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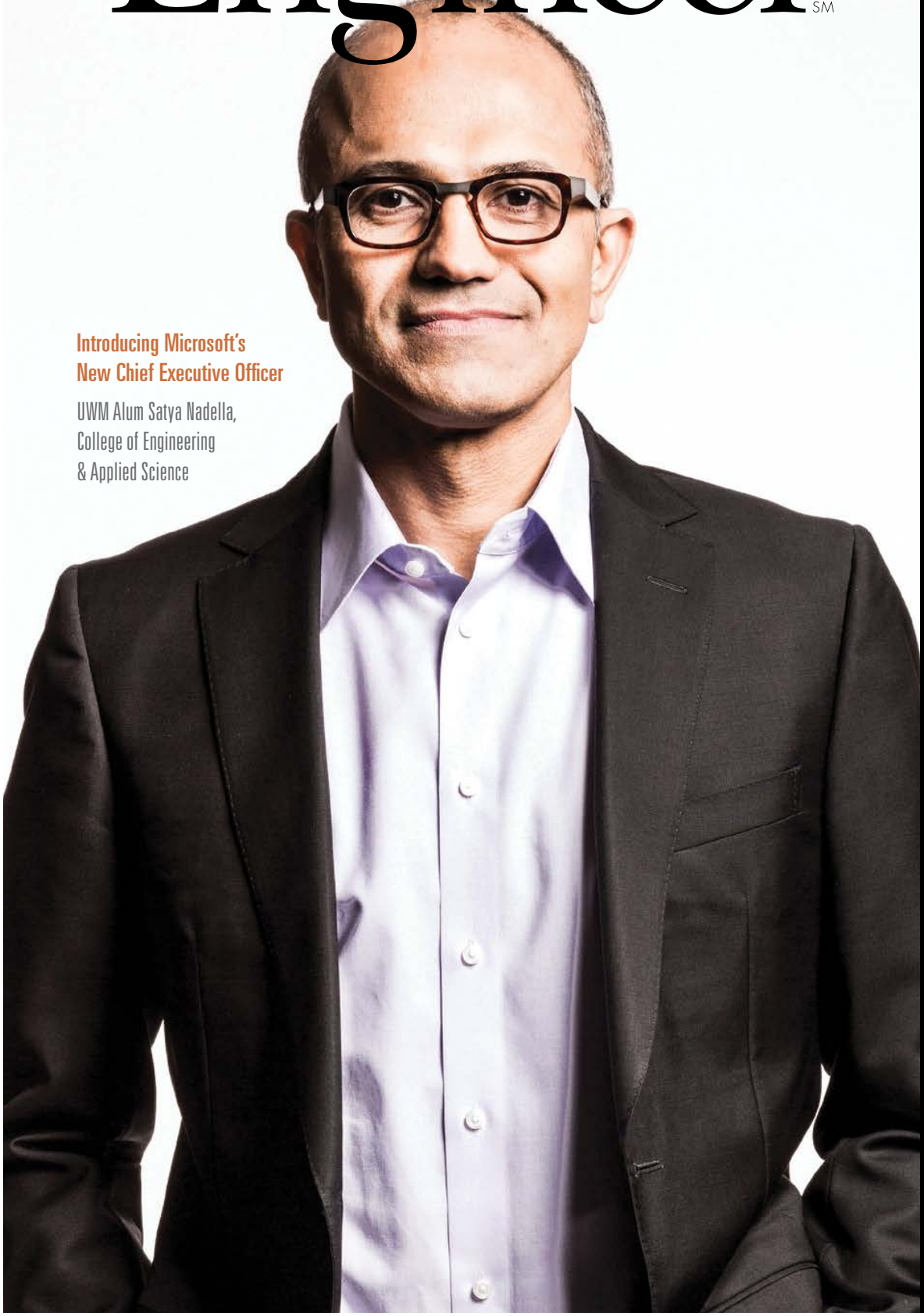

Introducing Microsoft's New Chief Executive Officer

UWM Alum Satya Nadella, College of Engineering & Applied Science

SPRING 2014

CREATING A CULTURE OF INNOVATION

TOUGHER, STRONGER, SMARTER CONCRETE

UWM WRENCH PUTS SAFETY FIRST

BIOMEDICAL BREAKTHROUGH ALLOWS SAFER TRANSPLANTS VIA OPTICAL BIOPSY

NSF CAREER GRANTS FUND BREAKTHROUGH RESEARCH

UNIVERSITY of WISCONSIN
UWMILWAUKEE
College of Engineering & Applied Science

MILWAUKEE Engineer

A tri-annual publication of the University of Wisconsin - Milwaukee College of Engineering & Applied Science

Dean
Brett Peters

Editor
Sandra Nichols
Assistant Dean/ Director of Marketing

Contributing Writers
Barbara Haig
Laura Hunt
Lorin Oswald
Marjorie Piechowski, Ph.D.

Coordinator
Anne Taylor

Graphic Designer
Mary Machare

Photographers
Troye Fox
Pat Goetzinger
Peter Jakubowski
Alan Magayne-Roshak

Requests to be added to the mailing list, suggestions for future articles and feedback can be sent to the editor: sandras3@uwm.edu

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FROM THE DEAN

Engineering expansion

Dean Brett Peters

In the wake of the Great Recession, there is a renewed trust in the power of engineers to solve problems and create a more promising future. Today, once again, we recognize the value of "building things." And, the importance of engineering to a vital and sustainable economy is unquestionable. As a result, it's an exciting time to be at UWM's College of Engineering & Applied Science as we continue to expand.

Energized by the need for big ideas and breakthrough solutions, our faculty are conducting research that has the power to change lives. Within this issue of *Milwaukee Engineer*SM, you will find stories of how our faculty are advancing knowledge in several fields – with real-world results that benefit us all.

These articles tell a larger story about UWM – one of research, discovery, collaboration and entrepreneurial spirit. As you will read, faculty, students and business are working together to solve some of today's most challenging problems. In the process, they are expanding the boundaries of knowledge, making business, the community and individual lives better - and contributing to the economic vitality of our region through joint ventures and business startups.

Even our undergraduates are applying what they learn – in the classroom, in research projects, and in co-ops and internships – to real-world problems. They are already a dynamic force, as you will see. And we are expanding our college by hiring new faculty, increasing our student population, developing new educational programs, and growing our research activity to address even more of society's challenges.

I hope you enjoy learning about how our faculty and students are changing the world. I am very proud of the work we are doing and inspired by the possibilities to come.

Best Regards,

Brett

Brett Peters, Ph.D.
Dean, College of Engineering & Applied Science

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Satya Nadella to lead tech industry giant,

UWM alum is seen as visionary

The new CEO of Microsoft Corporation – and only the third chief executive officer in the famed company's history – has strong Milwaukee ties. Satya Nadella, an alumnus of UWM's College of Engineering and Applied Science, is remembered as an extremely talented graduate student who was one of scores of students from India attracted to UWM's strong computer science program.

"I have always used [Nadella] as a good example of student success: how to dream big and work hard in developing strong interpersonal and technical skills that foster success in life and career."

– Hossein Hosseini, professor

Nadella, who was once described by Business Week as a member of Bill Gates's "kitchen cabinet of techno-whizzes," was about 20 years old when he began the master's degree program in computer science here.

"His prior academic background was in electrical engineering," says K. Vairavan, emeritus professor and former chair of the Department of Electrical Engineering and Computer Science. "But he took less time to complete our challenging and strong MS program than most students who already had a solid computer science background. I would attribute his impressive success to his intellectual ability, hard work and razor-sharp focus."

In fact, Vairavan remembers finding a sleeping bag in his lab on the seventh floor of the Engineering and Mathematical Sciences building. "I was told by another student that Satya had slept there several nights, after working late hours on his research. Such was his dedication to his goals."

Master's Degree in 1990

A native of Hyderabad, in south-central India, Nadella earned a master's degree in computer science from UWM in 1990, after completing his bachelor's degree in electrical engineering from Mangalore University in India.

"I think Satya being named CEO of Microsoft helps our students know the kind of education they get on our campus will take them anywhere they want to go," says Dean Brett Peters.

In his first interview after the appointment, Nadella says he had always wanted to "build things" and had developed a passion for computer science as a means to achieve that.

"I am a learner," he says. "I fundamentally believe that if you are not learning new things … you stop doing great and useful things. Our industry does not respect tradition – it only respects innovation."

Professor Hossein Hosseini, Nadella's former thesis adviser, agrees that Nadella is the perfect role model for students. "You got a sense that he had a burning passion for learning," says Hosseini. "I have always used him as a good example of student success: how to dream big and work hard in developing strong interpersonal and technical skills that foster success in life and career."

Microsoft

Nadella has been with Microsoft for 21 years, mostly recently as executive vice president of the Cloud and Enterprise group. He succeeds Steve Ballmer, who stepped down from the Microsoft helm after 14 years, and Bill Gates, the company's first CEO and current chairman.

Graduate Teaching Assistant

As a graduate teaching assistant at UWM, Nadella participated in the college's Upward Bound program, helping to teach college preparatory courses to inner-city high school students and hosting them on campus for a summer.

After graduation from UWM he joined Sun Microsystems' Chicago office and earned a master's degree in business from the University of Chicago. By 1992, he had taken a job with Microsoft in Seattle.

Early in his Microsoft career, he stood out. In a 1999 *Businessweek* article, Nadella and four other Microsoft employees were described as the "new crew" needed at Microsoft to implement Gates's technical vision for the company.

When he was named president of Microsoft's $19 billion Server and Tools Business in 2011, Ballmer told the media that Nadella "will define the future of business computing" and help the company realize the business potential of the cloud "in game-changing ways."

He has also served as senior vice president of R&D for the Online Services Division, which includes the Search (Bing), Portal (MSN) and Advertising platforms, and vice president of the Microsoft Business Division. Most recently, he has been responsible for building and running the company's computing platforms, developer tools and cloud services, including "Cloud OS" – Microsoft's next-generation back-end platform.

Chancellor's Innovation Award

In 2012, UWM Chancellor Michael R. Lovell met with Nadella in Seattle and discussed ideas for advancing UWM, including a possible link between UWM's School of Freshwater Sciences and the Bill and Melinda Gates Foundation's efforts in clean water research. At that meeting, Nadella also expressed interest in the UWM partnership with Johnson Controls around battery research and in UWM's computer science program.

Last year Nadella visited the UWM campus to accept the Chancellor's Innovation Award and speak with students and faculty. The award recognizes a visionary whose professional achievements show entrepreneurial drive; creative, intelligent risk-taking; transformative thinking; effective change management; and a passion for lifelong learning.

True to his character, when he received the award, instead of talking about the products he developed for Microsoft, he talked about how he learned empathy on the campus by working with students from local high schools and getting engaged in their success. ●

In 2000, UWM recognized Nadella with the Dean's Award for Outstanding Achievement. In 2012, UWM awarded Nadella with the Chancellor's Innovation Award.

Grasping independence: Wristband

Patent-pending TheraBracelet provides unfelt vibrations

Imagine the frustration if you couldn't button your shirt or comb your hair.

For the seven million people in the United States who have survived strokes, the loss of sensitive touch also can mean a tremendous loss of independence, let alone the financial implications of funding assistants who offer help for these seemingly minor tasks.

> *"Just as you would wear your glasses all day, the TheraBracelet allows anyone with a loss of fine motor skills to go about their daily routines and maintain independence."*
>
> *— Na Jin Seo*

A multi-university team that includes Na Jin Seo, assistant professor of industrial and manufacturing engineering, is addressing the problems experienced by stroke patients and others with debilitating neuropathic disorders. Along with graduate student Leah Enders, she is developing the TheraBracelet, a wristband that acts to increase touch sensation, movement, and general motor skills in the hands.

"Like a hearing aid amplifies sound and eye glasses enhance vision, the TheraBracelet augments the body's natural ability to feel touch," said Seo. "Just as you would wear your glasses all day, the TheraBracelet allows anyone with a loss of fine motor skills to go about their daily routines and maintain independence."

The prototype for the battery-powered wireless bracelet is as light and portable as the activity trackers that athletes wear. It works by delivering unfelt or sub-threshold vibrations throughout a patient's hand, which enhances finger touch sensation and indirectly helps the user's fine motor skills and manual dexterity.

Testing with stroke patients has shown that the wristband improves functional abilities so users can go about their daily routines: brushing teeth, playing card games or eating, with greater ease.

University of Louisville Collaboration

At UWM, Seo is an assistant professor of industrial and manufacturing engineering. She's also an assistant adjunct professor at the Medical College of Wisconsin.

Seo's research attracted the attention of University of Louisville College of Business students who contacted her about collaborating to develop the bracelet into a marketable product. Pitching the TheraBracelet, the University of Louisville College of Business student team recently competed in one of the country's oldest intercollegiate competitions for entrepreneurs: the Georgia Bowl Business Plan Competition at Kennesaw State University. The team brought home a first place win and received an automatic invitation to compete at the "Super Bowl" of collegiate business plan competitions in Texas. The Louisville collaborators also formed a small company, TheraBracelet LLC, and submitted a 510 (k) application to the FDA in March of 2014 for regulatory clearance. Approval could take three to six months, after which it can be sold as a medical device.

"Once we receive approval from the FDA, we'll be able to work directly with physical therapists to continue clinical trials as we develop the final non-invasive prototype, expected to be complete by November 2014," Seo said.

helps stroke patients

"It's a very positive step toward bringing this technology to the public."

Aimed at "Stroke Belt" States

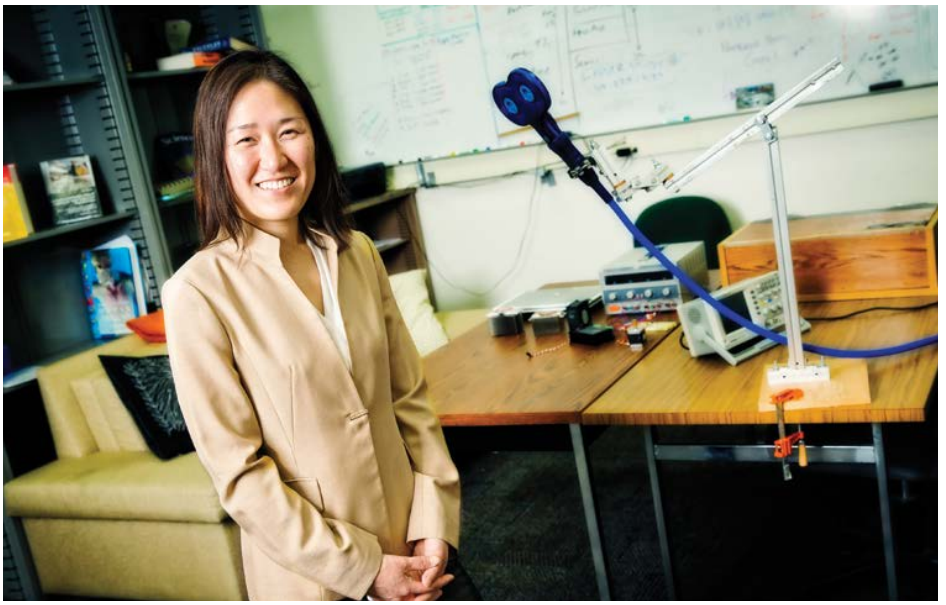
"We have been working over the past several months to develop our intended sales and distribution strategy, which is focused on targeting physical therapists and large rehabilitation clinics in the 'stroke belt,'" said Matthew Raggard, CEO, TheraBracelet, LLC. This is an 11-state region in the southeast recognized by public health authorities for having an unusually high incidence of stroke and other forms of cardiovascular disease.

"Additionally, we have been working with several major rehabilitation centers in Louisville to further our commercialization efforts and get our device on the wrists of stroke survivors starting in 2016," he says.

"The final version of TheraBracelet will be the first all-day wearable device that aids people suffering from neuropathies and stroke," Raggard said.

UWM Research Foundation has filed a formal application with the U.S. Patent and Trademark Office seeking patent protection on the TheraBracelet and has completed an option agreement with the startup company.

"We will continue to work to secure intellectual property rights and work with the company – TheraBracelet LLC – to make this part of their commercialization strategy," said Brian Thompson, UWM Research Foundation president.

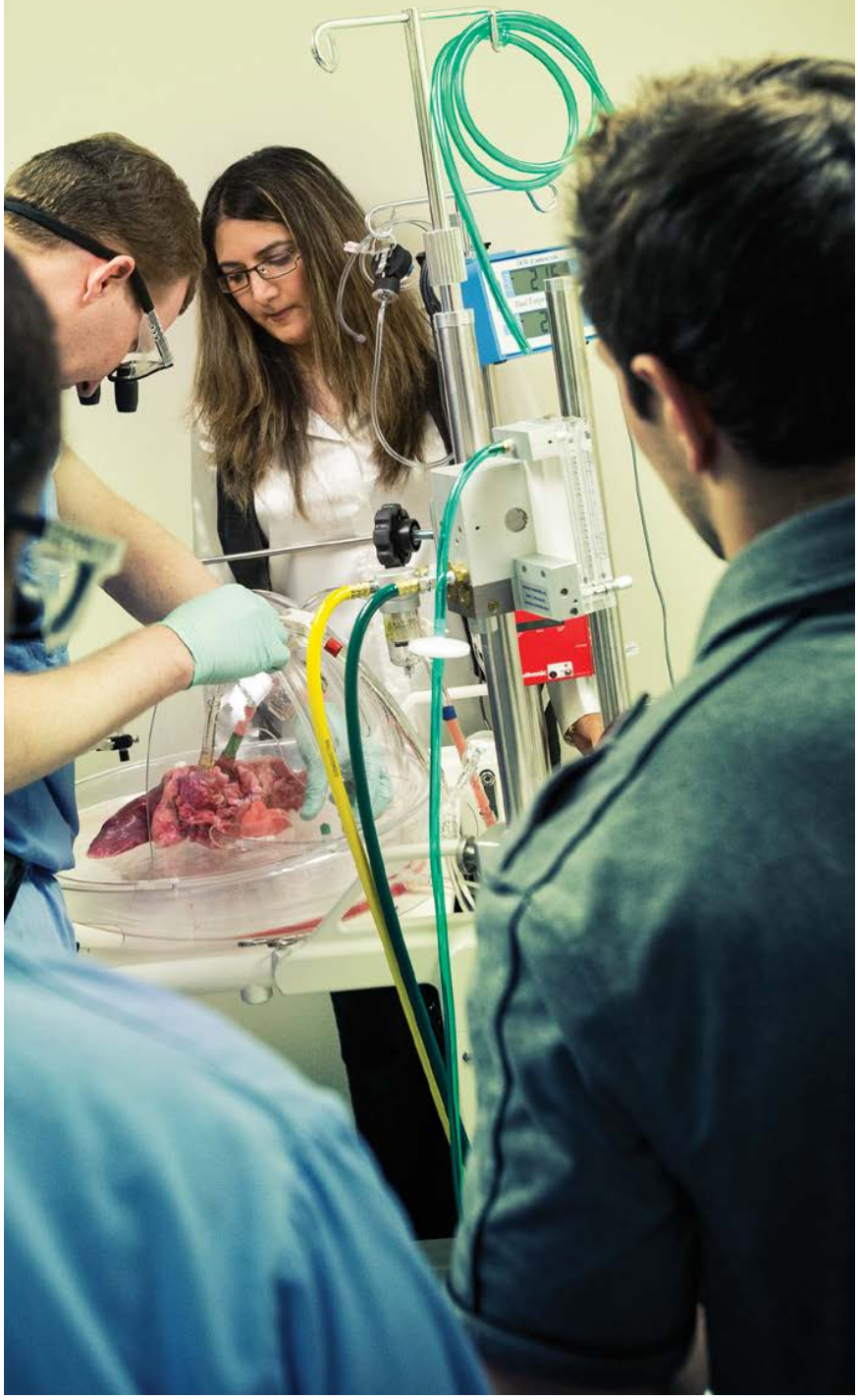


Na Jin Seo, assistant professor of industrial and manufacturing engineering, is addressing the problems experienced by stroke patients and others with debilitating neuropathic disorders.

Along with her associate, professor emeritus John Webster, Seo received one of only a few 2013-14 UW-System Applied Research Grants, and in 2012 received a UW-Madison Graduate School / UWM Foundation Intercampus Research Incentive grant, which recognizes and encourages assistant and associate professors who have shown the potential to achieve distinction in their academic disciplines through scholarship, creative activity and the dissemination of knowledge.

Her work will continue with the Medical College of Wisconsin at the Rehabilitation Innovation Laboratory located at UWM's new Accelerator building on the Innovation Campus in Wauwatosa, scheduled to open in June of 2014. ●

Assistant professor Mahsa Ranji tests her optical biopsy technology on the lung tissue of an animal model in this experiment at the Medical College of Wisconsin.



Using light, not

Optical biopsy gauges tissue health — aimed at increasing organ transplants.

Only a small number of human lungs available for transplant are accepted by surgeons.

"Thousands of patients die waiting for a suitable organ that can support life, and we have limited means to assess whether a [donor] organ is irreversibly damaged," says Robert Love, M.D., a professor of surgery at the Medical College of Wisconsin (MCW).

The assessment process relies heavily on how the organs look externally.

Mahsa Ranji, a UWM assistant professor of electrical engineering, has developed a method that could dramatically increase the number of organs deemed usable for transplants. Called "optical biopsy," it gives doctors a noninvasive tool that gauges the metabolic health of tissue. "Before now, the only way to see whether tissue is injured is through surgical biopsy," says Ranji. "The main idea behind optical biopsy is to follow the metabolic state of the tissue through a catheter over time."

The change in the tissue's metabolism is the key to assessing the extent of injury, she adds. That's exactly what her technology delivers.

"It is important because the gold standard now is a snapshot at the end point of an event," she says. "You don't have the story of what happened to the tissue at the beginning or in the middle."

surgery, for biopsies

Patented Technology Developed at UWM

Ranji's patented technology works by exciting certain proteins in living tissue that glow when they absorb blue and ultraviolet (UV) light. Since a catheter remains in contact with the tissue, drugs can also be administered while monitoring the efficacy of any treatments.

"We are interested in providing a deeper look at the mitochondria, the energy centers of the cells," she says. "The intensity of the glow corresponds to the health of the tissue."

Doctoral student Zahra Ghanian has been working on a related diagnostic tool created in Ranji's lab – one that can extract markers of tissue damage on a cellular level.

Ghanian gathers visual biomarkers of the level of oxidative changes in cells – clues that the tissue is injured. Then she writes a computer program that takes all the markers into account in determining the extent of damage.

In a process called segmentation, Ghanian can comb through images of retina cells, for example, to create the required data to use as diagnostic markers of diabetic retinopathy.

"This gives you a picture of cells in the retina, indicating the number, kind and how they are distributed," says Ghanian. "When the ratio of one kind of cell to another kind rises, it means the disease is progressing. This is one of the earliest signs of diabetic retinopathy that we can quantify."

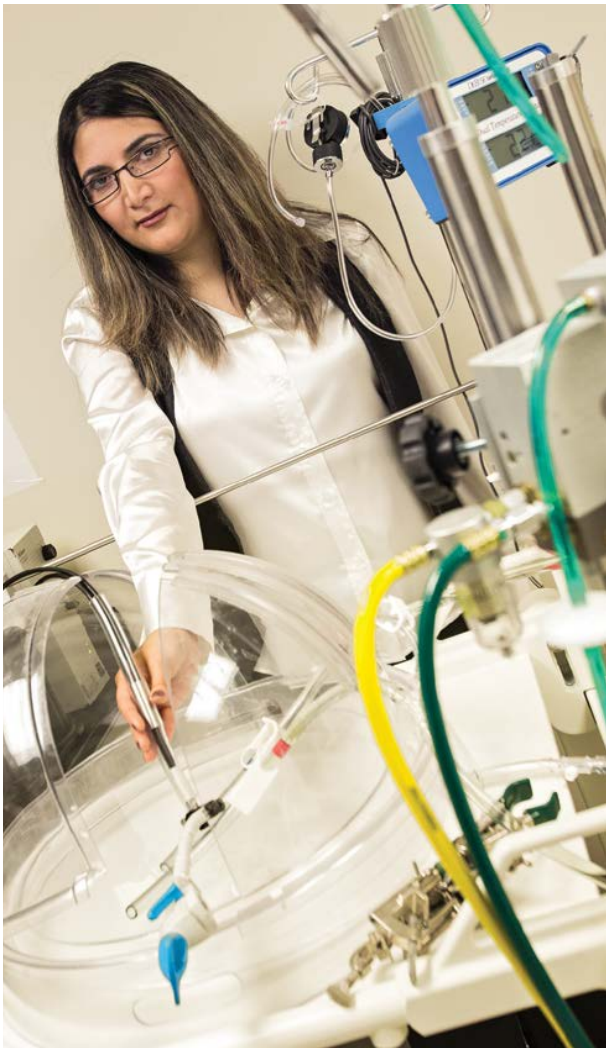
New Campus Invites Collaboration

The work of Ghanian and Ranji exemplifies the advantage of locating UWM researchers at Innovation Campus in Wauwatosa near the Medical College of Wisconsin (MCW). It brings biomedical research much closer to the regional medical center where partnerships like those with Ranji's lab can help accelerate discovery and support students.

Ranji has partnered on the lung transplant project with Elizabeth Jacobs, M.D., MCW associate dean of research and associate chief of staff for research at the Zablocki VA Medical Center. Testing of the optical biopsy system has already begun with human organs in experiments with Jacobs and Love.

"If we need to do an experiment at MCW that needs animal models, we are right there. These experiments are expensive, time-consuming and involve a lot of people," Ranji says. "So the proximity will help."

She believes it will lead to more opportunities to work with medical professionals, allowing graduate students to see firsthand how the instrumentation they build is used on the patient-care side. ●



Mahsa Ranji, assistant professor of electrical engineering, is collaborating with the Medical College of Wisconsin on breakthrough research.

Measurement in motion

Faculty start-up applies motion-tracking markers for medical research

Magnetic resonance imaging (MRI) is a powerful diagnostic tool, but because the patient must remain completely still during the scan, the technology can be challenging to use with patients who are disabled as well as with patients who are children.

A motion detection system co-developed by UWM engineering professor Brian Armstrong can help address that problem. His system produces accurate measurements of movements and can be used to correct the motion of patient movements that could otherwise ruin the medical image.

Years ago, it took about eight seconds to process an image. Today the system can process more than 100 images per second. That's progress.

Motion correction for MRI could reduce the need to sedate children for medically necessary scans, creating a safer and less expensive process, Armstrong says. It also eventually could be used for research in brain development.

From Laboratory Research to Commercialization

Armstrong's research on motion-detection equipment is moving to the marketplace through Metria Innovation Inc., a start-up firm in Wauwatosa that launched to commercialize this novel motion-tracking technology. It is one of six start-up companies that have evolved from UWM research.

The system he helped to create, called moiré phase tracking, incorporates a motion-tracking marker and a single camera. The system uses a phenomenon you may have noticed on silk or satin fabric when darker shaded swaths appear as one layer of fabric shifts in front of another. Called moiré patterns, these occur when light passes through two overlapping weaves.

The moiré patterns of a Metria motion-tracking marker are a highly engineered phenomenon. "Moiré patterns amplify the optical effect of angles, permitting accurate measurement in each image," says Randy Holl, an adviser to Metria Innovation and CIO of Contact Solutions, Inc.

"From each image we can very accurately detect the orientation of the motion-tracking marker," adds Armstrong. "For motion tracking, software interprets the changing moiré patterns, yielding an exact location of the tagged part of the body. The imaging process moves continuously with the subject."

Substantially Faster Systems

The researchers spent years making the process faster and more reliable. In 2007, it took about eight seconds to process an image. Today the moiré phase tracking system can process more than 100 images per second.

Moiré phase tracking technology is being targeted to researchers and research laboratories. It is already in use at seven scanning facilities around the world. Armstrong and Kristian O'Connor, chair of UWM's kinesiology department, are also working to apply moiré phase tracking to the analysis of human movement during walking. Gait is affected by such conditions as knee and hip injuries, arthritis and orthopedic surgery.

O'Connor and Armstrong have won two grants to develop the technology, including a prestigious National Institutes of Health research award and UWM's highly competitive Research Growth Initiative. The grants have supported UWM graduate students and are moving the technology closer to being a useful

O'Connor and Armstrong have won two grants to develop the technology, including a prestigious National Institutes of Health research award and UWM's highly competitive Research Growth Initiative.

tool for analysis of human gait. O'Connor and Armstrong are currently working on a Small Business Innovation Research Phase II proposal to continue commercialization of this research.

The UWM Research Foundation has licensed two patents-pending to Metria Innovation. One provides an opportunity to further optimize the motion tracking marker, and the other involves using a ceramic element to reduce vibration in cameras that are used to track motion in an MRI scanner. The ceramic camera is already in use.

Professor Brian Armstrong (right) and Kristian O'Connor (left) prepare a student subject for gait analysis using moiré phase tracking equipment. Armstrong is a co-founder of Metria Innovations Inc., the start-up that is taking the equipment to market.

FLYING HIGH with robotics research

Aerial drones track fish in hard-to-reach places

Trying to track fish as they migrate can be tricky. The closer the tracking equipment can come, the stronger the radio signal will be.

So it's clear the best way to track radio-tagged sturgeon as the fish travel up and down the Wolf River is from above. But getting near the surface of the water can be dangerous – and expensive – in a human-piloted airplane.

Call in the robotic aerial drones!

It's a complex system with many parts and very little time to respond when something goes wrong.

"With drones, we can fly more often than people going out in a real plane to accomplish the task," says Tom Consi, assistant professor of freshwater sciences and engineering. "And we can get the kinds of information that are currently not available, like the average velocity of certain kinds of fish."

But it was the sturgeon-tracking, a project of another scientist at UWM's School of Freshwater Sciences, that provided the impetus for two engineering undergrads, Brady Moe and Kris Rockey, to build a drone.

Multidimensional Tasks

Developing a drone is a multidimensional task that includes aerodynamics, control, electronics and software. Before they could stock it with sensing equipment, GPS and a radio receiver, Rockey had to customize a very large remote-control model airplane to carry the gear.

"There is a relatively heavy payload," he says. "The average weight it can handle is around two pounds. But the radio we're using adds five pounds and is about the size of a car battery."

"We are using an industry-standard fish telemetry radio, because we want to be able to compare our work to something people can already do with this equipment," adds Rockey, who is working on his second UWM bachelor's degree to pursue his interest in robotics.

Using a basic remote, the pair sets up the controls to respond to certain plane functions, including programming flight patterns into the GPS. "Often, it's a 'lawn mower survey' – a simple back and forth over a specific area," says Rockey.

Learning to Fly

Moe is in charge of the computer programming necessary to autopilot the plane – and he also had to learn to fly it, which was a lot more difficult than he expected.

Programming the autopilot had to be worked out through trial and error. To measure signal strength over a large area, he used pre-existing software and modified it to follow and scan for radio signals.

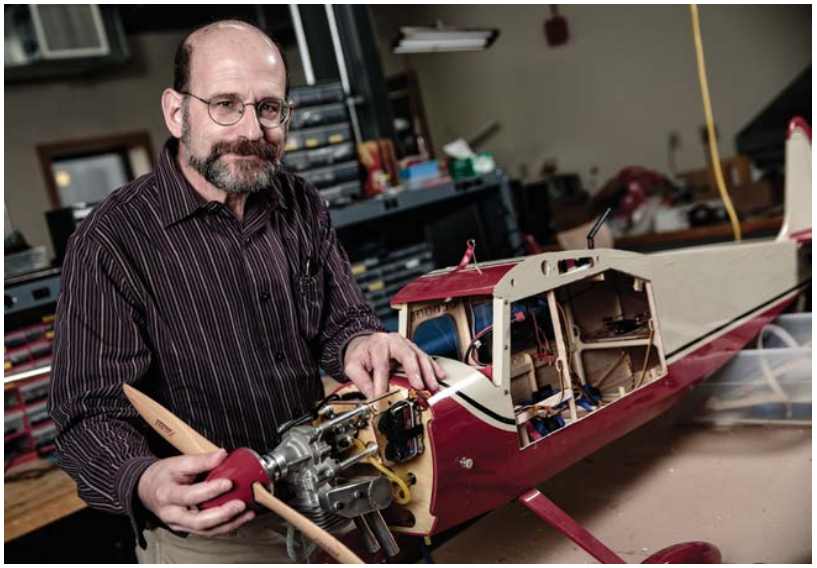
Kris Rockey, left, and Brady Moe combine computer, mechanical and electrical engineering to help biologists follow fish in Wisconsin rivers.

He then had to create a topographical map by plotting the signals using a course consisting of five randomly placed points. When he steered the plane successfully over each point, the radio picked up the signal and coordinated it with the autopilot.

It's a complex system with many parts and very little time to respond when something goes wrong. But, Moe says, the sense of accomplishment is great.

"I like writing code and then watching it do that specific work in the physical world," he says.

Consi calls fish-tracking a niche application for the robot but notes that there are broader uses. One is multispectral imaging, a method of remotely monitoring harmful algae blooms, like red tide, to determine how fast – and where – they spread. ●



Assistant Professor Tom Consi is able to track sturgeon, thanks to a drone developed by UWM undergraduate engineering students.

At long last: Nearly maintenance-free

New composite surface addresses transportation infrastructure and safety issues.

To Scott Muzenski, the large crack that weather and wear had caused in the driveway of a parking structure at the University of Wisconsin-Milwaukee (UWM) presented an opportunity to test his research.

Muzenski, a civil engineering graduate student, had been working on a new kind of high-performance concrete created in the lab of Konstantin Sobolev, associate professor of civil and environmental engineering. Their cement composite is a durable, water-resistant and malleable paving material with such a high level of "crack control" that the researchers estimate it has a service life of 120 years or more.

To compare, the average life span of concrete roads in Wisconsin falls in the 40-50-year range, with up to 10 percent of reinforced bridge decks needing replacement after 30 years.

In August, a crew of 25 students joined Muzenski in patching the driveway using the unique material. Then, in order to track whether the material was indeed holding up better than ordinary concrete, they gave the 4-by-15-foot slab the ability to monitor its own performance.

Smart Concrete

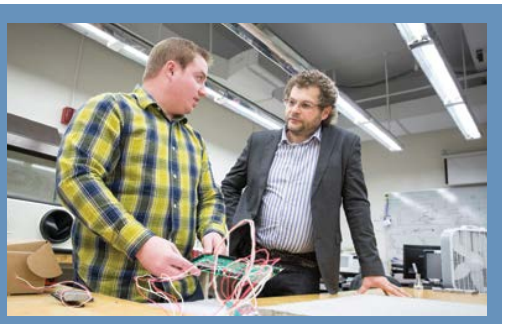
About an inch below the surface, the students embedded electrodes in this "smart" concrete that are linked to a data acquisition system located behind an adjacent retaining wall. "This is going to tell us whether water is getting into the material and how deep it goes," says Muzenski. "It also detects the presence of chloride ions within the material, and senses load and stress as vehicles pass over it."

Later this year when the software is completed, the real-time data will be fed wirelessly to an online repository. "We'll be able to observe the performance of concrete as it happens, in real time" says Sobolev.

The slab project will confirm the important features of this hybrid concrete, called a Superhydrophobic Engineered Cementitious Composite (SECC). This newly developed composite is made of cement-based materials with polyvinyl alcohol fibers and superhydrophobic admixtures.

The researchers point to two reasons they believe their SECC is a superior material.





Students embed electrodes linked to a data acquisition system into "smart" concrete.

concrete

- **The composite contains compounds that make the material nearly waterproof.** As Sobolev squeezes an eyedropper of water over a small piece of the hybrid concrete, the liquid beads up on contact into almost perfect spheres that rush off the hard surface at the smallest tilt. Normally, water pools on the surface of pavement and permeates through cracks. Add freezing and thawing cycles, and it's no wonder that roadways are in need of frequent repair, says Sobolev. Additives in the hybrid change the concrete on a molecular level when the pavement hardens, creating a spiky surface that, although microscopic, causes the water to bead and roll off.
- **The material can bend without breaking.** Although some examples of a malleable concrete are currently commercially available, Sobolev's lab has improved ductility with their composite. Super-strong unwoven polyvinyl alcohol fibers, each the width of a human hair, are mixed into and bond with the concrete. When cracks begin, the fibers keep them from becoming larger tears.

In fact, the aim of Sobolev's material is not to minimize cracking. Instead, it's designed to allow multiple micro-cracking, which distributes the load across many tiny cracks that are too small to let water penetrate.

Conventional reinforced concrete, in contrast, is relatively brittle, and cracks get progressively worse with the constant loading. When that happens, the entire stress is transferred to the reinforcing steel that bridges the crack.

"Our architecture allows the material to withstand four times the compression with 200 times the ductility of traditional concrete," says Sobolev.

Civil engineering students examine smart concrete with Konstantin Sobolev, associate professor of civil and environmental engineering (right).

Targeting Deterioration

Since ductile concrete is more expensive than regular concrete, he sees its best application in specific places where deterioration begins, such as on bridge approach decks. That's where concrete that is heavily reinforced meets regular asphalt. The joint, says Sobolev, cannot withstand the continuous loading.

"The bridge and the road aren't designed to work together," he says. "You need something between them that has the durability to handle the stress." He adds that the cost of his SECC is drastically offset by the reduction in labor costs for maintenance and early repairs.

In addition to his high-performance concrete, Sobolev also sees a promising future for smart concrete, with uses beyond transportation. Remote monitoring at facilities such as nuclear power plants allows problems to be detected while limiting the risk of harm to employees.

The prototype of the SECC material was created in collaboration with Habib Tabatabai and Jian Zhao, associate professors of civil engineering, with funding from UWM's Research Growth Initiative (RGI). Further support was provided by the National Center for Freight and Infrastructure Research & Education (CFIRE), and involved Michael Oliva and Tom Krupenkin of UW-Madison. ●

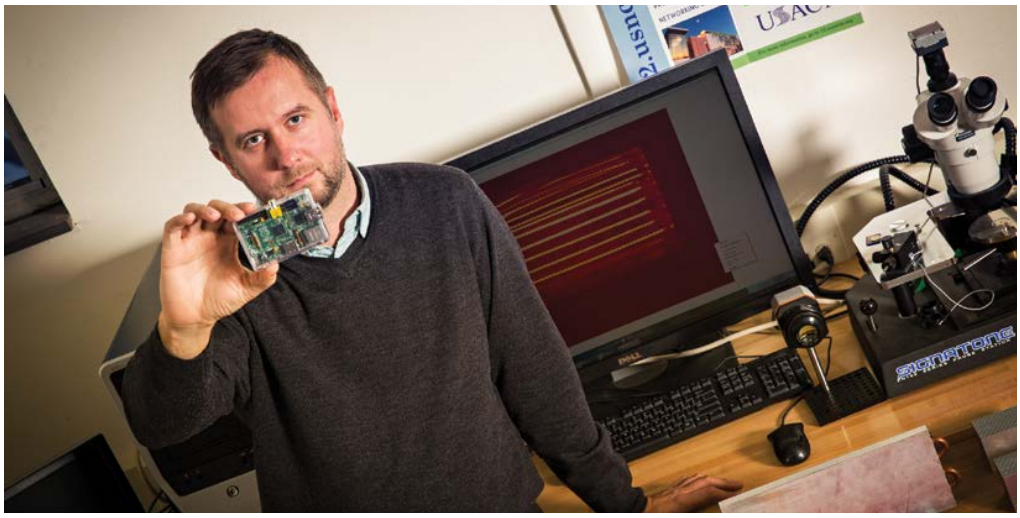
"We'll be able to observe the performance of concrete as it happens in real time."

— Konstantin Sobolev, UW-Milwaukee

GE Healthcare funds early-stage research

Catalyst Grants foster commercialization of new technology

GE Healthcare has funded three projects through UWM's Catalyst Grant program, which invests in promising, early-stage research that fosters commercialization of new technology.



Ilya Avdeev, assistant professor

Better Images at Lower Costs For More Accurate Diagnoses

Assistant Professor **Ilya Avdeev** channels his industrial know-how earned from years of experience at The ANSYS Institute for Industrial Innovation into researching ways to manage heat so machinery can operate more effectively. He and his students find solutions by using computational mechanics – turning the real world into the virtual world of computer simulations.

Avdeev's team is developing algorithms to monitor and model what happens inside computed tomography (CT) scanners in real time as temperatures rise. This equipment uses computer-processed X-rays to produce diagnostic images. The cooling solutions rely on many thermal sensors sending real-time information to computers that provide complex thermal control.

"There's quite a bit of heat generated by a CT detector. If the detector gets too hot, it might have a negative effect on scan accuracy as well as reduce the system's lifetime," Avdeev explains. "Additionally, we can't just put sensors everywhere. Our real-time computer simulations can predict how hot the system will get, as well as help determine the best sensor placement for the most effective thermal management."

His team's work will ultimately help companies like GE Healthcare provide better image quality at a lower cost so physicians can deliver a more accurate diagnosis to a broader range of patients. Alternative ways to manage energy also will help reduce healthcare costs through lower utility bills and fewer equipment breakdowns.

Avdeev founded UWM's Advanced Manufacturing and Design Laboratory, a collaborative research group that focuses on advanced modeling techniques, real-time field simulations, and design and characterization of micro-mechanical sensors and actuators.

Advanced Signal Processing Enhances X-Ray Image Quality

Having an X-ray taken is more complex than it seems: A technician stands behind a protective shield and presses a button, targeting X-rays through the body and striking a detector panel that converts the X-ray energy into electronic signals which are converted into digital images.

Thanks to Catalyst Grant funding from GE Healthcare and supplemental federal support, Professor **Jun Zhang** and his students are researching ways to reduce the cost and complexity of digital X-ray machines, helping medical centers around the world have better access to this important technology.

GE Healthcare's high-tech facility is only a 15-minute drive to UWM's College of Engineering & Applied Science where Zhang and his students apply his expertise in advanced signal processing to improve detector cells in digital imaging systems.

The smaller the detector cell, the more that can be packed into a panel and the higher the image resolution but those smaller cells cost more to manufacture – and some parts of the world just can't afford the technology.

"We want to see if we can use larger detector cells and then use a mathematical technique to make the picture look better," Zhang says.

Zhang uses a computational approach to solve the problem. "If we model the application mathematically, we can enhance the images and implement solutions in hardware or software. Significant improvement in the images is possible," Zhang says. ●

Jun Zhang, professor

Charged Up: Testing Batteries for CT Scanners

Traditional lead-acid power source has given way to other types of batteries, especially lithium-ion (li-ion), for cars. Now a UWM team is exploring ways to use these same li-ion batteries in healthcare and provide a smaller and more efficient power supply to computed tomography or CT scanners. CT scans are used in hospitals around the world to diagnose medical conditions with a series of images that create a cross-section picture of the body.

Adel Nasiri, professor of electrical engineering, is using a GE Healthcare Catalyst Grant to test and find the best battery and design and implement the best energy conversion system for CT scanners. Just like starting a car, "CT scanners need a burst of energy to power the X-ray tube," says Nasiri.

Nasiri's team is looking at ways to reduce the energy used by providing a strong battery to supply that initial charge, then relying on traditional power sources at lower levels to keep the scanner functioning during the rest of the procedure while the li-ion battery recharges. The model is estimated to save almost three-fourths of the previous cost.

Which li-ion battery is best? They've only been on the market a few years.

Using samples from the U.S., France and China, Nasiri's students developed a rating analysis for a variety of factors – including energy density, stability, safety, expense, and life cycle – to provide the best recommendation for GE Healthcare and other companies in their ongoing efforts to improve and reduce the cost of health care delivery. ●

Adel Nasiri, professor

Where academia meets industry

UWM Accelerator Houses Multidisciplinary R&D

"It's a place where brilliant minds in areas such as biomedical engineering and ergonomics come together with others in complementary fields to create a better tomorrow."

– Dean Brett Peters

After decades of discussion, years of negotiations and months of construction, the UWM Accelerator building on the Innovation Campus is almost ready to open its doors.

The first building at the UWM Real Estate Foundation's Wauwatosa research park, the Accelerator houses laboratories that bring together industry, academia and medical practice.

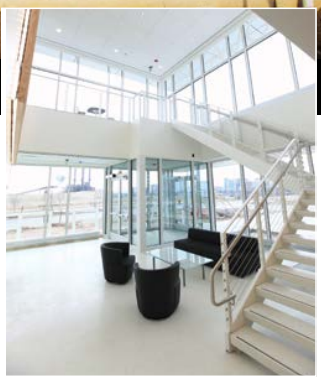
"This exceptional space is becoming the epicenter for collaboration and innovation between scientists, engineers and business in Wisconsin. It's a place where brilliant minds in areas such as biomedical engineering and ergonomics come together with others in complementary fields to create a better tomorrow. Plus, the job creation and business spin-offs that will follow put UWM at the forefront of economic growth in the state," says Dean Brett Peters.

The 25,000 square foot facility is located in a 51.5-acre area that includes more than 11 acres of wildlife habitat. A $5.4 million federal grant helped fund the building, with $2.7 million invested from the university. Work broke ground in February 2013. A four-story, 127-room hotel is being built to accommodate professionals who have long-term work or research at the building or the nearby Milwaukee Regional Medical Center.

UWM researchers designated to work at the Accelerator include:

- **Junhong Chen** uses nanotechnology to create ultra-sensitive, low-cost sensors for medical, water and gas applications. He has founded NanoAffix Sciences LLC to commercialize his work. The company has received two Small Business Innovative Research grants.
- **Naira Campbell-Kyureghyan** applies her expertise in biomechanics to develop new tools, methodologies and non-invasive devices that can reduce injuries and fatalities *(see page 21)*. She recently received a grant from the US Department of Defense Small Business Innovation and Research program. Her team's work at the Accelerator will involve developing physical and numerical models of the human pelvis for research related to blast injuries.
- **Mahsa Ranji** is developing noninvasive tools that gauge the health of tissue using only light. This optical biopsy technology provides a look at the mitochondria, the energy centers of the cells, to assess the extent of tissue injury – without surgery *(see page 6)*.
- **Na Jin Seo** is working to improve rehabilitation of stroke victims, including helping them regain motor function in their hands using techniques that include video gaming and developing devices that help improve small motor skills *(see page 4)*.
- **Ramin Pashaie** brings expertise in optics and photonics, which he applies to neuroscience. He has created devices that can be used to optically stimulate nerves in the brain, which may someday lead to improved treatments for Parkinson's disease.

For more information, visit www4.uwm.edu/research-impact/acc/



Corporate and Academic Partners

The facility involves a cooperative agreement with Concordia University Wisconsin, which will locate drug-discovery facilities, including a good manufacturing practice pilot plant and a laboratory for analytical, formation and process chemists, and the nearby Medical College of Wisconsin, which will work with engineers to develop medical device prototypes.

Additionally, entrepreneur Frank Langley is bringing Pel-Freez Biologicals to Milwaukee. The company produces blood and tissue products for diagnostic, pharmaceutical, biotechnology and medical-device companies, and research institutions. And Brooks Stevens, a full-service product development company, will re-establish a Milwaukee presence with a satellite office.

HOW Green IS MY BATTERY?

Pioneering study on sustainable electric car battery manufacturing

Next generation lithium-ion batteries (NGLIBs) will give electric vehicles the capacity to drive much farther on a single charge. And new materials, including nanomaterials, have already produced the necessary performance at the lab scale, says **Chris Yingchun Yuan**, an assistant professor of mechanical engineering.

Yuan's research in NGLIBs inspired him to conduct the first study of the environmental impacts of NGLIB technology – a project that has resulted in an Early CAREER grant from the National Science Foundation (NSF).

Chris Yingchun Yuan, assistant professor of mechanical engineering

"Making these batteries requires the use of more chemicals than the current technology, in addition to creation of the nanomaterials themselves," says Yuan.

The manufacturing process raises questions about how best to dispose of waste and control environmental emissions, especially since exposure to nanowastes and nanoparticle emissions may pose risks for both occupational and public health.

"With this project, we're investigating the environmental sustainability of NGLIBs," he says. "We assume the technology will eventually move into the commercial arena, and we want to be prepared for these questions while the research is still going on."

CAREER awards are the NSF's most prestigious grants for younger researchers. They support the career development of teacher-scholars who are most likely to become the academic leaders of this century.

Industry Collaboration

Working with three industrial participants – General Motors, Johnson Controls and PE International – Yuan will model the manufacturing process step-by-step, quantifying the emissions and identifying the factors that affect waste and emissions.

Continued on page 20

Novel optical fibers earn UWM researcher CAREER award

Arash Mafi, an associate professor of electrical engineering, wondered if a solution to a more secure Internet might lie in a curious phenomenon that had been observed in 1958, but has never been put to practical use: Anderson localization.

The phenomenon is named for physicist Philip W. Anderson, who first theorized the "trapping" of electrons in a highly disordered medium, work that earned a Nobel Prize in 1977.

In a commonly used single-core fiber, only one spatial channel of light traverses through. That limits the information-carrying capacity.

Mafi and graduate student Salman Karbasi decided to apply the phenomenon in the work they were doing to improve the performance of optical fibers. The research has tremendous potential: Data transmission through conventional optical fibers is the backbone of the Internet.

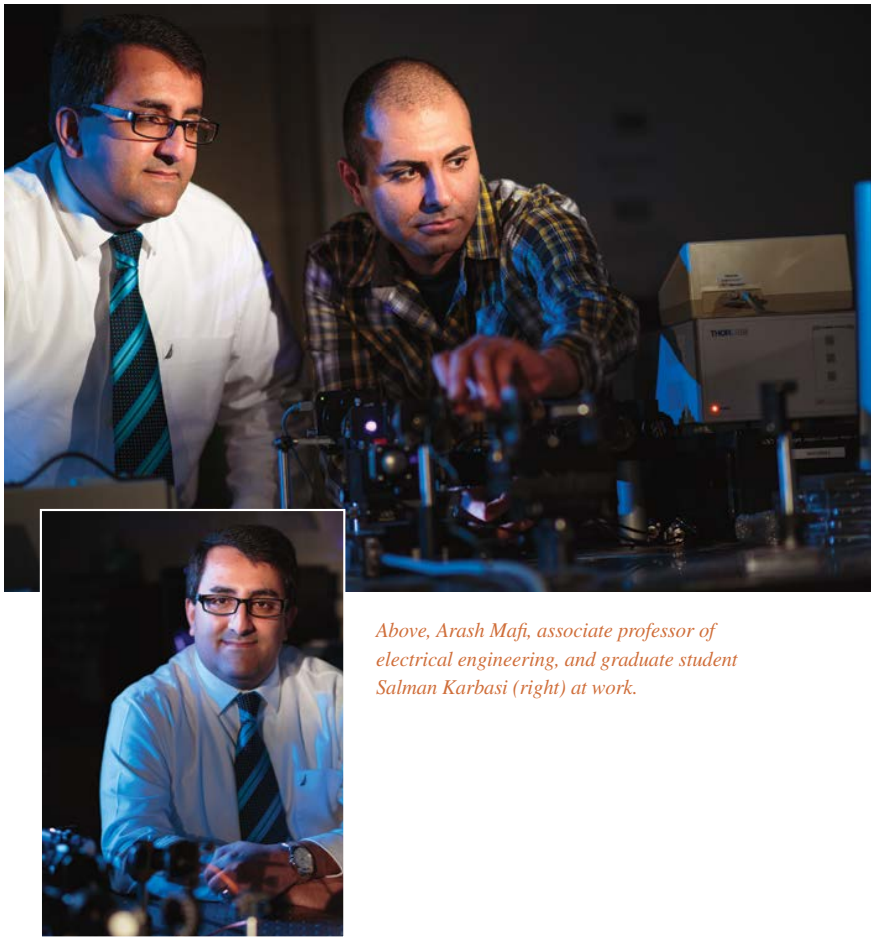
"In a commonly used single-core fiber, only one spatial channel of light traverses through. That limits the information-carrying capacity," says Mafi, who worked as a scientist at Corning Incorporated, the world's largest manufacturer of optical fibers.

Mafi and Karbasi have found that Anderson localization is one way of propagating multiple beams in a single strand of optical fiber.

Karbasi's fiber architecture brought the idea to life. The design consists of two randomly distributed materials that increase the scattering of photons within the fiber.

Karbasi's calculations indicated Anderson localization would occur within this disordered interior, causing a beam of light traveling through it to freeze laterally. His design worked and also allowed multiple frozen beams to pass through a single fiber.

Continued on page 20



Above, Arash Mafi, associate professor of electrical engineering, and graduate student Salman Karbasi (right) at work.

How Green is My Battery *(continued from page 18)*

CAREER awards are the National Science Foundation's most prestigious grants for young researchers. They support teacher-scholars most likely to become the academic leaders of this century.

The project has three elements:

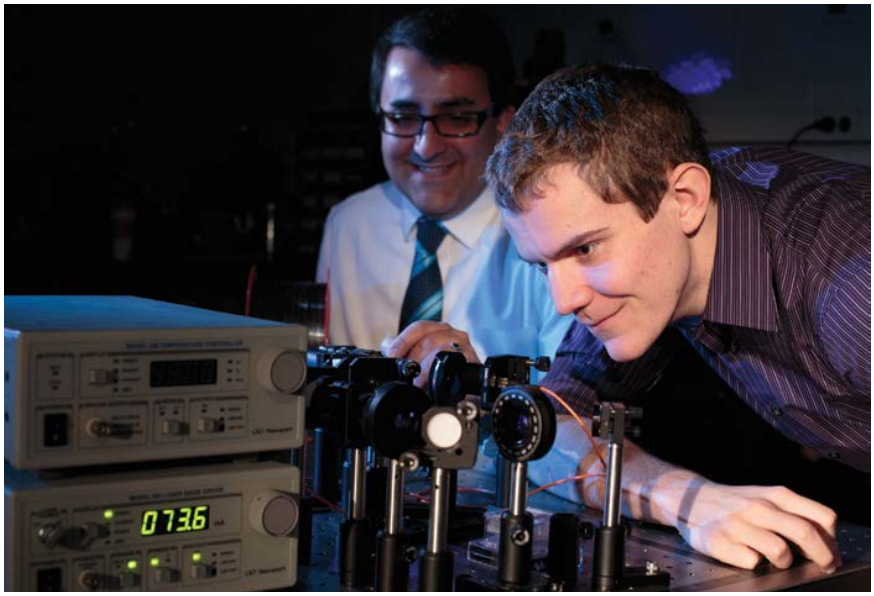
- Develop a sustainability assessment tool for use in large-scale production.
- Develop a thermodynamic energy consumption model that also will help reduce energy-related greenhouse gases and bring down costs.
- Investigate what to do with NGLIBs when they reach the end of their 10-year life spans. Yuan's research will explore disposal and recycling of the batteries, which will include techniques for removing nanomaterials without releasing them into the environment.

Yuan already is collaborating with Johnson Controls and General Motors on separate research projects centered on NGLIB technology development and green manufacturing of vehicles. Students will be involved in the research itself and also have access to an informational website. The funding supports one postdoctoral researcher, one graduate student and two undergraduates. Yuan also will offer lectures and short courses for professional development at the three participating companies.

A 2014 recipient of a "Citation of Commendation" award from the Wisconsin state legislature, Yuan joined the UWM faculty in 2009, after earning a Ph.D. in mechanical engineering from the University of California, Berkeley and a master's degree in industrial engineering from Texas Tech University. ●

For more information, visit: http://uwm.edu/lsnm/

Arash Mafi *(continued from page 19)*



Arash Mafi and research assistant Ryan Frazier working with fiber optics in the lab.

"We designed our fiber so that it provides more physical places where the light can propagate," says Karbasi of the project, which also includes Karl Koch, a scientist with Corning.

The opportunity to work alongside Mafi, winner of a CAREER grant from the National Science Foundation, is the reason Karbasi chose to study at UWM.

"When I'm involved in doing the experiment, my mind is busy," Karbasi says. "But the time I spend doesn't always end in a resolution I expect. That's when I often get the best ideas." ●

Innovative wrench design moving to production

Patrick Dix, a UWM graduate student in industrial engineering, tests a new type of wrench aimed at reducing worker injuries as UWM Professor Naira Campbell-Kyureghyan adjusts a sensor used to measure muscle activity.

An ergonomically designed wrench aimed at helping prevent worker injuries is now in production by Snap-on Tools, a southeastern Wisconsin company.

Several wrench prototypes were designed and tested by UWM faculty Naira Campbell-Kyureghyan and Benjamin Church and a student research team led by graduate student Patrick Dix and supported by UWM's Consortium for Advanced Research in Gas Industries (CARGI).

Snap-on Incorporated, a Kenosha, Wisconsin-based corporation, approved the prototype and has entered into a license agreement with the UWM Research Foundation to commercialize the product. Production starts this summer for the wrench, which has a longer handle and larger hand grip than other types, and the company expects to have it available for purchase in late 2014.

"CARGI is excited to collaborate with Snap-on to manufacture the wrench so that we can help prevent shoulder injuries in gas utility workers that often result during gas meter change-outs in the field," said Campbell-Kyureghyan, professor and chair of the department of industrial and manufacturing engineering.

"This product should provide a safer work environment for the utility workers, reduce company costs associated with these injuries, and increase the overall productivity for the companies," she said.

Utility workers have had injuries that required shoulder surgery and up to $100,000 in medical bills and lost work days, according to the UWM researchers.

UWM in the vanguard

Groundbreaking program brings real-world perspective to classroom

"UWM will turn out a workforce better prepared to strengthen the economy through innovative, entrepreneurial activities in companies both small and large."

– Dean Brett Peters

UWM is among the first 12 US universities to participate in a new program that helps universities embed innovative and entrepreneurial thinking into undergraduate engineering education.

The program, called Pathways to Innovation, was created by the National Center for Engineering Pathways to Innovation (Epicenter), funded by the National Science Foundation (NSF) and is managed by Stanford University.

During the two-year Pathways program, UWM faculty and administrators will work with the Epicenter staff and Stanford to weave a customized culture of innovation and entrepreneurship into the curriculum. UWM will receive access to successful models for integrating innovation and entrepreneurship into their curriculum and a national network of engineering and entrepreneurship faculty.

Among the members of the Pathways team are Dean Brett Peters (from left); Michael Hostad, UWM director of Web and Mobile Strategy; Kim Beckmann, associate professor of art and design; Nathaniel Stern, associate professor of art and design; and Ilya Avdeev, assistant professor of mechanical engineering.

"Participation in Pathways will help the college chart its own direction through the coursework that can turn out talented engineers who are both technically proficient but also capable of identifying opportunities to bring their ideas to life in the marketplace," says Dean Brett Peters. "That means UWM will turn out a workforce better prepared to strengthen the economy through innovative, entrepreneurial activities in companies both small and large."

Through the Pathways program, the college intends to both create new elective classes and encourage engineering students to look at innovation-cultivating courses outside their department, says Ilya Avdeev, the assistant professor of mechanical engineering who is the UWM implementation team leader.

"Engineering students don't necessarily have time in their busy curriculum to take some business courses or other types of courses that would help their ventures or their innovative processes," says Avdeev, who notes that most courses available to students in the Student Startup Challenge are outside the curriculum for engineering majors. "We plan to look at these gaps and see how we can create space in the programs in engineering so that students have an opportunity to take these courses."

According to a recent report by the US Department of Commerce, the majority of job creation in our country during the last two decades has occurred in young, start-up companies. ●

Students chosen as Innovation Fellows

Streamlining entrepreneurial resources into a single clearinghouse

In a bid to increase UWM student awareness of the entrepreneurial resources available to them, three UWM engineering students are among the 110 students nationwide chosen as University Innovation Fellows.

The fellows, all from mechanical engineering, are postdoctoral researcher Carlton Reeves, graduate student Alex Francis and undergraduate Robert Salamon. They are charged with implementing programs that will boost entrepreneurial activities for UWM students in all disciplines.

The fellowship program is a joint endeavor between the National Center for Engineering Pathways to Innovation (Epicenter) at Stanford University and the National Collegiate Inventors and Innovators Alliance (NCIIA), which trained the students to guide the entrepreneurial education initiatives at their schools.

One of the goals of the UWM fellows is to streamline all the different entrepreneurial resources available to students into a single clearinghouse on campus, says Francis.

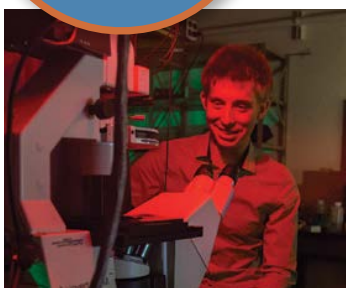
Recently the UWM fellows organized and hosted a 3 Day Startup event at the college, a speed-dating inspired brainstorming effort to kick-start new student-run companies and build entrepreneurial capabilities. UWM's event was held concurrently with other 3 Day Startup events at 55 other institutions.

The event culminated with investor pitches and prototype demonstrations from all participants to a panel of notable investors, entrepreneurs and professors. ●

As national University Innovation Fellows, Carlton Reeves (from left), Alex Francis and Robert Salamon, will implement programs that will boost entrepreneurial activities for UWM students in all disciplines.

Engineers win university's challenge

Student Startup Challenge



E-Trap: Alex Francis, mechanical engineering

Aqua Sensor: Marcia Silva, environmental engineering and Tom Hansen, computer science alum

Level Camera Products: Kyle Ilenda, mechanical engineering

How far can an idea get you? Just ask the current UWM students and recent alums who won this year's Student Startup Challenge (SSC).

Eight teams won financial backing and mentoring to launch a business on the strength of an original product idea in the competition. Three of the winning teams include at least one engineering student or alum.

SSC encourages student and alumni entrepreneurs to find new ways to tap the commercial potential of their ideas and helps turn their products into a business.

"The competition's aim of creating innovators and leaders through the entrepreneurial start-up process is working," says Ilya Avdeev, assistant professor of mechanical engineering and SSC co-founder.

It began as an extension of a product realization course which is open to engineering, arts and architecture students. SSC's founding partners – the College of Engineering & Applied Science, Peck School of the Arts, and the UWM Research Foundation – limited submissions the first year to traditional "hardware" products.

This year, the School of Information Studies joined the partnership, adding coursework in mobile app development. Organizers hope that this year's submission of an aquatic sensor will result in the addition next year of a freshwater technologies track.

In addition, the competition has attracted two new funding sources: the UW System's Growth Agenda for Wisconsin and the National Collegiate Inventors and Innovators Alliance.

"Ultimately, the SSC is designed to teach first," says Nathaniel Stern, associate professor of art and design who co-founded the SSC with Avdeev. "It's not just about starting up, but starting out," he says. "We see this as an opportunity for them to fail and try again."

Three teams with engineers include:

E-Trap – Alex Francis, graduate student, mechanical engineering. An electrostatic trap that confines a single particle, like a virus or DNA molecule, so it can be analyzed through a microscope. It involves a microscope slide that has been treated with a thin, metal coating, but at the center is a small, circular space that's left untreated. When a particle floats into the circle, the device applies voltage to the coated portions, creating a kind of force field to hold the particle in the viewing area.

Aqua Sensor – Marcia Silva, recent Ph.D, environmental engineering, and **Tom Hansen**, computer science alum and current doctoral student, freshwater sciences. This low-cost, hand-held device allows users to dramatically cut the turnaround time for detecting bacteria in drinking water. Hardware and software produces a holographic image of particles found in a water sample by interpreting the interference patterns.

LEVEL Camera Products – Kyle Ilenda, senior, mechanical engineering, and Spencer Johnson, now a systems engineer at NetApp. The LEVEL kit includes seven pieces that allow users to make one of three different accessories: a camera slider that creates smooth linear motion, a shoulder rig to stabilize handheld footage, and a table-top dolly that allows users to create linear motion shots on a flat surface. ●

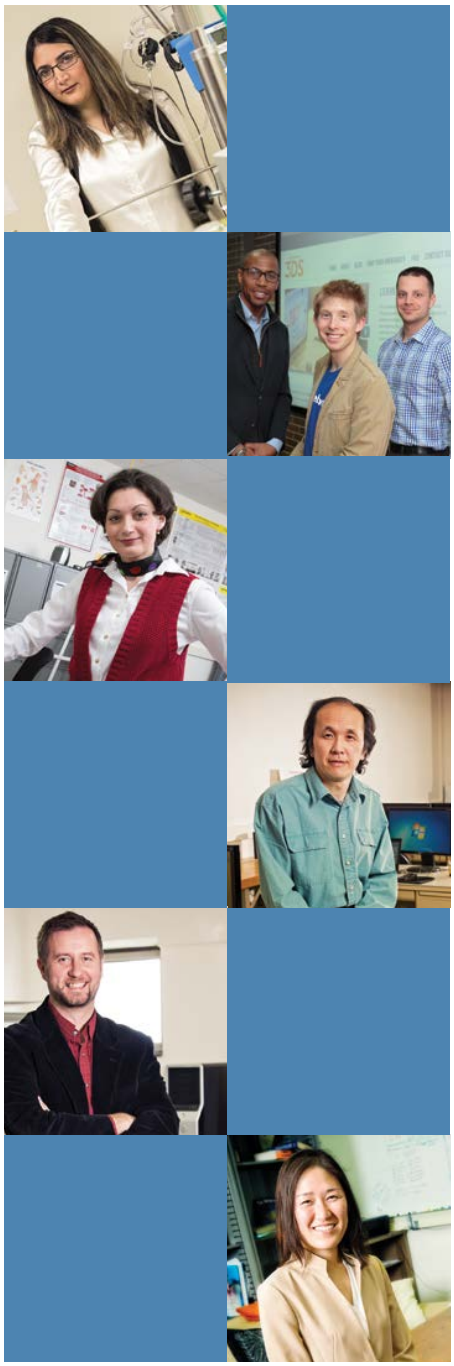
To view all the 2014 Student Start-up winners, visit **www4.uwm.edu/startupchallenge.cfm**

Make a gift. Change the world.

Thanks to your contributions, the collective energy of our professors, graduate students and undergrads is a driving force, fueling economic growth and job creation in southeastern Wisconsin – and increasingly powering the state, country and world.

With your support, we help build the future and change the world every day:

- **Encouraging Students** – With more than 1,900 students, we're helping to shape the next generation of engineers who can and are making a difference. You've read about Tom Consi's students helping wildlife populations through technology *(page 10)*. Your gift supports the student experience through scholarships, co-ops and internships, study abroad programs, diversity initiatives and much more.
- **Supporting Faculty** – From remarkable inventions that will improve quality of life for stroke patients *(page 4)* to smart concrete that advances infrastructure *(page 12)*, you've seen examples of the world-class College of Engineering & Applied Science faculty helping transform society. Your gift will aid faculty by creating funds for endowed chairs or named professorships, contributing to faculty fellowships or supporting career development professorships.
- **Sparking Innovation** – Programs like the Student Startup Challenge *(page 24)* and Pathways to Innovation *(page 22)* are connecting research to economic growth and progressive business development. With your contribution, we can support these programs and provide more experiences that expand learning beyond the classroom and develop important life skills.



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