with optimizing distributed energies.

Making electric power systems greener, more cost effective and secure is the aim of the Center for Sustainable Electrical Energy Systems, headed by Professor Adel Nasiri, who researches energy storage, microgrid systems and renewable energy sources.

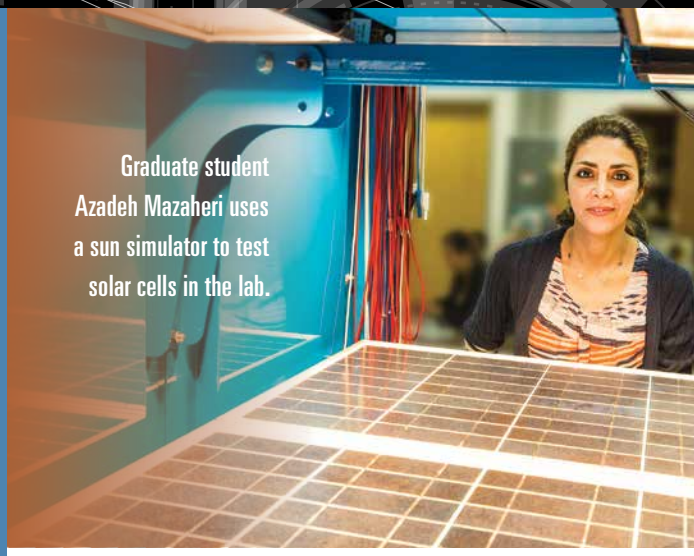
Researchers at the center are also developing architectures for future power distribution systems, for residential and industry use, and for emerging applications such as improved power systems for medical devices and electric vehicles.

The Center will provide a platform for collaboration between the UWM Engineering & Applied Science's faculty, industry, and federal and state agencies on electrical energy systems, Nasiri says. The Center is building a talent pipeline for companies in Southeastern Wisconsin as industries work directly with the center researchers and students to develop new technologies.

Microgrid construction with renewable energy sources is one project of the Power Electronics and Electric Drives Lab. This lab, existing within the Center, focuses on all aspects of electrical energy generation and conversion.

Midwest Energy Research Consortium

Bringing innovation to market



Graduate student Azadeh Mazaheri uses a sun simulator to test solar cells in the lab.

The State of Wisconsin has provided more than $900,000 to Midwest Energy Research Consortium (M-WERC) to support a new Energy Innovation Center (EIC) in Milwaukee, a facility expected to solidify the region's role as leader in energy, power and controls (EPC). The EIC will include its own microgrid lab that conducts research closer to the commercialization end of the product development process than the academic labs.

M-WERC's goal is to overcome obstacles that prevent products from moving from concept to production in energy, power and controls.

M-WERC began in 2010 with only seven members in southeast Wisconsin and now has 76 members in eight states. The organization is promoting and uniting the region's EPC cluster by focusing on workforce development and public policy as well as product and process development.

Companies like Milwaukee's Johnson Controls and Chicago's S&C Electric are members, along with Eaton Corp., Kohler and DRS, all companies with an interest in microgrid technology, says Alan Perlstein, M-WERC executive director and CEO.

M-WERC founded two labs on UW System campuses. UW-Madison's lab is simulating microgrid hardware to predict performance and impact on the electrical grid. UWM's lab is testing the actual hardware from M-WERC companies on its microgrid testbed.

Continued from page 3

With 76 industry and academic members, M-WERC combines resources to accelerate research and provide a trained workforce, helping sustain the eight-state region as a national stronghold. *(See sidebar, left.)*

M-WERC is a financial supporter of the testbed research and six members are contributing parts, including Kohler, Rockwell Automation, LEM, Odyne, Eaton Corporation and ZBB Energy Corp.

Integrating hardware

A state-of-the-art testbed will give area companies a first look at the compatibility of their parts.

The various pieces necessary to build the microgrid are produced by different companies, Nasiri says. When using them together, he will determine whether companies need to adapt their products to fit this new environment.

LEM USA, headquartered in Milwaukee, is one of those participating in the project. The company is the world's largest producer of transducers, a key component in the power electronics industry. Power electronics are a key feature of microgrids and the DC current that is part of the system.

"We have the good fortune to be involved at the ground floor of a new market," says Erik Lange, senior marketing and technology manager. "LEM wants to be there as the microgrid is evolving, so we have the right product when the market is ready." ●

UWM Alumni Association recognizes We Energies with Corporate Partner Award

The UWM Alumni Association (UWMAA) honored We Energies with its 2014 Corporate Partner Award, which recognizes the company's significant impact on the campus and the lives of alumni and students by assisting in the advancement, growth and development of UWM.

We Energies is one of UWM's most significant philanthropic partners. Over the span of 39 years, they have supported numerous UWM initiatives. Among the many strategic investments are those for wind energy research and the Renewable Energy Research Fund in the College of Engineering & Applied Science. We Energies also made exceptional investments in Innovation Campus, the UWM Real Estate Foundation's new campus in Wauwatosa. ●

Ramin Pashaie featured in *IEEE Reviews in Biomedical Engineering*

Ramin Pashaie, assistant professor of electrical engineering

Ramin Pashaie, assistant professor of electrical engineering at UWM, led a group of researchers from MIT, Stanford, University of Wisconsin-Madison and Weisman Institute to write a review paper on Optogenetic Brain Interfaces. The paper appeared in *IEEE Reviews in Biomedical Engineering* and was featured on the journal's cover.

Optogenetics is a technique used in neuroscience that uses light to control neurons that have been genetically sensitized to light. The light manipulates nerve activity and measures the effects of those manipulations in real-time. It is a powerful experimental approach for studying the circuitry of psychiatric and neurological disorders. ●

Bringing together bright minds

UWM hosts InterPore conference

The University of Wisconsin-Milwaukee (UWM) hosted the sixth annual conference of the International Society for Porous Media (InterPore) May 27-30.

InterPore is a non-profit, independent scientific organization. Its goal is to advance and disseminate knowledge for the understanding, description, and modeling of natural and industrial porous media systems.

The conference welcomed more than 300 delegates from all over the world. It was organized by professors of the College of Engineering & Applied Science and the College of Letters & Science, including Drs. Krishna Pillai, Woo-Jin Chang and Jin Li, of the College of Engineering, and Drs. Weon Shik Han, Shangping Xu, and Thomas Hooyer from the Geosciences department in the College of Letters & Science.

A head start on treating disease

Novel nanomaterials in sensors make diagnosis as easy as spitting

Drs. Chen and Hernandez collaborate on biosensors that will help patients manage health conditions.

How does an engineer who created a unique sensing material find a collaborator qualified to explore its potential uses in medicine?

Junhong Chen, professor of mechanical engineering, didn't have to look any further than his personal doctor, Milwaukee physician Lyndon Hernandez.

"I am interested in medical devices that can improve patient care in my field," says Hernandez, who specializes in gastroenterology. "I found an intersection of Chen's expertise in engineering with my research interests."

Hernandez, who has conducted research and teaches at the Medical College of Wisconsin, also has been involved in a startup ultrasound technology company. He and Chen are collaborating on developing biosensors that can help patients manage conditions such as acid reflux disease and obesity.

Though all are still in the concept phase, the most promising sensor will measure and monitor the pH levels in the patient's saliva, helping people with acid reflux to better manage their disease. Their findings were presented in a recent international meeting of gastroenterologists.

"[Doctors] must diagnose this condition invasively with a probe threaded through the patient's nasal passage and down into the esophagus," says Hernandez. "It takes time and money to place the probes with endoscopy and then have the data evaluated later."

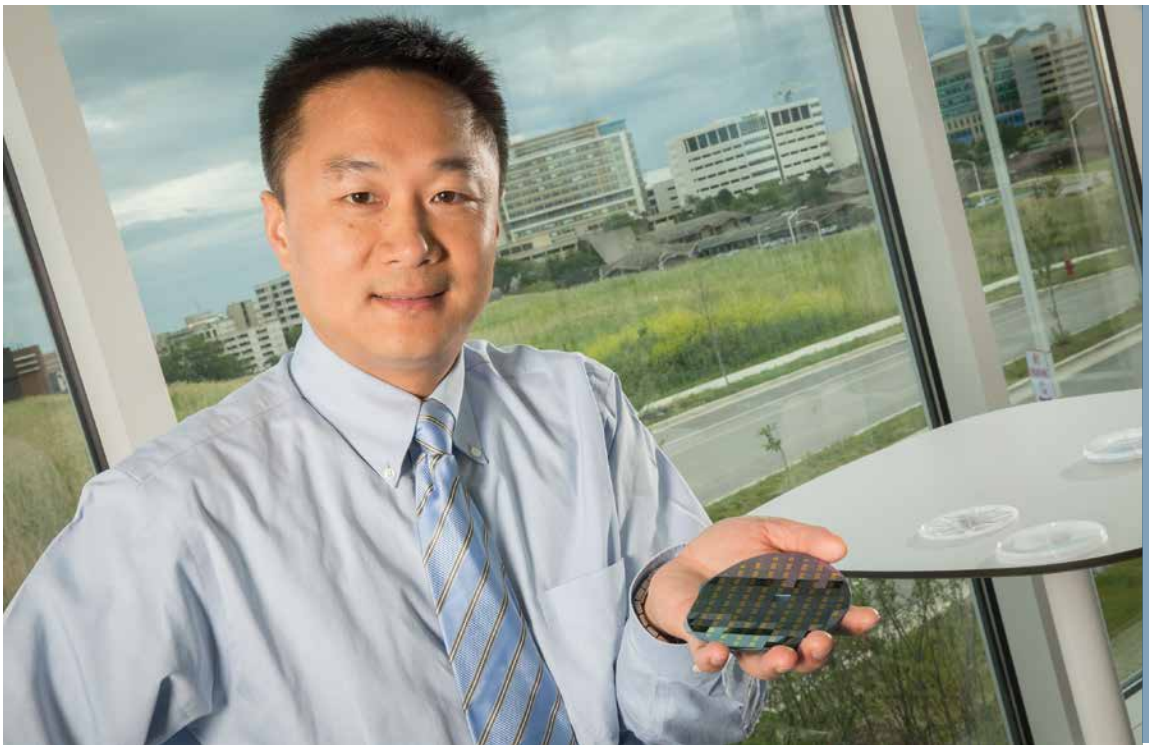
For now, the sensors the two are designing provide a simple "spit test" that could be done at home by the patients themselves. In the future, however, Chen says the sensor could take the form of a test strip that adheres to the patient's upper lip, accomplishing the same thing by detecting indicators of pH levels in their breath and sending the readings wirelessly to a smartphone in real time.

More testing to ensure the accuracy of the method is needed before the sensor is ready for human trials.

Besides Chen and Hernandez, co-inventors of this technology include California gastroenterologist George Triadafilopoulos, an adjunct professor at Stanford University; Minnesota gastroenterologist Robert Ganz, an adjunct associate professor at the University of Minnesota; and Jingbo Chang, a post-doctoral researcher in Chen's lab.

The material

Chen's material is composed of carbon nanotubes studded with specific nanoparticles.



"The world lags behind in using nanotechnology in medical applications. That's because it requires a closer working relationship between engineers and health care providers."

— Junhong Chen

The properties of the resulting hybrid can be "tuned" to sense particular targets by attaching different nanoparticles. Identification occurs by a change in the resistance of electrons flowing through the graphene, a material known for its strength, conductivity and flexibility.

This combination of nanostructures makes the material both high-performance and cost-effective, giving it potential applications in medicine, green energy technology, food processing and environmental monitoring. Two patents on the material are licensed to Chen's startup company, NanoAffix Science LLC.

At Innovation Campus, UWM's new technical park in Wauwatosa, Chen plans to produce these sensors on a chip to demonstrate how inexpensive they could be — perhaps as little as a penny a sensor if produced in bulk.

It's another benefit of locating the UWM engineering and biomechanics labs across the street from Milwaukee's regional medical hub. "At Innovation Campus, we can perfect the prototype and make it on site," he says.

Wide-open possibilities

Because Chen's hybrid nanomaterial is tunable, the possibilities for applications are numerous. Besides developing a sensor for pH, he and Hernandez also have an idea for a sensor — perhaps one attached to a tooth — that can count calories to help obese people manage their food intake.

Another idea of Chen's, inspired by a family member with diabetes, is a sensor that continuously monitors blood sugar levels for diabetics.

"The world lags behind in using nanotechnology in medical applications," he says. "That's because it requires a closer working relationship between engineers and health care providers." ●

To demonstrate how inexpensive they could be, Chen plans to produce these sensors on a chip at Innovation Campus, UWM's new technical park in Wauwatosa.

Safer water saves lives

Research aims to reduce risk of water-borne illness

Dr. Jin Li's research holds the promise of improving public safety.

In 1993, the presence of the water-borne parasite, Cryptosporidium, in Milwaukee's water supply caused an estimated 400,000 cases of gastrointestinal illness and at least 69 deaths. In May of this year, 670,000 residents of Portland, Oregon were placed under a boil advisory after the city found *E. coli* in water samples. Each year, beaches are closed for swimming throughout the country due to high levels of *E. coli* in the water — based on readings that are at least 24 hours old.

UWM's student researchers obtain sand samples from Milwaukee-area beaches to test for *E. coli*.

E. coli is a strain of bacteria that lives in the intestines and is present in human and animal fecal matter. Rainfalls and snow melts can wash *E. coli* from animal waste into nearby water sources such as creeks, streams, rivers, lakes and ground water. Sewage overflows can send *E. coli* from human waste into water sources as well.

UWM Professor of Civil and Environmental Engineering Jin Li is doing research that holds the promise of improving public safety by increasing the accuracy of beach health reports and enhancing the effectiveness of public water filtration systems.

Dr. Li is studying how *E. coli* is contained and transported through groundwater and beach sand. This research is important not only because *E. coli* itself can be a dangerous pathogen, but because it is an indicator that other pathogens may be present as well, such as Cryptosporidium. If we understand how *E. coli* behaves, we can predict when and where beach water will be contaminated and whether the sand will be contaminated as well. We can also improve the sand filters in our water filtration systems. All of these steps will help prevent contamination and illness from occurring.

The attraction to sand

Dr. Li began her research on *E. coli* eight years ago. At that time, she was interested in how *E. coli* from farm run-off was transported in groundwater. More recently, with funding from the National Science Foundation, she has been studying the interplay between sand and *E. coli*.

"There are different forces at work between *E. coli* and sand," Li explains. "Some are natural and some can be manipulated. If we use engineering expertise to increase the attraction between the sand and the bacteria, we may be able to more effectively 'trap' *E. coli*." This could help prevent the sort of sand filtration failure that caused Milwaukee's Cryptosporidium outbreak in 1993.

The fact that sand absorbs and holds *E. coli* is positive for filtration systems but unfortunate for beach-goers. People and pets can be unknowingly contaminated when *E. coli* from contaminated water infiltrates sand in the "swash zone," the area washed by waves. Anyone who's played at the beach knows that this is the best place to make sand castles. It's also a favorite place for dogs to run and play.

Because current beach closings are based upon water readings that are 24 hours old, beaches could be open while unsafe levels of bacteria remain in the sand. Dr. Li wants to change that. A system that used a predictive model to identify unsafe stretches of water in combination with sand monitoring would better ensure public safety.

A collaborative effort

Dr. Li and her students have been conducting experiments for the past several years on farms, on Milwaukee beaches and in her lab, where she has a sand column that simulates the movement of groundwater. Due to the nature of her work, she has also collaborated at various times with Dr. Shangping Xu in the GeoSciences department, Dr. Ching-Hong Yang in the Biological Sciences department, and Dr. Sandra McLellan in the School of Freshwater Sciences. Currently, she is working with a department colleague, Dr. Qian Liao, to develop a research model that can be used by others to replicate and verify her findings.

Dr. Li's long-term goal is to enhance public safety by:

- Improving the effectiveness of water filtration systems,
- Producing a predictive model that more accurately determines beach water safety,
- Demonstrating the importance of beach sand testing to public health.

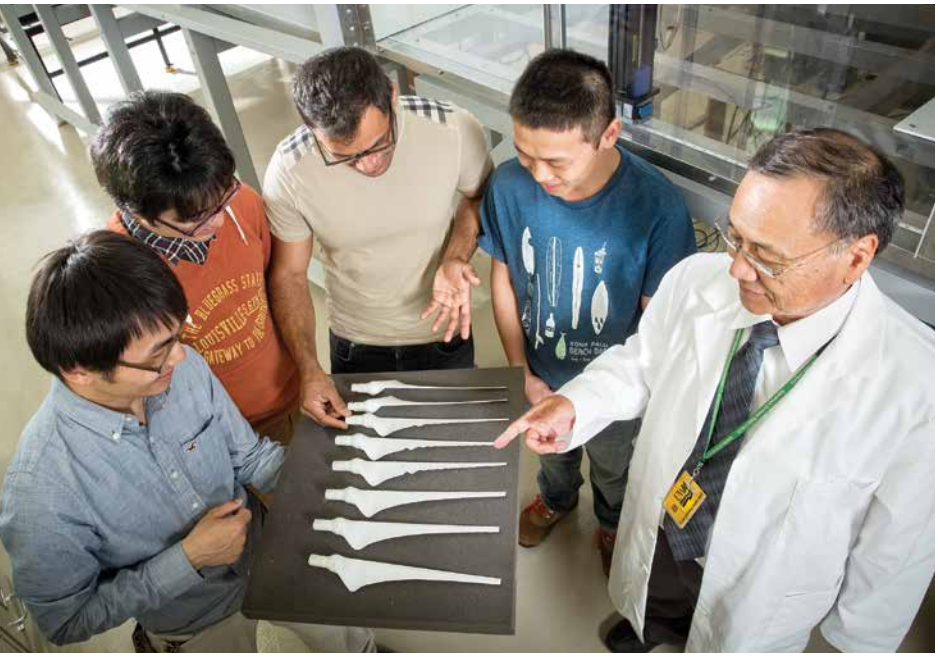
She sees the work she is doing today as a first step in understanding how all contaminants travel through groundwater. Her work is especially important considering the growing number of contaminants that may end up in groundwater, such as pharmaceuticals and nanoparticles used in cosmetics, paint and other manufactured materials. Because groundwater is the source for 25-40 percent of the world's drinking water, Li's work is critical, even life-saving. ●

Dr. Jin Li's research has the potential to improve beach safety and water filtration systems.

WINDS *of* CHANGE

Research focuses on increased efficiency and productivity of wind turbines

Looking out his office window, Dr. Ryoichi Amano sees the future. On this windy summer day, the 100-foot-tall wind turbine outside his office building is in constant motion. As concerns about climate change and traditional energy sources grow, there is little doubt that renewable energy sources will gain an increasing share of the energy market. Dr. Amano, professor of mechanical engineering at UWM, is interested in many of these sources, but right now, his attention is focused on wind.



Dr. Amano and his students test various blade designs that mimic shapes found in nature.

Dr. Amano and his team are working to increase the efficiency of wind turbine blades by altering both the design and the material composition

Wind technology is of particular interest to Dr. Amano because it is closely related to aeronautics — a field he has studied for decades. Earlier in his career, Dr. Amano's research focused on aeronautics and aerospace engineering. While his achievements include contributing to NASA's space shuttle program, his current research project brings his work closer to home.

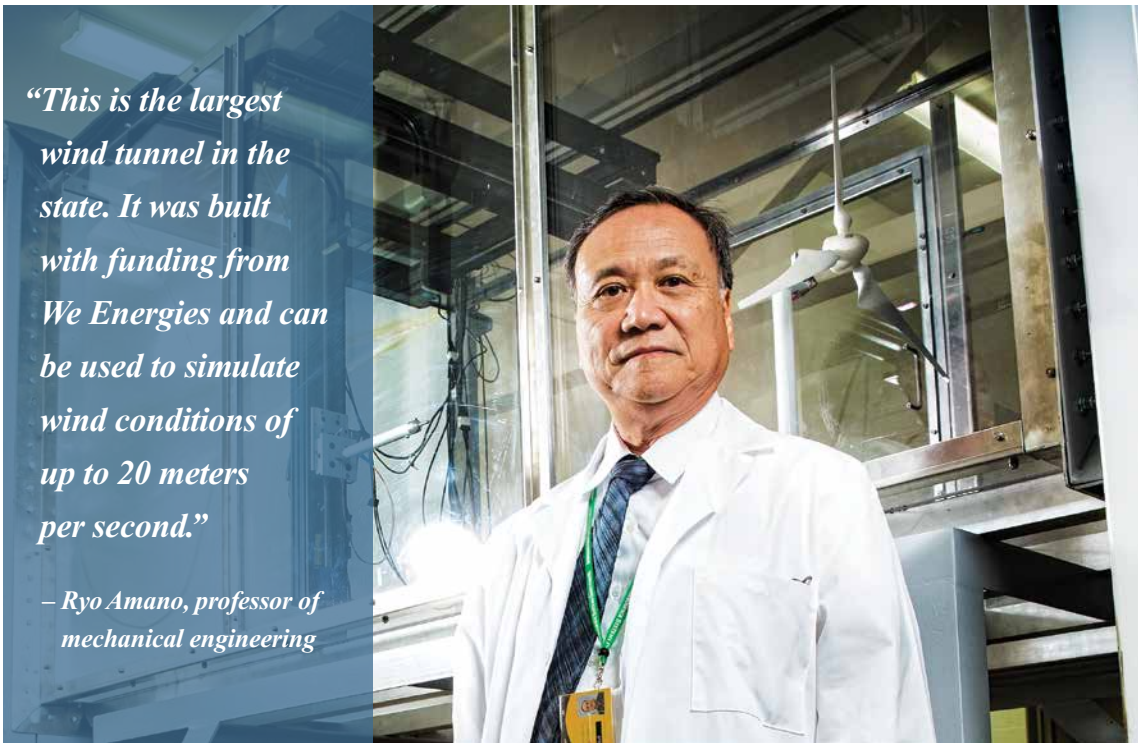
Natural selection

For design inspiration, Amano's team is turning to nature, using biomimicry to guide its efforts. With funding from the U.S. Department of Energy, the National Science Foundation (NSF), and We Energies, the team is studying examples of efficient flow in the air and the sea and experimenting with various blade designs—including one that undulates like a whale fin and one that allows air to pass through the blade the way air passes through the feathers of a bird's wing. Using computational design analysis, the team tests variations for performance under differing wind conditions. Modifications are made as needed, and prototypes are created to test in Dr. Amano's wind tunnel.

At 10' x 10' x 40', the wind tunnel is an imposing presence in Dr. Amano's lab. "This is the largest wind tunnel in Wisconsin. It was built with funding from We Energies and can be used to simulate wind conditions of up to 20 meters per second," says Amano. Data derived from wind

tunnel tests are collected and analyzed, resulting in further refinements to blade designs.

In addition to design research, the team is evaluating material options. With funding from a National Science Foundation (NSF) grant, and working in collaboration with Dr. Pradeep Rohatgi's team in Materials Science and Engineering, Dr. Amano is working to develop a self-healing wind turbine blade. This research could lead to important advances in wind energy efficiency and safety.



"This is the largest wind tunnel in the state. It was built with funding from We Energies and can be used to simulate wind conditions of up to 20 meters per second."

– Ryo Amano, professor of mechanical engineering

A material difference

Wind turbines are exposed to heat in the summer, cold in the winter and every type of precipitation. These conditions take their toll. Blades eventually crack and chip, reducing efficiency and creating unsafe conditions around the turbine. When repairs are required, the turbines must go offline, and service crews must be sent to diagnose and fix the problem. This is costly and inefficient. Energy companies would benefit from a more durable blade with a longer useful life.

Drs. Amano and Rohatgi are working to develop a material that is durable, light, and most importantly, embedded with special properties that "heal" cracks when they occur. High-performance polymers are being tested that respond to surface fractures with "micro-tubes" that travel to the damaged area and seal it off. At this stage of research, the polymers show promise, but challenges remain. "Researchers have been working on self-healing designs for more than a decade," says Amano. "The healing properties are known to work under carefully controlled conditions. The challenge is to replicate the healing behavior under realistic conditions." This is something that the team hopes to do when they put a prototype to the test in the wind tunnel.

The polymers that are ultimately chosen will need to make a blade that satisfies many demands: it will have to be lightweight for easy transport and minimal stress on the turbine base; it will need to be simple to mass produce; and it will have to hold up under every potential condition whether it is installed in the prairie, the desert or the open ocean.

These challenges merit solving. Wind is a growing source of energy around the world. It is clean, renewable, uses virtually no water and emits no greenhouse gases. With an increasing number of countries looking to wind to meet at least a portion of their energy needs, the research stands to benefit us all. ●

'Mr. Green Flame'

Dr. Ashwani Gupta receives honorary Doctor of Energy and Engineering Science degree for his work with renewable energy

Dr. Ashwani Gupta is well known and respected for his development of innovative technologies that reduce environmentally hazardous emissions from airplanes, power plants, industrial systems and automobiles. His recent research includes the development of waste management techniques that would enable the incineration of waste material without significant emissions of hazardous gases.

"Through our work at the University of Wisconsin-Milwaukee (UWM), we have successfully demonstrated that we can take biomass garbage and effectively and efficiently process it to create liquid fuel with high performance yet low pollution levels."

— Ashwani Gupta, Ph.D.

A noted leader in the renewable energy field, Gupta, or "Mr. Green Flame" as some call him, is known by some colleagues as the father of High Temperature Air Combustion Technology (called HiTAC). This is a novel technology used worldwide in industrial furnaces. HiTAC has proven simultaneous benefits of:

- Significant energy savings (about 30%),
- Pollution reduction (about 50%),
- Smaller plant size (about 25%),
- Longer plant life and better quality of product produced.

Gupta further developed this technology for use in power plants and waste-to-energy systems achieving similar benefits.

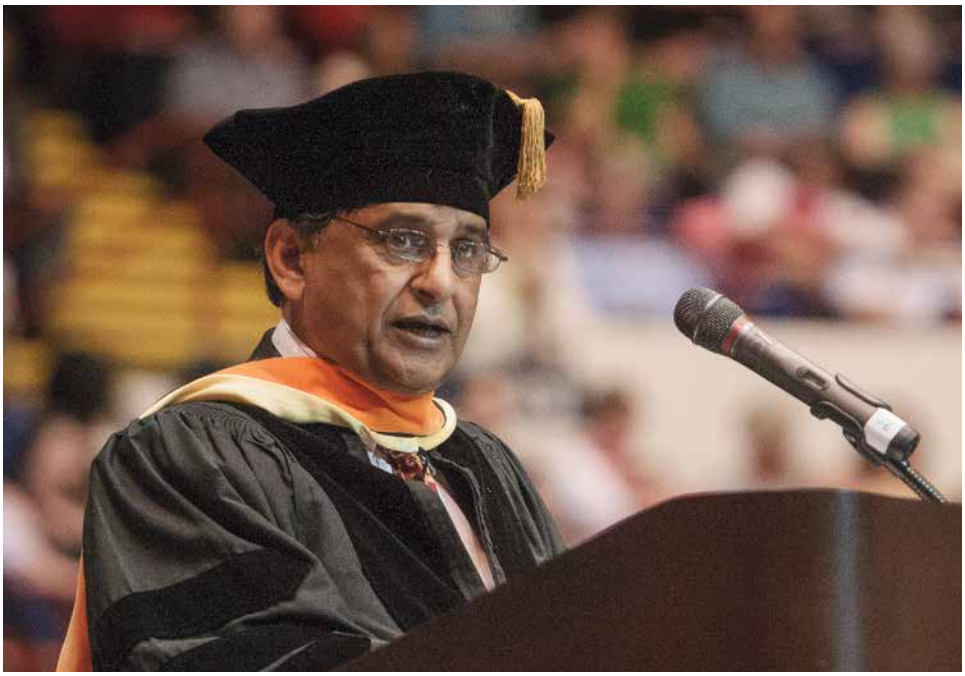
And now, Dr. Gupta, distinguished university professor, University of Maryland, College Park, can add Honorary Doctor of Energy and Engineering Science to his list of accomplishments.

"I am privileged to receive this honorary doctorate," says Dr. Gupta. "This was important work when I started 15 years ago, and it's going to become even more important in the next 50 years as our current oil reserves diminish. We see the end of road and we are working together to find other ways to produce energy independence. Through our work at UWM we have successfully demonstrated that we can take biomass garbage and effectively and efficiently process it to create liquid fuel with high performance yet low pollution levels."

Dr. Gupta has taken his knowledge on the road, delivering lectures and keynote speeches at major environmental and energy sciences conferences in the United States, Asia, Europe, the Middle East and Africa.

"UWM is especially grateful to Dr. Gupta for being a frequent guest speaker at our seminar series for students, faculty and staff members," says Brett Peters, Dean of the College of Engineering and Applied Science. "He has provided advice to graduate and undergraduate students working on research projects in the areas of renewable energy and reducing hazardous emissions, ensuring that our next generation can continue to advance this work."

Dr. Gupta has engaged in research collaborations with UWM faculty on several projects, including the "Transformation of Chicken Litter to Clean Syngas for Independent



Dr. Gupta, known for his work in renewable energy, has authored over 650 technical papers and delivered over 100 plenary and keynote lectures at international conferences and organizations. His work has led to novel combustor designs for gas turbine engines with significant benefits to pollution reduction, enhanced performance and engine life, and fuel savings.

Power Production in Milwaukee Farms," an important social and environmental project that is expected to significantly benefit and expand the scientific knowledge and database while providing new innovative business opportunities for Milwaukee.

He has developed and written research proposals with Dr. Pradeep Rohatgi, UWM distinguished professor and state of Wisconsin distinguished professor of materials, and Dr. Ryoichi Amano, professor of mechanical engineering.

"Because we each have a slightly different research focus, working together has elevated our contributions around energy systems and combustion," says Dr. Amano. "I admire his strong collaboration locally, with the business community in Milwaukee and Wisconsin, as well as his work nationally and internationally. He is a tremendous leader, openly exchanging ideas with others in the field while connecting people and resources to expand the positive influence of his work. This is good for our students, our faculty, our community and our world." ●

UWM student earns honors

UWM senior Erika Pliner was named one of five 2014 Tau Beta Pi Laureates by the national engineering honor society. In the last 32 years, (since 1982) there have only been 94 Tau Beta Pi Laureates named. The program recognizes gifted engineering students who have excelled in areas beyond their majors. Erika will graduate in December with a degree in mechanical engineering.

UWM project selected for NASA's 2015 X-Hab Academic Innovation Challenge

Rani Elhajjar, Ph.D., civil and environmental engineering

The University of Wisconsin-Milwaukee (UWM) has been named one of five universities by NASA and the National Space Grant Foundation to participate in the 2015 Exploration Habitat (X-Hab) Academic Innovation Challenge.

The X-Hab Challenge invites student teams to develop concepts and prototypes for technology that will be needed on future deep space missions. They will design, manufacture, assemble and test their deep space systems and concepts in close cooperation with members of the NASA Exploration Augmentation Module (EAM) concept team.

> *"Just like most innovations developed by NASA, the solutions our students construct could have real-world applicability in industry and manufacturing."*
>
> *— Rani Elhajjar, Ph.D., civil and environmental engineering*

The UWM team will be led by Rani Elhajjar, PhD, Associate Professor of Civil and Environmental Engineering in the College of Engineering & Applied Science. His team will design a fused deposition modeling manufacturing system that would enable parts to be manufactured in space when needed. The team will investigate methods for incorporating continuous carbon fiber reinforcements to increase the strength and stiffness of parts.

Such a capability is vitally important to the future of deep space exploration because while the cosmos has infinite possibilities, a spacecraft has finite room to carry spares. With such a system, if you don't have a component along, you can make it and following its use it can be recycled into another part.

"This is an incredible opportunity for our students and our university," says Elhajjar. "The foundation of this academic challenge is innovation. Our students will explore NASA's work on development of deep space habitats while also helping the agency gather new ideas to complement current research and development."

The challenge encourages multidisciplinary approaches between different engineering disciplines while strengthening partnerships between NASA, academia and industry.

"Just like most innovations developed by NASA, the solutions our students construct will have real-world applicability in industry and manufacturing," says Elhajjar. "Key will be the ability to recycle materials already on the craft to create something totally new – but with high mechanical properties and little loss in those properties every time the product is recycled. Our students are enthusiastic, innovative and brilliant. That's an unstoppable combination."

While Elhajjar has provided a broad outline of the project for the two-semester course sequence, these students will be placed in NASA's systems engineering approach and will be required to report periodically like any other subsystem team working on the project.

"This is the fifth year of the X-Hab Academic Innovation Challenge, and we continue to be impressed by the innovative university proposals to advance capabilities for spaceflight," says Tracy Gill, NASA lead for the X-Hab Challenge. "Our team was very interested in looking at innovations that will improve additive manufacturing space applications for future

exploration missions. And the project proposed by UWM fit the bill."

"I was so excited when I reviewed UWM's proposal," says Niki Werkheiser, NASA's Project Manager for the first 3D printer in space, "because it touched on the exact areas where we want to focus. The technology of the 3D printer itself is really exciting, but what I believe will ultimately lead to 3D printing becoming a daily part of our lives — just like the Internet and cell phones — will be developing a generation of 'makers' who understand the art and science behind optimizing the design of the printed parts. This will be what will result in the capability to produce on-demand parts that have meaningful functionality." ●

Charged up

Milwaukee County's first fast-charge stations at UWM

More electric vehicles (EVs) are hitting the road, and to make sure drivers can get where they need to go, the University of Wisconsin-Milwaukee (with support from Nissan and ABB) has installed two EV fast chargers for public use.

Allowing the public to park-and-charge helps EV drivers experience the freedom that's the foundation of the EV value statement and in alignment with our focus on energy and sustainability. The vehicles have a range of up to 100 miles on one charge. The two new DC stations, which will charge EVs in less than 90 minutes, are the latest addition to UWM's two AC charge stations, which take 4-8 hours to charge a vehicle.

"We were excited to be part of the university's sustainable transportation efforts," says Andy Bartosh, program manager for the electric vehicle charging infrastructure business at ABB. "We see fast-charging technology supporting electric vehicle adoption rates all over the world, so this project is an important milestone for both the university community and the greater Milwaukee region." ●

Ken Graber uses the newest DC charging station on campus to fully charge an EV in less than 90 minutes.

A legend lives on

Scholarship recipients inspired to achieve

"This scholarship helped me pay for my last two years of college, which allowed me to live my dream of racing and earn a degree in mechanical engineering at the same time, exactly the same path that Alan took."

— Kelsey Bauer

Alan Kulwicki was the first NASCAR Cup champion to hold a college degree.

After his death in 1993, his family was determined to create a legacy befitting a champion: helping students pursue their dreams as engineering pioneers.

A gift from Alan's stepmother, Thelma, created the Alan Kulwicki Memorial Scholarship as well as the Kulwicki Student Center in the College of Engineering & Applied Science at UWM.

Kulwicki distinguished himself from most of his fellow drivers with his scientific strategy, understanding the mechanics of the car.

That strategy is something Kelsey Bauer, (2012, BS in Engineering [Mechanical]) the first recipient of the Kulwicki scholarship, understands. She majored in mechanical engineering and remains involved in late-model stock car racing. Like Kulwicki, Bauer believes her engineering degree will make her a better driver.

Kelsey Bauer, the first recipient of the Kulwicki scholarship, shown in her racecar.

"Knowing more about your car and making the adjustments you need to make," Bauer said, "helps you communicate with your team on how the car is handling."

"I thank Alan's family for helping me," Bauer said. "It's going to help me not give up and work as hard as I possibly can because I know he did it. So I can do it."

Kulwicki motivates Gaynor to "do something important"

Ethan Gaynor, (2014, BS in Engineering [Mechanical]) is working for Chrysler in Detroit, Michigan, developing braking systems for plug-in hybrid vehicles.

About Alan Kulwicki

Alan Kulwicki graduated in 1977 from UWM with a degree in mechanical engineering. The Wisconsin native also received a UWM Alumni Association Distinguished Alumnus Award in 1992, the year he won the Winston Cup Series title by the closest margin in the series history — beating Bill Elliott by 10 points. Less than a year later, he died in a plane crash at the age of 38. He was the first college graduate to win stock car racing's premier title, now called the "Sprint Cup Series."

"The Kulwicki scholarship not only allowed me to continue into the final years of studying, but Alan's story gave me even more motivation to be a self starter and to do something important," says Gaynor. "Working for an original equipment manufacturer was a dream job of mine, and through hard work, determination, and lots of support, it is now a reality."

Gaynor wants his engineering skills and passion for automobiles and motorsports to push the creative envelope. "Whether that's developing new technology to reduce fossil fuel reliance, new material and manufacturing methods to reduce weight, or creating innovative, out-of-the-box solutions that challenge the status quo to make a better, faster, more reliable product, there are many things I have yet to do. Because of my education at UWM and the generosity of the Kulwicki family, I am now able to put those activities into real world practice."

> *"It is a great honor to race with Alan's name and recognize the Kulwicki family on my racecar."*
>
> *— Louis Goss*

Scholarship allows Goss to follow his dream

Louis Goss (2012, BS in Engineering [Mechanical] is grateful for the Kulwicki scholarship because it made it possible for him to follow his dream: as a lead designer and mechanical engineer for family-owned Therma-Tron-XI in Sturgeon Bay, Wisconsin, Goss is helping to provide energy efficient technology. "For a world that has a fixed energy source I would love to be able to be a part of something that could provide for the entire world," he says.

Goss is still racing his late model on tracks throughout Wisconsin. "It is a great honor to race with Alan's name," he says, "and recognize the Kulwicki family on my racecar." ●

Here's your chance to make a difference

The donation by Thelma Kulwicki is helping students become the next generation of engineers who are changing the world. You can help change the world too.

Encourage students, support faculty and spark innovation with your gift. Look for the envelope inside of this issue to learn more, or visit http://uwm.edu/engineering/donate/.

Kulwicki Student Center fuels collaboration for UWM students

The Pit Stop, located in the Alan Kulwicki Memorial Student Center, is a student meeting space in the Engineering and Mathematical Sciences Building.

This year the Pit Stop is expanding to become a collaborative meeting space for students from UWM Engineering & Applied Science to meet with each other and with students from other disciplines across campus. The space has flexible furniture configurations that fosters an active learning environment.

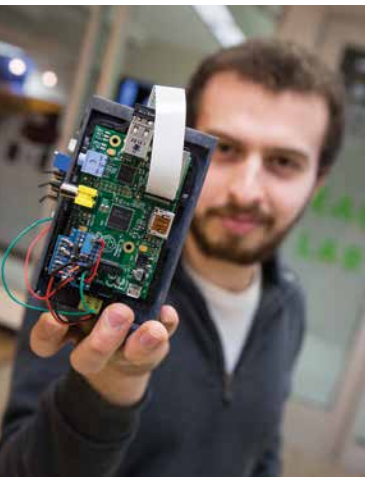
NASCAR memorabilia from Alan Kulwicki located in the Pit Stop.

Closing the G A P

UWM Engineering & Applied Science develops next-generation engineer

For the ninth consecutive year, a ManpowerGroup survey reports a shortage of engineers with skills global employers seek. Manpower Senior Vice President for North America Jorge Perez identifies reasons for the shortage. "Many people aren't 'workforce-ready.' They don't know how to work on teams and adapt ideas based on feedback. They also lack the critical thinking skills to effectively tackle big problems," says Perez.

The Product Realization class provides students the chance to develop practical business skills working with corporate sponsors such as Aurora Healthcare, Rexnord, Eaton and Norman Direct among others.



Ashraf Al-hajjeh, undergraduate in electrical engineering, holds a project developed in the Product Realization class.

Mike Krauski, director of corporate relations in the College of Engineering & Applied Science, agrees: "More companies say they need engineers who can spot customer needs, identify and solve problems, innovate, think out-of-the-box and work on teams to deliver solutions that touch the end customer."

Automation has also changed employers' needs. "Automation systems need to be run by people who understand the whole workflow. From the CNC [Computer Numerical Control] operator all the way up the chain, people need to have a more sophisticated understanding of the entire system," says Krauski.

Perez adds, "The lines are being blurred between the technicians and the managers who supervise them."

All of this adds up to a more complex workplace — one that demands an engineer with a comprehensive skill set that includes entrepreneurial thinking to spot market needs, technical expertise, "soft" skills such as collaboration and communication, and the ability to take an engineering problem from concept to commercialization.

Delivering next-generation talent

UWM Engineering & Applied Science attracts and develops engineers who excel in all of these areas and connect the dots along the value stream. Through programs and opportunities such as the Product Realization class, Senior Capstone Design Project, Student Start-Up Challenge, co-ops, internships, and undergraduate research, students acquire an understanding of "real-world" problems and employer expectations. And, they develop the skills that employers seek.

"The field of engineering has changed dramatically in the past decade, and our program has changed with it," says Brett Peters, dean of the College of Engineering & Applied Science. "We work with industry colleagues in our research labs, Product Realization class and co-ops and internships. We've heard what they've said about globalization, innovation and changing demands. So, we've adapted our programs to ensure students graduate ready to meet these challenges.

"Today's engineer needs to understand the big picture and be a problem-solver — our emphasis on real-world experience attracts and develops students who seek this challenge.," says Peters.

Solving real problems for companies

The Product Realization class is one example

of how UWM Engineering & Applied Science develops students' problem-solving skills. Corporate sponsors buy into the program and have student teams build out new product prototypes before they take them to market or solve actual engineering problems they are experiencing on the job.

The class is jointly taught by Ilya Avdeev, assistant professor of mechanical engineering, and Nathaniel Stern, associate professor of art and design and the head of digital studio practice in the Peck School of the Arts at UWM.

The class helps to break down functional silos before students enter the workplace by pairing engineering students with art students in teams. Bringing the right and left sides of the brain together is key. People are more effective in identifying, developing and testing potential solutions.

"We create multidisciplinary teams to challenge the way the students think about problems," explains Avdeev. "Students learn to consider alternative perspectives and work together to create solutions that are creative and viable."

Moving into its fifth year, the class is in high demand. The fresh thinking that students bring to problems has helped companies like Rexnord, Eaton, Aurora Healthcare and dozens of others launch new products and make headway on proprietary product innovations.

This past spring, students developed a prototype of a battery-charged hair dryer, a grill device that can be cost-effectively produced to keep food warm and fresh for two hours, and an Android app for Eaton Corporation. According to Eaton's Steve Dimino, the company was looking for something to support market expansion:

"We have a motor protection device for an overload relay, and we want to get connected to a smart device over a wireless network to expand our market into the more commercial space with wireless sub-metering and energy efficiency."

"Looking back, my [Product Realization] team grappled with a lot of issues that I face in my job today."

– Sarah Sloan
industrialization engineer
Rockwell Automation
UWM alumna

Developing critical business acumen

In addition to cultivating students' teamwork skills, the class exposes students to valuable real-world challenges such as thinking about problems from a customer perspective and addressing issues of cost and manufacturability.

Ask Christine Barden, mechanical engineering student, what she thinks of the class. She says, "It's like we have our own little company and we get to work with someone and actually bring something to fruition."

UWM alumna, Sarah Sloan, attests to the value of these experiences as she transitioned from student to professional. As a Rockwell Automation industrialization engineer, she appreciates how the class prepared her for work. "When I was in the Product Realization class, my team worked on designing a fuel cell to replace the batteries used in our sponsor's

Continued on page 20

UWM Engineering & Applied Science's curriculum builds problem-solving skills and encourages students to understand the context in which they work.

Closing the Gap *- Continued from page 19*

The breadth, depth and scope of opportunities here builds confidence, maturity, and experience.

product. We had to consider issues like whether the company had parts on hand that we could use, whether we could ensure manufacturability and what the cost of the final product would be. My team grappled with a lot of issues that I face in my job today."

Sarah is one of many UWM alumni who Rockwell Automation employs. She is also the engineering liaison for the UWM alumni group, Panthers at Work. "There are a number of UWM graduates who work here. We stay connected to each other and to the interns who work here. We are committed to each other and to UWM," says Sloan.

Workforce-ready graduates

Another company that can attest to the quality of UWM engineering students is the Milwaukee branch of DRS Technologies, a leading global defense technologies company. Since 2010, the company has participated in the college's internship program. "About fifteen students have interned with our company, and we've hired more than half of them," says Bill Weber, vice president of engineering and test. "The students are technically competent, able to work in teams, and they have a very strong work ethic," says Weber.

It is no accident that UWM graduates are selected by some of the world's leading companies.

The breadth, depth and scope of opportunities here builds confidence, maturity, and experience — and helps create engineers who are ready to meet the challenges of today's workplace and fill that talent gap for local and global employers. ●

This is not your father's engineer

Assistant Professor Na Jin Seo with doctoral student Leah Enders in the lab.

UWM's emphasis on applied research is an opportunity for students to make an early mark. Collaborating with faculty, students innovate:

- **Doctoral student Leah Enders** worked with Assistant Professor of Industrial and Manufacturing Engineering Na Jin Seo to develop a therapeutic bracelet that helps stroke victims accomplish day-to-day tasks. The two took out a provisional patent through the UWM Research Foundation, and Enders is now part of a start-up that aims to commercialize the device.
- **Graduate student Patrick Dix** led the student team that developed an ergonomic wrench prototype with Associate Professor Naira Campbell-Kyureghyan of the Industrial & Manufacturing Engineering Department and Assistant Professor Ben Church of the Materials Science and Engineering Department. The wrench has been licensed by Kenosha-based Snap-on Incorporated for development.
- **Graduate Fellow Carlton Reeves** launched a business to market the cloud-based ordering and payment application he developed while participating in the University Innovation Fellows program at UWM.

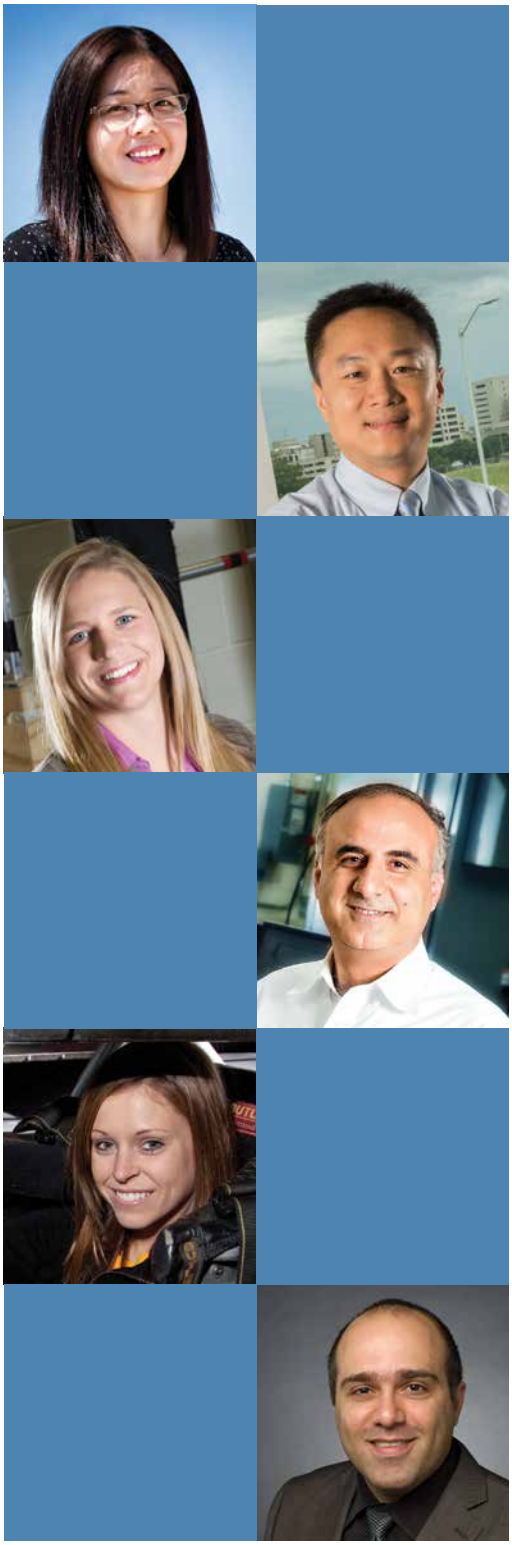
UWM has a long tradition of applied learning. Today, this emphasis is more valuable than ever as globalization and technology accelerate change and demand innovative, practical thinkers.

Make a gift. Change the world.

Your support of UWM Engineering & Applied Science creates positive changes every day. Drs. Nasiri (p. 2) and Amano's (p. 10) work in energy are two examples of how faculty are working hard to make ours a more efficient, sustainable world. You've learned about the increased demand for engineers who bring an entrepreneurial spirit —who can spot a real world problem, look for a solution and deliver it — the type of engineers that are cultivated through our distinctive curriculum and student experience (p. 18). And, you've learned how students are working with faculty to promote public health (p. 8) and to help NASA by designing a collapsible fused deposition modeling (FDM) 3D printer that would enable parts to be manufactured in space when needed (p. 14). With your support, we help build the future and change the world every day:

- **Encouraging Students** — The family of Alan Kulwicki is ensuring that Alan's legacy as the first NASCAR Cup champion to hold a college degree lives on. Thelma Kulwicki's donation created the Alan Kulwicki Memorial Scholarship as well as the Kulwicki Student Center, which fuel innovation and shift the engineering dreams of current students into high gear.
- **Supporting Faculty**— Your gift will aid faculty like Jin Li (p. 8) and Ryo Amano (p. 10) by creating funds for endowed chairs or named professorships, contributing to faculty fellowships or supporting career development professorships so our faculty can continue their breakthrough research and education while using their research to make the world a better place.
- **Sparking Innovation** — From Adel Nasiri's breakthrough research in energy (p. 2) and Rani Elhajjar's (p. 14) work with students to support NASA to programs like the Product Realization class (p. 18), your gift will expand knowledge and learning beyond the classroom, ultimately impacting real world change, economic growth and development.

Thanks for your ongoing support.



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We measure growth one breakthrough at a time.

New this fall at the College of Engineering & Applied Science

- **More state-of-the-art research facilities** opening at Innovation Campus and the Global Water Center
- **Additional research funding** including an $800,000 National Science Foundation award
- **Realization and commercialization of our research** in biomedical and health, energy and sustainability, water and the environment, and more
- **Eight new faculty members** to discover, innovate, and lead

Meet our new faculty members and learn how our expanding research capability fuels innovation in the Winter issue of *Milwaukee Engineer.*

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Photo courtesy of Kahler Slater