DEPARTMENT OF
Mechanical Engineering
UNIVERSITY OF WISCONSIN–MADISON

SUMMER 2016
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UW-Madison places among top teams in SpaceX Hyperloop competition

Greetings! We have just concluded another successful academic year, and as you'll read in this publication, we have much good news to share with you.

Jaal Ghandhi

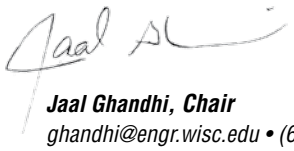
It has truly been a banner year for our student-led teams at national and international competitions. The UW-Madison BadgerLoop team, which is led by two mechanical engineering students, won third place overall in the SpaceX competition to design a pod for shuttling people on a futuristic high-speed transportation system known as the Hyperloop. Students on the BadgerLoop team have been busy building their prototype pod, which they will test on SpaceX's one-mile test track in California later this summer. The "Net Zero Wisconsin" team, which includes several mechanical engineering students, placed second in the Department of Energy's third annual Race to Zero student design competition. The team designed an affordable home capable of achieving a zero energy balance—in other words, it would require no external energy. For the second year in a row, our Clean Snowmobile Team took first place in the internal combustion division at the 2016 SAE International Clean Snowmobile Challenge. And the Wisconsin Robotics team is competing in the University Rover Challenge in Utah in June 2016.

These successes speak to the high caliber of our undergraduate students, who are highly driven, creative problem solvers and capable builders—altogether well-rounded, first-rate engineers. The fabrication facilities that are available to our students through the Henry Yu (BS '52, PhD '57) Innovation Center have also enabled these achievements. The Innovation Center was made possible by Yu's $1 million gift when the Engineering Centers Building was being constructed.

Increasingly, our courses require that students complete training to receive a shop permit, and clearly the students are making good use of these skills. The college's forthcoming makerspace, which is slated to open in 2017, will further expand these opportunities for students.

Money from the department's discretionary fund has been used to support all of the student teams I mentioned, and I'd like to thank everyone who has generously contributed. Your gifts are helping enrich the educational experience for our students.

ON, WISCONSIN!



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Helping attract top faculty with a gift

Among the nation's top universities, competition is fierce to attract and hire the very best professors. That's because high-quality faculty members are the driving force behind a college's excellence.

Outstanding professors make high-impact research breakthroughs, attract the brightest students, bring in significant grant funding and strengthen their department's reputation. "I know the most important thing a university can do is attract and retain talented faculty, and anything I can do to support that is a great way to help sustain a strong mechanical engineering department into the future," says Brian Rauch (MSEMA '90, PhDEMA '93), of Dubuque, Iowa.

Brian Rauch

Motivated by his desire to help ensure the ongoing excellence of the department at a time of fewer funding resources for the university, Rauch recently made a gift to support faculty startup costs in the department.

When new faculty members are hired, they can face some big up-front costs associated with starting their research program. For example, new faculty members need to purchase equipment for their laboratories and to hire graduate research assistants.

Rauch's gift will not only enable the department to recruit top candidates with a competitive startup package but will also allow a new faculty member to hit the ground running when he or she arrives on campus. "What you'd really like is for new faculty members to come into the department and be able to focus on engaging with students and their research right away and not have to immediately focus on how they're going to pay for things to set up their research program," Rauch says.

As the senior vice president of engineering, manufacturing and supply management for John Deere's Worldwide Construction and Forestry Division, Rauch leads 600 engineers in a global organization that develops construction and forestry equipment, such as backhoes, bulldozers, skidders and forestry harvesters.

Rauch says his graduate education at UW-Madison has served him well throughout his career. "My engineering graduate degrees gave me a strong technical education and, just as importantly, as I worked on my PhD thesis, I learned how to think independently and develop new approaches for solving complex, unfamiliar problems," he says. "I use these skills all the time in my career."

The BadgerLoop team's innovative pod design.

A team of UW-Madison engineering undergrads won third place overall in a worldwide competition to design a pod for shuttling people on a futuristic high-speed transportation system known as the Hyperloop.

UW-Madison places among top teams in SpaceX Hyperloop competition

The UW-Madison BadgerLoop team competed against more than 115 student teams at the first-ever SpaceX Hyperloop pod design competition held at Texas A&M University on January 29-30, 2016. The teams came from 27 U.S. states and 20 different countries.

The Hyperloop is a conceptual rapid-transit system first proposed by SpaceX and Tesla Motors co-founder Elon Musk in 2013. It involves transporting passengers in pods traveling as fast as 760 mph in vacuum tubes above ground. With the Hyperloop, passengers could travel from Los Angeles to San Francisco in less than 30 minutes.

During the two-day competition, teams presented their designs to a panel of SpaceX, Tesla and university judges for a chance to build and test their design prototype at the world's first Hyperloop test track being built by SpaceX adjacent to its headquarters in Hawthorne, California.

The BadgerLoop team's design, which harnesses an array of magnets to levitate the pod in the Hyperloop tube, impressed the SpaceX and Tesla engineers, according to BadgerLoop co-president Brett Sjostrom, a senior majoring in mechanical engineering.

The team's pod design features innovative spinning wheels that have powerful magnets around the outside. These so-called Halbach wheels stabilize the pod and propel it down the tube. "The Halbach wheels allow us to speed up the pod, slow it down or maintain its speed," Sjostrom says. "Our pod will be fully levitating and won't be touching any part of the tube."

Competitive on an international stage

BadgerLoop is unique among the top teams because it consists primarily of engineering undergraduates, as opposed to teams like MIT that are made up of graduate students, and the BadgerLoop students only worked on the project in their free time rather than as part of their engineering coursework. The only teams to score higher than BadgerLoop were MIT and Delft University of Technology from the Netherlands. "The design competition was a huge success for BadgerLoop," Sjostrom says. "I cannot emphasize enough how impressed and proud I am of our team of engineers."

The BadgerLoop team presidents with founder of SpaceX Elon Musk.

Elon Musk made a cameo during the final day of the competition and gave a short talk to the rapt audience. Sjostrom and BadgerLoop co-president Tieler Callazo, a mechanical engineering senior, even got the unexpected honor of meeting backstage with Musk for a half hour along with the presidents of the other top four teams. "It was surreal to get to have a conversation with someone as brilliant and inspiring as Musk," Sjostrom says. "We talked about Hyperloop designs, and it was one of the coolest experiences of my life."

BadgerLoop is one of 22 student teams heading to California later in 2016 to test their actual human-scale pods on SpaceX's one-mile test track. With funding from company sponsorships, the team has purchased materials and is constructing its 15-foot, 2,200-pound pod prototype to race on the test track. Michael Cheadle, a lecturer in mechanical engineering, is the team's advisor.

Team members say participating in BadgerLoop has added a valuable new dimension to their UW-Madison engineering education. "BadgerLoop has given me a much more diversified skillset that is simply impossible to learn in the classroom," Callazo says.

Hard work comes full circle

Regardless of whether the Hyperloop concept ever becomes a reality, the students' experiences and achievements with BadgerLoop are putting them on the fast track to bright engineering careers. For example, SpaceX was so impressed with Duncan Adams' work on BadgerLoop that recruiters at the event offered the mechanical engineering senior an internship on the spot.

Sjostrom says it's very rewarding to see the hundreds of hours and numerous all-nighters that team members devoted to this project pay off with BadgerLoop advancing to the final round of the Hyperloop competition.

"BagerLoop has the ability to make an impact in the world, and we look forward to innovating transportation when we test out our pod on the track in California. We are honored to be representing UW-Madison, and we hope to make the college proud," Sjostrom says.

UW-Madison team wins second place in Race to Zero competition

Ellen Jaskol

The students accept their award at the National Renewable Energy Laboratory in Golden, Colorado, April 17, 2016. From left to right: Rachel Romero (DOE), Robert Schaffer, Jacob Moffatt, Nicholas Scharping, Drew Dillmann (all UW-Madison), Jonathon Nelson (UW-Milwaukee), Daniel Baker (UW-Madison), Sam Rashkin (DOE). Additional team members included Laura Valdivia and Nasim Shareghiboroujeni from UW-Milwaukee.

The commencement ceremony at Camp Randall was not the first time in spring 2016 that senior Drew Dillmann had reason to celebrate. Just one month earlier, he and his teammates placed second in the U.S. Department of Energy's third annual Race to Zero Student Design Competition, in the "Urban-Single Family Housing" category.

The experience is also playing a key role in Dillmann's job search. "In my last interview, this was pretty much all I talked about," he says. "I was fairly certain I wanted to work in the building industry, but this solidified my decision."

Last fall, Dillmann and fellow mechanical engineering students Nicholas Scharping, Daniel Baker and Jacob Moffatt joined Robert Schaffer, interior design student from UW-Madison's School of Human Ecology, and Laura Valdivia, Nasim Shareghiboroujeni and Jonathon Nelson from the University of Wisconsin-Milwaukee's School of Architecture and Urban Planning, to form the "Net Zero Wisconsin" team, representing their home state for the first time in the Race to Zero competition.

The team's main charge was to design a zero-energy-ready home—capable of producing as much energy as it consumed with rooftop solar panels—for Milwaukee's Franklin Heights neighborhood, an area where foreclosures during the Great Recession left behind many vacant lots.

But a second constraint was equally important. "The students had to design a home capable of generating a zero energy balance while also being affordable for someone making Wisconsin's median income of $51,000," explains Michael Cheadle, the team's advisor and a senior design program coordinator in mechanical engineering. "That's because the competition's goal is to have a real impact on net zero housing in the community. A developer could take the students' plans and actually build the house."

So what does it take to build a net zero home in Wisconsin? First and foremost, a passive solar design that can heat the house during the winter, but also keep it comfortable on hot summer days. While south-facing windows are ideal for this design, the students had to consider their site's limitations. "We selected a lot with an east-west orientation whose south side was blocked off by adjacent houses," Dillmann says. "Since this was typical for most of the neighborhood, we wanted to develop a design that would address this limitation."

Their solution was a second-floor dormer that lifts the rooftop solar panels—whether installed at construction time or down the road—high enough to be powered year-round, combined with an open stairwell to extend the area receiving natural light into the first floor.

Insulating against cold Wisconsin winters was another challenge. "You basically need to wrap the house in an air and vapor barrier while maintaining the ability to circulate fresh air," Cheadle says. "That means strategically placing the minimum required number of ducts so that the inside and outside air can be exchanged most efficiently."

Other notable features of the house—dubbed "Forward Home" after Wisconsin's state motto—include wheelchair accessibility on the first floor to allow for a family's "aging in place," and a Nest thermostat that conserves energy by learning to predict a homeowner's behavior, such as when she will most likely want a hot shower.

The competition helped Cheadle realize his longstanding plan of forming an undergraduate student chapter of the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE), as well as to begin assembling teams for other student competitions, such as the Solar Decathlon, a technology-based competition requiring more planning and an application for financial support."Energy conservation is a topic that is here to stay," he says. "With so many available jobs in the building industry, this is a great platform for our students to get involved in."

UW-Madison awards posthumous engineering degree to WWI aviator

When Milton Pettit Griswold entered the University of Wisconsin, fighting in World War I had been going on for slightly more than a year—yet that was overseas, and here in Madison, students were content to immerse themselves in as many academic and social pursuits as time would afford them.

That was 1915, and Griswold was a cadet in the university's Naval Science program—a naval aviator who was studying to become a mechanical engineer.

However, circumstances changed, and Griswold never actually received his degree.

He spent his childhood in Wilmette, Illinois. His father died when Griswold was 14, and a few years later, aiming to take advantage of a free university education for Wisconsin residents, Griswold's mother Caroline moved to Madison with him and his younger brother Henry.

Griswold was quiet, intelligent and highly respected. A recommendation on his university application includes an apt description: " … a very serious minded student of fine ambition." Indeed; in his first semester on campus, Griswold's courses included *Chemistry, Mechanical Drawing 3 and 4, General Lecture Engineering, Shop 2 and 3,* and *Spanish 2*, as well as military drill and the requisite physical education course.

Outside of the classroom, Griswold joined the Wisconsin Engineer magazine staff, pledged the Psi Upsilon fraternity, was elected to the military honor society the Sword and Scabbard, and was invited to the Iron Cross, one of the university's most prestigious honor societies. He regularly attended social dances and as early as November 1915, met Lucile Yates, whom he ultimately would marry.

In Griswold's junior year, his courses consisted of *Aeronautics, Steam & Gas Engines, Wood Inspection*, and ROTC. Within the Naval Science program, his focus was naval aviation, and he had become a captain of cadets in the First Battalion, Company D. He was chairman of finance for the Officer's Military Ball, which during the war was held in place of the junior prom.

Griswold had, indeed, fulfilled the requirements of his degree

In March 1918, he enlisted in the Navy as an aviator, and in May 1918, at the conclusion of his junior year at the University of Wisconsin, he reported for duty as Ensign, CQM (Chief Quarter Master) to the Boston Navy Yard, for, as his orders stated, "duty instruction in heavier-than-aircraft." Because of his experience in the Naval Science program, the Navy needed him to help train fighter pilots.

When World War I ended, Griswold remained on active duty until April 1919. He returned home, still a member of the naval reserves. In June 1920, he married his love, Lucile Yates, and they moved first to Kenosha, Wisconsin, and then to Santa Monica, California. He became a successful petroleum engineer, and he and Lucile had four children—all of whom attended Stanford University (and two of whom earned engineering degrees from Stanford).

Most likely, when Griswold returned to Wisconsin after the war, he believed the university would award him a bachelor's degree in mechanical engineering—and with good reason. Quite simply, the university pledged that it would issue war credits to anyone who had served in the war. In December 1917, the university regents approved the Regents War Credits, which stipulates: "Seniors in full and regular standing who shall have enlisted in or been drafted into the army or navy of the United States or its associates since the close of the last academic year shall be granted at the next commencement their appropriate degrees in course in the respective colleges of the university."

The regents defined seniors as "having 90 credits of regular academic work in the general course leading to the B.A. degree in the College of Letters and Science or the equivalent number of credits of regular academic work in other courses and colleges."

Griswold had, indeed, fulfilled the requirements of his degree—yet during his lifetime, his petitions to the university for it went unheeded. He died in 1954.

Sixty-one years later, his granddaughter Loralee Kendall, succeeded; her master of liberal arts thesis, "Some Dance: The College Years, 1915 to 1919," about her grandparents' University of Wisconsin years, provided unequivocal documentation that Griswold deserved his degree.

And at the university's spring 2016 commencement ceremonies, Griswold's grandson Jack received that degree—the 1919 Regents War Degree—on behalf of the Griswold family. Jack attended the College of Engineering Graduate Recognition Ceremony and walked across the stage in the company of modern-day mechanical engineering grads.

Griswold's name is listed in the honor roll on page 372 of the university's 1920 yearbook, the *Liberty Badger,* along with 4,000 students who served in World War I.

Now, nearly a century later, his University of Wisconsin academic record is complete.

UW-Madison team wins 2016 Clean Snowmobile Challenge

A team of UW-Madison engineering students continued their tradition of dominance at the 2016 SAE International Clean Snowmobile Challenge, taking first place in the highly competitive internal combustion division for the second year in a row.

The Society of Automotive Engineers competition, held at the Michigan Technological University Keweenaw Research Center March 7 through 12, challenges students to redesign the powertrain of a conventional snow-mobile to make it exceptionally clean and quiet while maintaining performance and controlling costs.

The teams and their modified snowmobiles compete in a variety of events, including a 100-mile endurance ride, lab emissions, in-service emissions, fuel economy, acceleration, handling, noise, cold-start, technical paper and a design presentation. The student teams come from all over the northern United States and Canada, with a team from Finland also competing this year.

This year, team advisor Faculty Associate Glenn Bower challenged the UW-Madison Clean Snowmobile Team to make a significant departure from last year's winning design. "We had used that last engine design for two years, and it wouldn't have presented enough of a challenge for the students if I let them basically take the same sled back to the competition with only minor changes," Bower says. "I want to make this a valuable educational experience for the students and so I challenged them to come up with a new design that's significantly different from what the team has done in the past."

Rather than using a turbocharger, as the team did last year, the students increased the engine displacement to yield more horsepower. The team started with a 2013 Ski-Doo snowmobile equipped with a 600 cc four-stroke engine and increased the engine displacement to 674 cc while also adding an exhaust gas recirculation system to the engine. "To bore and stroke an engine is not a trivial thing to do," Bower says. "There are a lot of things that had to be checked and specially machined to do that."

Undergrad Kyle Karnick created an extensive computer model of the engine to verify the team's engine modifications before manufacturing new components. This allowed the students to predict how their modifications would change the engine's power output, Bower says.

The team's new engine and snowmobile were 11 percent more fuel efficient, 15 percent more powerful, 75 percent cleaner and 50 percent less noisy than the original.

In addition to winning first place overall and receiving $2,000 in prize money, the UW-Madison team also won awards for lowest in-service emissions, best design and quietest snowmobile. This was the fifth time in the past seven years that the UW-Madison team captured first place overall in the internal combustion division.

Bower says that in addition to the communication and project management skills that students learn, the Clean Snowmobile Team offers students extensive hands-on learning opportunities. "This experience enables students to actually build a real thing—a custom engine," Bower says. "They have to machine it, wrench it and test it. Then they refine it and compete with it. So they develop the ability to see how everything goes together and really learn what it takes to build something that works in the real world."

Alum's passion for giving helps grad students succeed

Looking back, Bruce Tobis marvels at how much he has benefitted from his engineering education at UW-Madison. "There's no question that I enjoyed my education at UW-Madison, and what it has done for me has been immeasurable," says Tobis. "The university gave me an absolutely first-rate engineering education, which led directly to me getting a job at a great place to work and establishing a very fulfilling career. I don't know how you could overestimate the impact of that."


Bruce Tobis

After earning his master's degree in mechanical engineering from UW-Madison in 1983, Tobis started his career at Ford Motor Company as a research engineer working on combustion in the powertrain area. After working at Ford just a few years, Tobis began making donations to the mechanical engineering department, and his support has continued over the decades.

In his 23 years with Ford he held several positions, including working on noise and vibration as an acoustics specialist. Tobis, who lives in Farmington Hills, Michigan, retired from Ford in 2007 when the company went through downsizing at the start of the recession. "Almost everyone on the staff was given some sort of incentive and mine would have been foolish to pass by, just based on the arithmetic," he says. "I hadn't planned on retiring at that time, but it was the right thing to do."

After leaving Ford, Tobis took a job at Signal.X Technologies, a technology consulting company that specializes in noise and vibration test and measurement applications, featuring software products developed in-house. "It's such a great place to work, and with my experience in noise and vibration at Ford, this job was a natural step," Tobis says.

He has worked in a variety of roles at Signal.X Technologies and is currently a technical writer for the company. As he nears the end of his career, Tobis says he has been thinking about the kind of legacy he wants to leave. That was part of his motivation for making a gift in 2009 to create an endowed graduate fellowship in mechanical engineering that bears his name and the name of his late wife, Alice.

Tobis considered setting up an estate gift to fund the endowment but ultimately decided that approach wasn't for him. "I guess I didn't like the idea of just setting it all up in my will and then letting someone else have the fun after I'm gone," he says. "I didn't want to wait, so I committed to doing what I can while I'm still alive."

Tobis is in the process of building up the endowment, which he hopes will eventually be large enough to support an award of about $15,000 a year to a graduate student. To achieve that goal, he methodically went about planning the maximum amount he could afford to contribute to the fund annually and then calculated the number of years it would take to reach his target. "I would love nothing more than to have the wealth to be a full-time philanthropist, but such is not my fate," he says. "I don't have money just lying around that I don't know what to do with. This is a very conscious decision about how I can make a difference by giving. I also find it personally very meaningful to make this kind of contribution."

Then, in June 2015, Tobis was ecstatic when he learned about a $50 million gift-matching opportunity from UW-Madison alumni Ab and Nancy Nicholas for endowments to provide support for UW-Madison students. "It was like an early Christmas present," he says. "I was walking on air there for awhile."

For Tobis, taking advantage of the Nicholas match for his endowed fellowship has essentially cut the time it will take to achieve his funding goal from 10 years down to five.

"That's huge—it's a really nice help for me," he says. "I'm not cashing the check, but it feels like a gift to me. The fact that alumni whom I've never met are going to be putting six figures into my endowment is amazing and totally unexpected. If you had $50 million to give away, would you do it in a way where your name never appears on the scholarship or fellowship? Because that's essentially what's happening with this match, and that's just awesome."

When Tobis set up his fellowship in 2009, he was eager for it to start helping students. So he provided enough funds for it to start supporting students right away with an award of $3,000 a year. "I realize $3,000 probably won't change a grad student's life, but it might help," he says. "When the endowment eventually supports a $15,000 annual award, my hope is that will be sizeable enough to make some things possible for students that weren't before."

"...this fellowship made it possible for me to focus on research and school..."—*Dan Janecek, fellowship recipient*

Dan Janecek, a mechanical engineering PhD student at the Engine Research Center, says receiving financial support from the fellowship made a big difference to him."This financial support is an enormous help for my graduate studies," Janecek says. "Attending college for seven to 10 years with limited sources of income is difficult, and this fellowship made it possible for me to focus on research and school and not have to seek multiple low-paying jobs just to make ends meet."

Janecek says he is very grateful to receive this award. "My dream is to one day have the financial means available to give back in a similar fashion and support the next generation of UW-Madison scientists and engineers," he says.

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Student startup Emonix wins innovation competition

Cadence Bambenek

Zach LaVallee and Neil Klingensmith

The inventors of a real-time monitoring platform aimed at making water softeners more efficient took home first place and a $7,500 cash prize in the inaugural Transcend Madison competition at UW-Madison in March 2016.

Emonix, developed by senior Zach LaVallee and computer engineering PhD student Neil Klingensmith, also received immediate enrollment into the Madworks seed accelerator, an intensive, 10-week program to provide LaVallee and Klingensmith with resources, mentorship and $5,000 in capital to take their idea to the next level.

Using sensors to moderate the salt applied by water softeners, Emonix cuts the amount of salt dispensed by nearly a quarter, saving in salt, expenses and reducing negative impact on the environment.

A total of 27 student teams from across the UW-Madison campus competed in the innovation contest. The students' entries were judged on the novelty of their idea, their prototype, their business model, their execution and their pitch.

COME TOGETHER, RIGHT NOW

Eriten receives NSF CAREER award to study dissipative properties of interfaces

Solid structures like bridges, buildings, airplanes or satellites are, in fact, assembled out of multiple components and materials functioning as one. The boundaries between different substances—interfaces—do most of the brunt work to hold things together and keep them upright. Even though microscopic meetings make-or-break the larger design, engineers struggle to predict how interfaces will behave in real-world conditions. Now however, Assistant Professor Melih Eriten received support from the National Science Foundation's Faculty Early Career Development Program (CAREER) to demystify the dissipative properties of interfaces all the way from the atomic to industrial scale. "The best models can barely reproduce what's measured in the lab. And that's mainly because of the interfaces," says Eriten. "Currently vibrations engineers cannot predict what they design for and what they observe experimentally. That's scary."

The ambiguity causes engineers to over-design, adding layer-upon-layer of uncertainty factors to address inconsistencies that they do not fully understand in the first place. Repeated rounds of prototyping drive up costs without guaranteeing consumer safety. "We could do better," says Eriten. "We could understand what mechanisms govern energy dissipation, on a broad spectrum of length and time scales which will guide us on smarter design of interfaces."

Eriten will incorporate experimental data into theoretical calculations to precisely predict how interfaces behave.

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