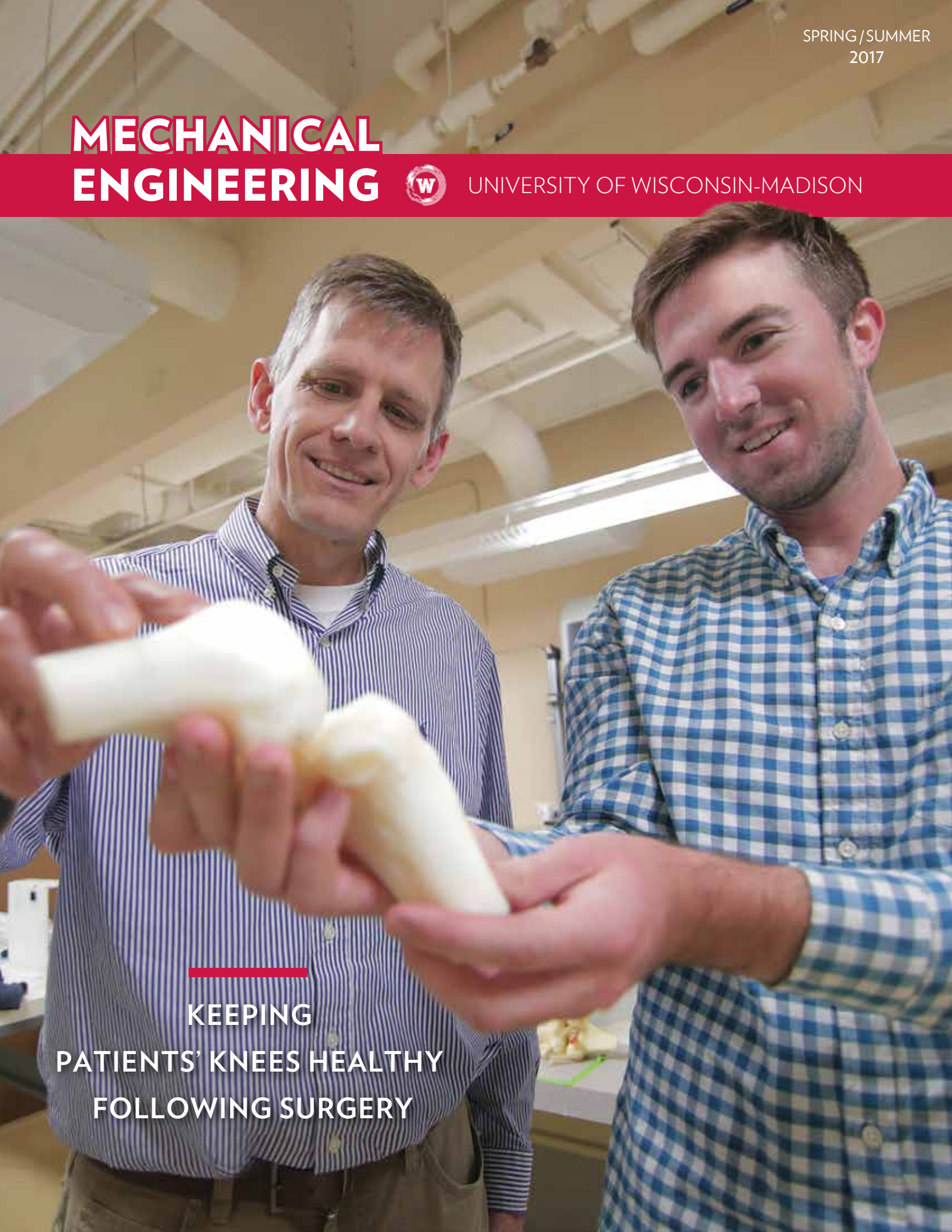
SPRING / SUMMER
2017

MECHANICAL ENGINEERING

UNIVERSITY OF WISCONSIN-MADISON



KEEPING PATIENTS' KNEES HEALTHY FOLLOWING SURGERY

Jaal Ghandhi

GREETINGS!

As the 2016-2017 academic year draws to a close, it is nice to reflect on the great things our students and faculty have accomplished this year. In this newsletter, it is my pleasure to share with you some of these recent achievements.

Each year at the end of the spring semester we hold our Undergraduate Research and Design Symposium for our graduating seniors to show off the innovative projects they have been working on in the senior design course. This event, which fills the atrium of the Mechanical Engineering Building with an impressive energy, brings together industry partners, faculty, and members of the department's Industrial Advisory Board, who serve as judges for a number of awarded prizes. (Watch a video about last year's event: go.wisc.edu/me-senior-design-2016)

While there are too many great projects to describe, one standout project at this event was the WiscWind project. The team won the advanced manufacturing prize that was sponsored and awarded by Milwaukee Tool for its innovative method of creating carbon fiber blades. In April 2017, the WiscWind team competed in the U.S. Department of Energy's Collegiate Wind Competition Technical Challenge, placing fifth overall and first in the Bonus Siting Challenge, which asks teams to design a hypothetical wind farm based on various siting factors such as cost, power production and local environmental impact. There were a number of projects this year that were based on student competitions, and we are happy to be to use gift funds to help support the student teams' travel to the respective competitions.

As we head into the summer months and start of another new academic year, there are sure to be many exciting things in store for the department. Be sure to follow us on Twitter via the handle @UW_MechEngr and like us on Facebook to stay involved with all the happenings in the department!

We all have reasons to be proud: Our university, our college and our Department of Mechanical Engineering remain vibrant—and our work makes a difference in the lives of people around the world. Thank you for your continued support and encouragement.

ON, WISCONSIN!

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The Division of Continuing Studies, which manages UW-Madison's Advance Your Career portal, has launched a new campaign to promote 21 online and accelerated engineering degrees. These expanded offerings enable us to better serve both traditional and adult students. Learn more at advanceyourcareer.wisc.edu/engineering/.

Student places second in nationwide engineering contest

Anna Scheibengraber decided to participate in the 2016 PepsiCo/Society of Women Engineers (SWE) Student Engineering Challenge, more or less on a whim. "I heard about the challenge, and after a good start on my design, I ended up being able to see the whole project unfold, had the motivation, and knew I could do it," she says.

Scheibengraber, a senior, had previously participated in the Boeing Team Tech competition for two years in a row, but couldn't return for a third year, as she was studying abroad in Copenhagen, Denmark. The PepsiCo/SWE Challenge allowed her to continue putting her design skills to good use, while also trying something completely new.

The yearly, national challenge encourages engineering students across the country to submit technical solutions for the improvement of PepsiCo operations.

Scheibengraber, who was the only individual competitor, won second place out of 10 teams in the contest with her design for a testing device and software to monitor performance of fountain machines. "My design streamlines the actions and reactions that take place, to better identify, diagnose and resolve things when a soda fountain breaks down," she says.

She flew from Copenhagen to Philadelphia in late October 2016 to join SWE for WE16, the organization's annual conference and career fair, where her design was judged by a panel of PepsiCo representatives.

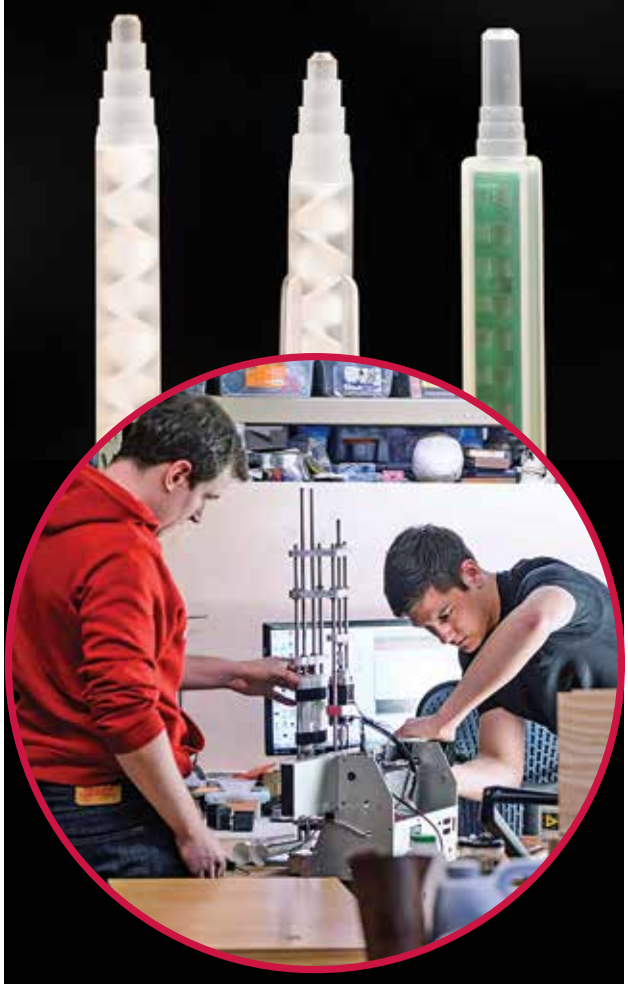
When Scheibengraber, a Wisconsin native, is on campus, she is a research assistant in the Polymer Engineering Center under Professor Tim Osswald. In summer 2017, she is living in Germany for a co-op with Volkswagen.

Anna *(left)* with SWE President Jessica Rannow (BSIE '99).

CAPITAL INFU$ION

PREPARES STARTUP TO STIR UP INDUSTRIAL ADHESIVE MARKET

An idea hatched during an engineering class promises to reduce waste in a common industrial mixing process. Epoxy and hardener, which must be mixed just before application, are used in a broad range of industries, including construction, manufacturing—even dentistry.



Alumni Brian Pekron *(left)* and Eric Ronning, CEO of Re Mixers Inc., make adjustments to an automated testing device.

Photos: Jeff Miller

These epoxies are blended in a "static mixing" nozzle—so named because it has no moving parts, says Eric Ronning, CEO of Re Mixers Inc., which was incorporated Dec. 27, 2016.

Upwards of 70 million static mixing nozzles are sold in the United States every year because epoxy quickly sets inside the nozzle and plugs it. The nozzle technology has changed little since the 1970s, Ronning says.

Ronning (BSME '14) had his "eureka" moment while listening to Professor Tim Osswald discuss the shortcomings of static mixers in a class on plastics at UW-Madison.

As he pondered the problem of quickly and thoroughly mixing two fluids, he realized that the problem was more interesting than it sounds. "Mixing is such a fundamental, basic action, but what is the most efficient way to do it? With a static mixer, there are not many factors to play with, not many tricks to employ."

Mixing, whether active or static, is something that 2-year-olds enjoy, Ronning says. "It's a natural process. If you are standing in a river and gently release a handful of sand, you can expect all of the individual grains to be dispersed as they flow downstream. But aside from the water itself, there aren't any moving components along the riverbed. That's a good way to envision what happens inside a static mixing nozzle, where there also aren't any moving components."

Static mixing and epoxy adhesive are critical to strong, lightweight construction in laptops, cellphones, cars and bikes, Ronning says. "These products could not exist in their present form without static mixers and the adhesives they make possible."

In the world of products, epoxy adhesive, enabled by static mixers, "is in everything we see," Ronning says, "but it's not where you're looking. Your computer, your phone, your car, your house—epoxy is everywhere, but it's behind the scenes. And every time a nozzle plugs up with epoxy, a new nozzle must be used."

To convert a eureka moment into a business, Ronning and Brian Pekron (MSNEEP '16, MSME '16) entered the Discovery to Product program on campus. They devoted a $65,800 grant from D2P to product development, testing prototypes, identifying customers and forming a company. "D2P helped us realize a business strategy that was realistic, which is vital when starting any venture," Ronning says.

In December 2016, Re Mixers received initial funding of $500,000 from N29 Capital Partners of Manitowish Waters, Wisconsin. "I have been really impressed with Re Mixers' adhesive and epoxy mixing technology," says Carl Ruedebusch, head of N29. "Being a contractor, this is a technical area that I know well."

The new design provides better mixing of the ingredients while dramatically reducing the amount of expensive material wasted when the epoxy hardens inside the nozzle. By improving bond strength, better mixing further cuts adhesive cost. Re Mixers has filed a patent on the invention.

"Our big selling point is reducing adhesive cost for the end user," says Ronning, "and at the same time, they get a stronger adhesive."

Ronning and Pekron hope to be on the market with their product within a year.

MENTORSHIP PROGRAM AIMS TO GROW THE NUMBER OF WOMEN IN MECHANICAL ENGINEERING

Senior Jessie Thomas *(left)* and freshman Mari McPheron *(right)*

Even as women and minorities pursue higher education at ever-increasing rates, some disciplines, especially in the sciences, continue to struggle to capture their interest. And that's why the Department of Mechanical Engineering is embarking on new efforts designed to attract more women to the program.

The statistics are striking: Of the 152 UW-Madison mechanical engineering bachelor's degrees conferred in the 2013-14 school year, 138—nearly 90 percent—were to men. Only 16 women received bachelor's degrees in mechanical engineering that year. Meanwhile, women made up about 20 percent of the graduating class of the entire College of Engineering that year (women received 53 percent of the bachelor's degrees university-wide in 2014).

As department chair Jaal Ghandhi sees it, the deficit of women in UW-Madison's mechanical engineering program is a longstanding challenge that requires immediate attention. "In essence, the department has been about 10 percent women for about as far back in time as I've gone to dig up statistics," Ghandhi says. "In the college, on the other hand, about a quarter are women. And our 10-percent number is actually a little bit below the national average for mechanical engineering."

As a first step toward a larger planned diversity initiative, in fall 2016 the department launched its Women in Mechanical Engineering program. At its core it is a mentorship program that pairs incoming female freshmen with juniors and seniors. The idea is to show the incoming women—who undoubtedly will continue to be outnumbered in the years to come—that women can be, and are, successful mechanical engineers at UW-Madison.

"In high school, the gender breakdown is 50/50," Ghandhi says. "These young women come here and probably their first year in calculus and chemistry and courses like that, it's still probably about 30 percent women. But then when they get into the upper-level mechanical engineering classes, there might be a class of 20 and they might be the only female in the class, and that's just a different experience."

It's an experience that senior Jessie Thomas knows well, which was a driving factor for her decision to become involved in the program as a mentor. "When they brought up the idea of the mentoring program I thought, 'Oh, that would be so cool because I wish I had that when I was a freshman,'" Thomas says. "That would've been awesome."

Thomas, a double major in mechanical engineering and English, recently completed a co-op at Sub Zero in Madison. It's a milestone that she says she wasn't always confident she would achieve, partly because she at times felt out of place in the mechanical engineering program, even though both her parents are engineers.

"I think it can be really intimidating as a woman in mechanical engineering because when you're coming in it seems like a lot of the guys know a lot of this stuff already," Thomas says. "They've been under the hood of a vehicle since they were five years old—and I'm not saying that some women haven't had that either—but that hadn't been my experience."

Thomas says as she's progressed through her major, she doesn't usually notice the gender disparity, but every once in a while it becomes glaringly obvious. "One of my friends who's also a woman leaned over to me the other day in our circuits class, and she says, 'There's like nine women in this class,' of 100-some," says Thomas.

She also says there's a feeling that all of the men know each other, and crossing social barriers is not always a straightforward task. "You want to be able to make friends, you want to learn from them as co-students," she says. "But that can be a challenge, because there aren't many women and it sometimes feels like the men are thinking, 'Oh, she's talking to me!' and I'm just being friendly."

Freshman Mari McPheron and Thomas were paired up through the Women in Mechanical Engineering program and have enjoyed the relationship from day one.

McPheron enrolled in the mechanical engineering program because she loved math in high school and enjoys the blend of technical and creative skill that engineering requires. She says she opted to join the Women in Mechanical Engineering because she felt overwhelmed by the transition into college. So far, McPheron's been very happy with the program, she says.

"My experience has been really good," McPheron says. "Jessie and I had a lot of similar experiences, so talking with her really helps me. Just getting her advice has really helped me and has given me a new perspective on things and encouraged me."

Though mentoring is at the center of the Women in ME program, Ghandhi says the department is hosting regular social hours so women in the program can share some social time with each other. "We want to avoid making this another student organization, with a president and vice president and responsibilities like that," Ghandhi says.

Instead, the department hosts monthly get-togethers, where women are invited to hang out, do homework or simply chat over pizza.

"Additionally, we plan to bring in speakers," Ghandhi says. "Mainly alumnae who have gone on to very successful careers and can come back and share their experiences both as students here as well as in the workplace."

To learn more about how you can contribute to the success of this program, contact Brad Green, director of development for the ME department, at brad.green@supportuw.org or (608) 308-5354.

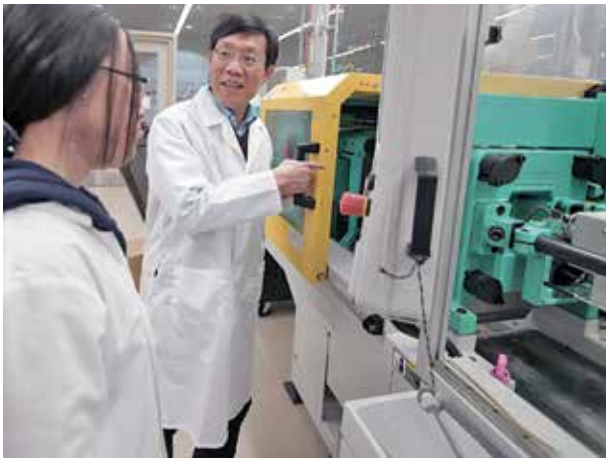
INVESTIGATING TISSUE-ENGINEERED ARTERIES FOR TRANSPLANT

The prospect of creating artery "banks" available for cardiovascular surgery, bypassing the need to harvest vessels from the patient, could transform treatment of many common heart and vascular ailments. But it's a big leap from concept to reality.

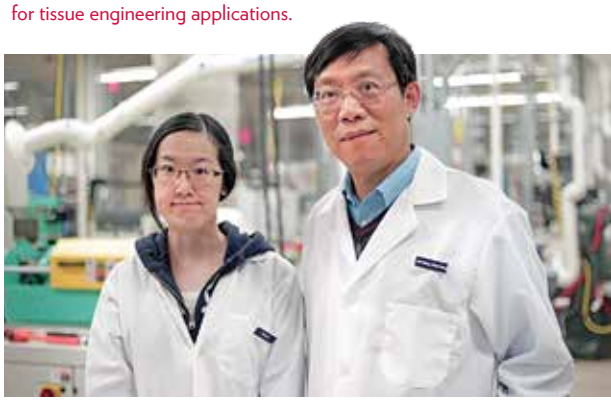
Professor Lih-sheng (Tom) Turng is collaborating on a Morgridge Institute for Research and UW-Madison project that will address both the engineering and biomedical hurdles in this process. The National Heart, Lung, and Blood Institute is funding the five year, $8 million project.

Patients needing bypass surgeries would benefit from a better source for arteries, says project leader James Thomson, a stem cell research pioneer and director of regenerative biology at Morgridge. Replacement tissue currently comes from another part of the patient's body, and suitable tissue can't be found for many patients. Current synthetic alternatives also fail at a high rate.

Diseases of blood vessels—including coronary artery disease—kill more people worldwide than any other single cause.



Professor Lih-Sheng (Tom) Turng and Emily Yu, a postdoctoral research associate in Turng's lab, brainstorming next to a micro-injection molding machine capable of mass producing plastic and composite parts with microscale dimensions or geometric features suitable for tissue engineering applications.



A promising approach is to create tissue with cells banked from a unique population of people who are genetically compatible donors, based on rare alleles that circumvent rejection. Alleles are gene pairings that control certain characteristics, such as blood type. It has been estimated that about 100 different cell lines from this rare population would be enough to cover a majority of the U.S. population.

The research effort will address key questions about the feasibility of this approach. The Thomson group is working to create the optimal cellular building blocks of the artery—endothelial and smooth muscle cells—that will be most suitable for transplantation and continue to grow and remodel in the patient.

In tandem, a team led by Turng, the Kuo K. and Cindy F. Wang Professor and Vilas Distinguished Achievement Professor in mechanical engineering, will develop scaffolds from natural and synthetic materials to provide structure and shape for the artery.

TEAM WINS INNOVATION AWARD IN HYPERLOOP COMPETITION

Photos courtesy of Badgerloop

The UW-Madison Badgerloop team won an innovation award in a worldwide SpaceX Hyperloop pod competition. The student team competed against 30 teams from colleges and universities from around the world in the second phase of SpaceX's Hyperloop pod competition, which was held Jan. 27-29, 2017, outside SpaceX headquarters in Hawthorne, California.

Elon Musk tries out the Badgerloop pod.

Teams spent the week leading up to the competition at SpaceX, where they put their pods through a litany of tests in hopes of getting the chance to run them on SpaceX's one-mile Hyperloop test track.

The brainchild of SpaceX and Tesla Motors co-founder Elon Musk, the Hyperloop is a futuristic high-speed transportation system. The idea is for passengers to travel in levitating vehicles—"Hyperloop pods"—through an above-ground vacuum tube, enabling super-fast travel between distant cities.

After more than a year of intensive design work and construction, the Badgerloop team brought its 15-foot-long, 2,100-pound pod to California for the competition. While some bugs in the pod's mechanical and electrical systems ultimately prevented Badgerloop from making a run on the test track, Badgerloop operations director Claire Holesovsky said the experience of building the pod as a team and participating in the competition has been very rewarding.

"It's been an awesome experience, and we've learned so much," Holesovsky says. "We received great feedback from the SpaceX judges and from talking with the other teams.

It's really exciting to be working on technology that has the potential to revolutionize high-speed transportation."

In the end, only three of the 30 teams in the competition were able to actually launch their pods on the test track, which highlights the extreme difficulty of the technical and engineering challenges the student teams faced as they attempted to design and build pods for a entirely new mode of transportation. When they announced the results of the competition, the SpaceX judges emphasized how difficult it was to build a levitating Hyperloop pod that doesn't crash, adding that they weren't sure if any of the teams would be able clear all the technical hurdles that would allow them to safely run their pod on the track. Delft University of Technology from the Netherlands was the overall winner with the highest score in the competition, and the Technical University of Munich won the award for fastest speed achieved in the Hyperloop tube.

Badgerloop received one of two innovation awards in the competition. The judges noted the team's innovative designs, including the virtual reality setup that Badgerloop created.

Badgerloop leaders said it's an honor to win the innovation award, especially since the team is led by undergraduates. "I think it's really exciting to see that something so technologically advanced can be made by a group of undergraduates," says Badgerloop team member Jack McGinty. "This experience has made me realize that I can do whatever I push myself to achieve."

The team purposely built its pod to fit Musk, who is 6 feet 2 inches tall. Badgerloop got its wish when, after delivering remarks at the competition, Musk toured the various teams' booths and took the opportunity to sit in the Badgerloop pod. "We were all ecstatic to see Elon sit in our pod," Holesovsky says. "He checked out our pod's technology. It was a great highlight in an incredible week for the team."

Badgerloop, which won third place in the initial round of SpaceX's Hyperloop pod continue to work on and refine its pod. The team will compete in the next installment of the competition, which is set to take place in summer 2017 at SpaceX's Hyperloop test track.

Photos: Stephanie Precourt

KEEPING PATIENTS' KNEES HEALTHY FOLLOWING SURGERY

Unlike the assembly of a machine, there is no "one-size-fits-all" approach to medicine. Professor Darryl Thelen conducts research with this notion in mind while using computational models of the musculoskeletal system and high-throughput computing resources to refine knee surgical procedures.

Thelen's mechanical engineering background and interest in biomedical applications catalyzed his current research in knee biomechanics. Much like Thelen, PhD student Colin Smith gravitated to the field after studying machines as an undergraduate.

"What we do is use mechanics—all the things people use when designing cars such as how motors drive movement—and use those ideas to analyze how humans move," Smith says.

Thelen and Smith specifically look at knee surgical procedures and the complex variables that affect the outcome of surgeries. When somebody tears their anterior cruciate ligament (ACL), the surgeon must adjust a multitude of surgical parameters while performing the operation to achieve the best outcome for the patient. Such parameters include how tight to pull the graft before fixing it to the bones and what location and angle to attach the replacement ACL.

Darryl Thelen *(left)* and graduate student Colin Smith demonstrates knee laser geometric analysis in Thelen's lab.

While ACL reconstruction surgeries can enable individuals to return fully to activity, high rates of osteoarthritis, a degenerative joint disease, are seen 10 to 15 years after the procedure. Thelen and Smith want to come up with a strategic way to tell orthopedic surgeons, with increased certainty, what surgical adjustments may reduce the risk of osteoarthritis for each patient.

In order to do so, their lab uses OpenSim software to investigate joint contact pressures by simulating movements such as walking, running and stair climbing. OpenSim is a freely distributed open source software package that's used around the world to model the musculoskeletal system.

By harnessing high-throughput computing resources on campus, Thelen and Smith are able to run hundreds of simulations in a fraction of the time. Through more OpenSim simulations, the researchers hope to devise subject-specific treatment plans and have a better grasp predicting surgical outcomes.

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TEAMWORK—and lifelong learning—inspire alumna's career path

Jenny Topinka arrived at UW-Madison with an open mind, and no real idea of what her major would be.

She was searching for something high-impact, but wasn't interested in anything in particular, especially business (though, ironically, she would later work as a senior sales manager for General Electric). The Verona, Wisconsin, native finally found what she was looking for in engineering, when a few of her friends introduced her to the Hybrid Vehicle Team.

Still undecided in her major, and knowing almost nothing about the field, Topinka joined the team. On her first day, she hit the ground running, removing bolts from the team's car and draining the transmission fluid. While she initially saw engineering as an unattainable field reserved for "geniuses," such early, hands-on experiences—problem-solving in a supportive team environment—helped her understand the appeal.

"It was inspiring to see how the team taught me what I needed to know, while also using the strengths I had," she says. "It helped me understand that engineering was not some out-of-reach objective. It's problem solving—you take baby steps. The team taught me that if you put your heads together, you can solve any problem."

Before long, Topinka made mechanical engineering her major and took leadership roles on the team. Her senior year, she was team leader for the UW-Madison FutureTruck project, which sought to improve fuel-efficiency in sport-utility vehicles. She also continued to dabble in a variety of engineering-related pursuits, through projects in robotics, with the Engine Research Center, and under her professors. She graduated with a bachelor's degree in 2001.

She still points to her experience with the Hybrid Vehicle Team as an ideal example of what a team should be—a diversity of talents, and a diversity of strengths, all working together to achieve a goal, she says.

"We had many all-nighters and many failures, and it wasn't easy, but we always overcame," she says. "It was an amazing experience. It also made me comfortable with explaining things and helping me to understand my place at the university."

By developing her expertise in vehicles, she was able to work in an internship with Ford, which also sponsored her graduate research at the Massachusetts Institute of Technology. "All these connections built through the team enabled me to have a successful education, enabling a broader career," she says.

After graduating from MIT with a master's degree in mechanical engineering, she accepted a role as a research scientist at GE's Global Research Center in Niskayuna, NY.

However, Topinka felt that her role as an engineer wasn't necessarily maximizing her potential. She started to see the importance of business acumen in working for a corporation like GE.

After being an engineer for GE for approximately four years, Topinka joined the corporation's internal audit team. She compares this experience to earning an GE-internal MBA: She had to learn a whole new set of skills from scratch. "It was a way to spin myself into another orbit," she says.

As a rising star at GE, Topinka advanced into a number of business positions within the company, including becoming a senior sales manager as part of a GE's Experienced Leadership Program. Topinka moved to the San Francisco Bay Area in 2016 to take part in GE's new digital initiative as a business optimization partner manager—a position that puts her at the frontier of advances in the industry.

MORE: go.wisc.edu/topinka-alumna-profile