Wisconsin engineer. Volume 115, Number 4 September 2011

Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

https://digital.library.wisc.edu/1711.dl/7P3DBZ6M5SIJV8I

wisconsin engineer
SEPTEMBER 2011 VOLUME 115, NUMBER 4

Brewing

p. 10

Also inside

The New York Times, Chicago Tribune and *Michael Sievers* agree...

"The **Dahlmann Campus Inn** *offers a touch of boutique refinement in the heart of the campus, with rich wood furniture and floral tapestries."*
—*The New York Times*, July 5, 2009

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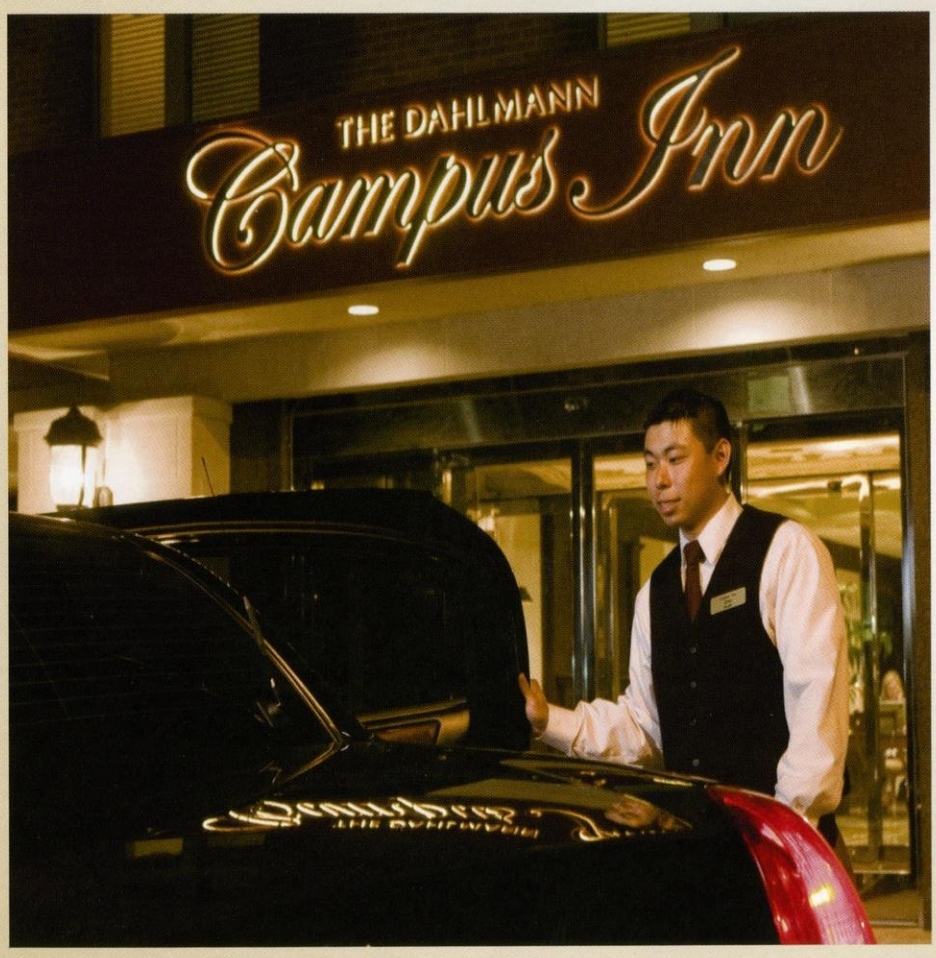
—*Chicago Tribune*, October 25, 2009



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Michael Sievers
Senior Project Manager,
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Published by the students of the University of Wisconsin-Madison VOLUME 115, NUMBER 4 SEPTEMBER 2011

Feature

General

Cover photo by
Victoria Yakovleva

Commentary

EDITORIAL

Chancellor 'Bids' UW Goodbye

The start of this new semester marks my first semester on campus that I will not be spending with my "beloved Biddy", a term I use with dear affection to refer to our former Chancellor. I knew getting an engineering degree might take a while, but I sure didn't expect to outlast a Chancellor at this fine institution. Martin bolted for Amherst College this summer and we can only hope that it wasn't for the promise of athletic competitiveness. She was a constant force at this University and worked hard to implement her Madison Initiative for Undergraduates and also spearheaded the bold plan outlined in the New Badger Partnership. The New Badger Partnership soon became synonymous with the phrase "greater flexibility" and never before had our email inboxes received so many lengthy and ambiguous emails from the Chancellor. The Chancellor's vision for unprecedented flexibility would ultimately provide a great deal of opposition from the University of Wisconsin System and its Board of Regents, opposition that some suspect forced her sudden departure.

Martin also lead UW-Madison during a time of unprecedented athletic prowess, but we can't kid ourselves and think she had much to do with the recruitment of the Watt's and Taylor's of her time. Regardless, she still looked good cheering on our teams from the sidelines. And it is not secret that Chancellor Martin won many hearts over with her unprecedented snow days and music video appearances on YouTube, but one thing sticks out in my mind during her tenure; her abrupt departure and the cloud of uncertainty regarding her replacement. Clearly, she just wanted to break free.

Martin is now gone and UW-Madison is left searching for a new Chancellor to lead it to glory. The opening at UW-Madison is a particularly unattractive one for several reasons, and replacing an intrepid Chancellor like Martin proves to be no easy task. The political situation in the state provides a major hurdle to lure some of the top talent into the state, not to mention a tense relationship with the Board of Regents. Our new Chancellor must do everything possible to navigate the political turmoil while also extending an olive branch to the intractable Board of Regents. As the challenges facing our new Chancellor pile up, the list of prospective replacements is sure to dwindle. Find me a candidate who will boldly stand up to the Board of Regents the way Martin did, and we've got a winner.

Finding a new Chancellor also proves difficult due to the mass exodus of other Chancellors around the country. UW-Madison is not the only top-notch school looking to fill a major void. Some of the major schools that are also looking to fill an opening at the Chancellor position include the University of Arizona, UC-Sand Diego, Iowa State University and Purdue University. While two of those schools offer plenty of warmth and sunshine, and the other two plenty of corn and farmland, there is no doubt that there will be fierce competition amongst many schools searching for a new Chancellor. A few snow days appears to be the less attractive option when compared to California sunshine.

So, if we don't lure someone new to be the Chancellor, would looking internally be an option? Hiring a Chancellor from within the university does have some benefits and might be just what the University needs for some stability during a time of such turbulence. In fact, six out of the last eight Chancellors have been current or former employees of the University. Bringing up a current employee might be the best chance to carry on the "legacy of Biddy". However, I'm willing to bet that our Board of Regents will do anything to put that legacy behind them.

The sweepstakes for a new Chancellor is on and I can only hope the search committee knows what is best. Regardless of where the new Chancellor comes from, their background or experience, one thing rings true; they must be able to face the challenges headstrong with confidence and optimism. They must mend the relationship with the rest of the UW-System, come up with fiscally sound policies that don't lead to exorbitant tuition levels, deal with significant budget cuts from state funding, continue to secure other means of funding and help recruit the next Russell Wilson. That shouldn't be too hard to find, should it?

Article by: Lauren Kern

COLLEGE OF ENGINEERING
UNIVERSITY OF WISCONSIN-MADISON

THE UNIVERSITY of WISCONSIN MADISON

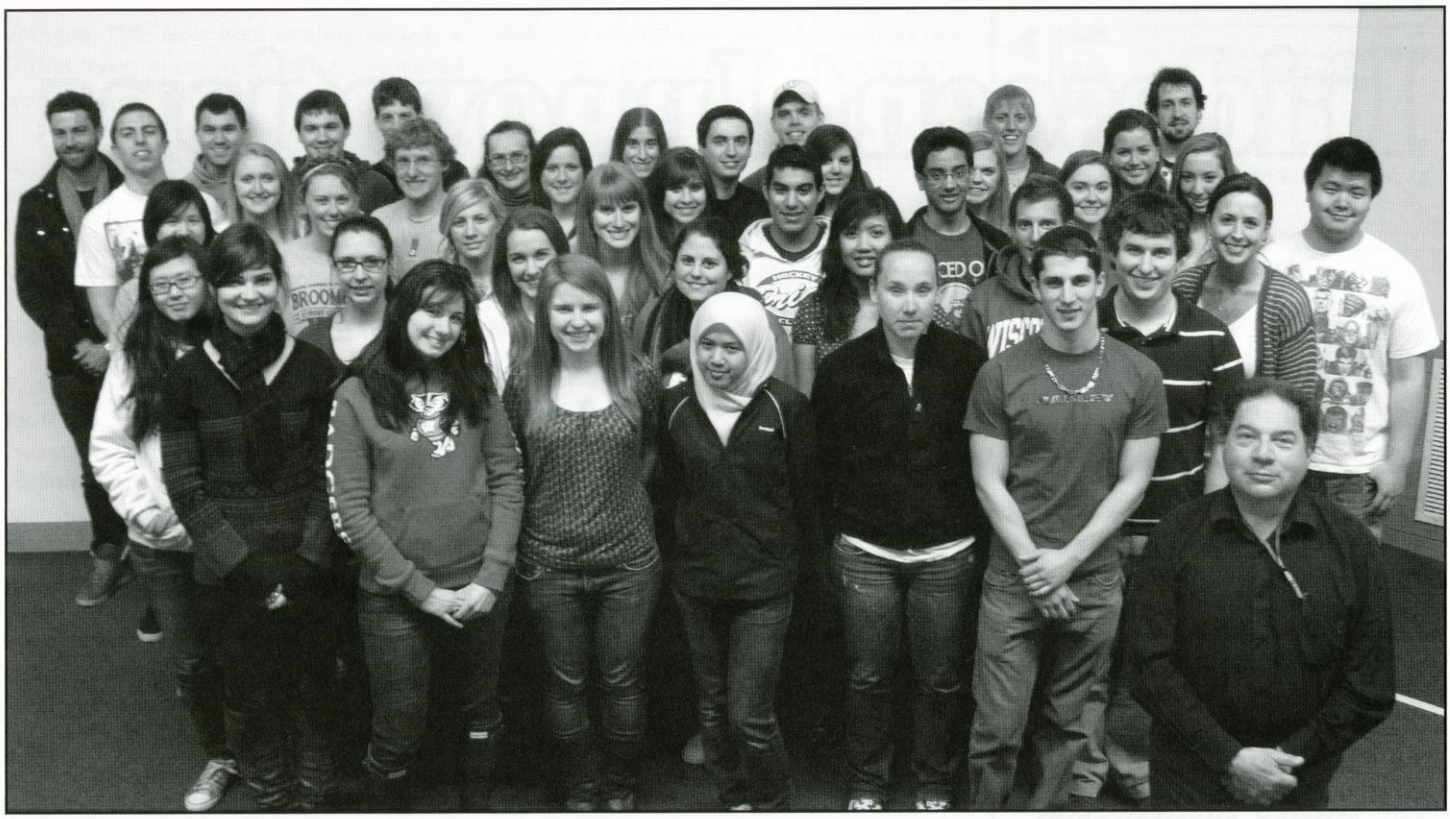
The *Wisconsin Engineer* magazine, a member of the Associated Collegiate Press, is published by students at UW-Madison. Philosophies and opinions expressed in this magazine do not necessarily reflect those of the College of Engineering and its management. All interested students have an equal opportunity to contribute to this publication.

Faculty Advisor: Steven Zwickel **Publisher:** American Printing Company, Madison, WI **Web address:** http://www.wisconsinengineer.com

Correspondence: *Wisconsin Engineer* Magazine; 1550 Engineering Drive; Madison, WI 53706 **Phone:** (608) 262-3494 **E-Mail:** wiscengr@cae.wisc.edu

The *Wisconsin Engineer* is published four times yearly in September, November, February and April by the Wisconsin Engineering Journal Association.

Subscription is $12 for one year.



Iridescent Innovations

A collaborative effort between the Morgridge Institute for Research, UW-Madison faculty, and the U.S. Department of Energy helps local start-up company SHINE.

The Wisconsin Idea is a concept that has been a profound piece of the UW-Madison character for over a century, and is especially evident in the College of Engineering. It is the notion that education should extend beyond the borders of campus. Students, faculty and staff embrace the Wisconsin Idea daily through activities and studies that impact people across the state, country and world. As one of the top research universities in the country, UW-Madison helps to attract a stable supply of the best scientists and engineers to Wisconsin.

Despite this outstanding record in research, Wisconsin suffers from underinvestment, ranking 42nd among the states in business creation. While young companies dominate job creation in the United States, launching start-ups is precisely where Wisconsin has lagged for decades. The Wisconsin Idea promotes the transference of the University's innovative ideas and remarkable science to Wisconsin business, creating high-quality, well-paying jobs. One particular group of UW-Madison colleagues has recently embodied this concept to the fullest, pioneering the production of a much-needed medical isotope for not only Wisconsin, but the entire nation.

Shortly, Madison startup company SHINE will be the only United States organization producing technetium-99m, a substance critical for cardiac stress tests and cancer scans performed on tens of thousands of patients daily. By granting the Morgridge Institute for Research (MIR) twenty-five million dollars, the Department of Energy is helping fund and nationally recognize this project. The partnership between the Morgridge Institute for Research and SHINE spotlights the world-class equipment being developed in laboratories founded by UW-Madison graduates, and is the first collaboration between MIR and a private company that has received such a significant federal grant.

"We look for companies that we think, with some help, can become a great medical technology with a high impact on society," Dr. Thomas Mackie says, professor of medical physics at UW-Madison and director of medical devices at MIR.

The Morgridge Institute for Research was awarded this grant in order to support the institution's partnership with SHINE, a start-up company founded by Dr. Greg Piefer, graduate of UW-Madison who holds a Ph.D. in nuclear engineering and B.S. degrees in physics and electrical and computer engineering. This partnership is tremendously dynamic. "What a project like this needs is vigor and stability; the Morgridge Institute for Research provides experience and credibility and SHINE offers the inventive entrepreneurship and creative energy," Mackie says.

"What a project like this needs is vigor and stability; the Morgridge Institute for Research provides experience and credibility and SHINE offers the inventive entrepreneurship and creative energy."

- Dr. Thomas Mackie

With technology created by Phoenix Nuclear Labs—a company also founded by Piefer in 2005—SHINE will commercially produce technetium-99m by 2014, consequently illuminating the new vital industry of medical isotope production.

The demand for this isotope emanates from increasing use of radioactive isotopes in modern day medical procedures, where they provide a non-invasive image of the inside of a patient. "Technetium-99m is the most widely used medical isotope because it has such wonderful chemistry. It can be attached to a host of different drugs that are attracted to different diseases and can be used to image those diseases," Piefer says. "It does not yield an anatomical image like many other medical isotopes; rather it images various functions in the body. As the workhorse nuclear medicine agent, technetium-99m is used in fifty-five thousand medical procedures in the United States daily. Worldwide, it is used more frequently than once per second," Mackie says. This lustrous isotope is generated from a substance known as molybdenum-99, or "moly".

Historically, production facilities in Canada and the Netherlands have supplied the United States with molybdenum-99. However, the Canadian reactor recently shut down for fifteen months due to a leak found during routine testing. Concurrently, the reactor in the Netherlands malfunctioned due to old age. Serious supply disruptions world-wide have subsequently forced American medical facilities to ration the material for procedures. "In 2010, tens of millions of patients were no longer receiving the treatment they needed," Piefer says.

Furthermore, the United States has been equipping this old generation of reactors with a substantial amount of highly-enriched

uranium. "We have been sending Canada a few nuclear weapons worth of highly-enriched uranium every year," Piefer says.

By encouraging the domestic production of molybdenum-99 with four federal grants, the Department of Energy is addressing the nation's medical isotopes shortage while simultaneously eliminating the national security risk posed by sending uranium abroad.

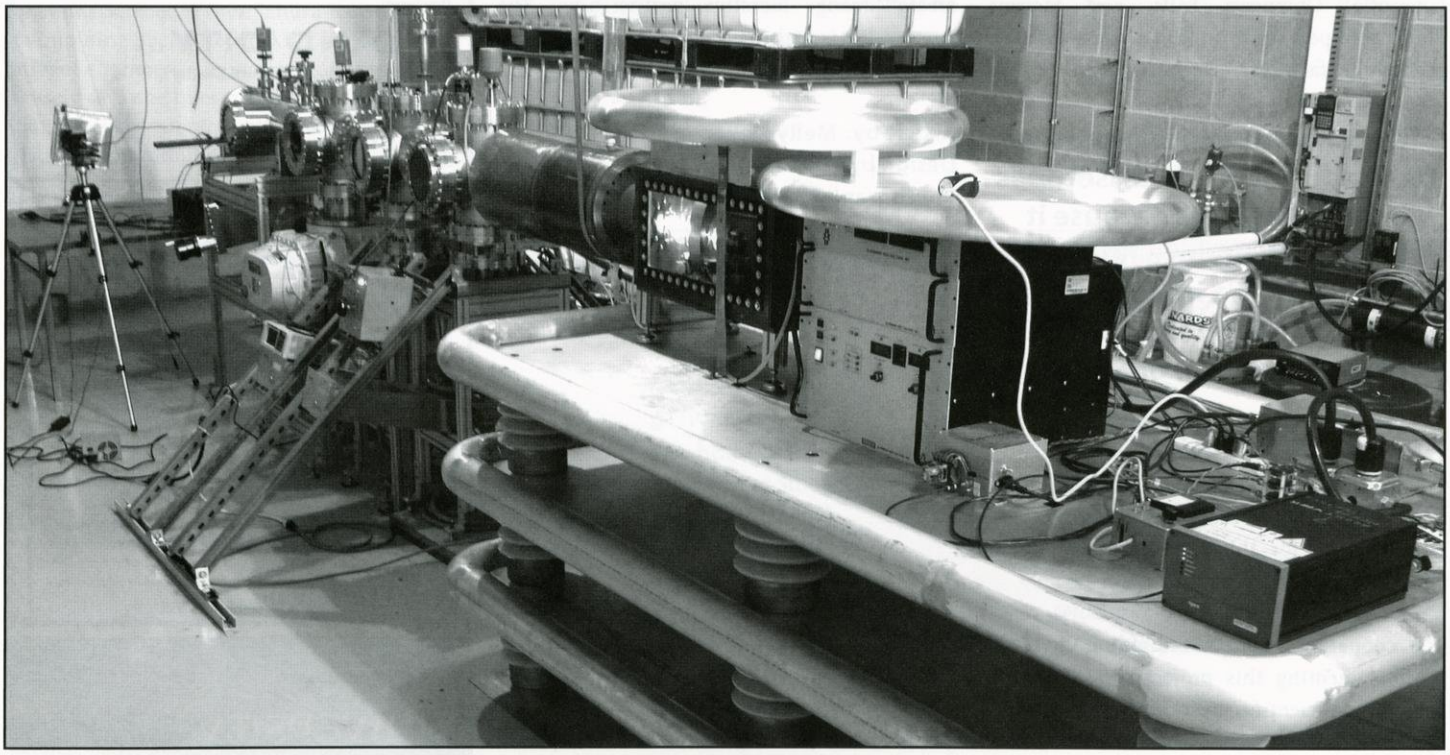
With funding from the Morgridge Institute for Research, ground-breaking technology from Phoenix Nuclear Labs, and an additional sixty million dollars from private investors, SHINE will produce a reliable supply of molybdenum-99 that does not rely on highly enriched uranium. "The Phoenix Nuclear process for producing medical isotopes is advantageous because it does not require a nuclear reactor. It uses a machine called a subcritical hybrid-intense neutron emitter, or SHINE," Piefer says. Undoubtedly, Piefer's new company will have an effervescent effect on the medical industry.

Unlike a reactor, the machine does not create a self-sustaining nuclear chain reaction; it instead uses an accelerator driven by electricity. Piefer's new method is fundamentally safer, does not require elaborate control systems and eliminates the chance of a nuclear meltdown. "But the new method still harnesses the same potential of a nuclear reactor. So from an investor's stand point it is much less risky," Piefer says.

Moreover, the new method actually destroys waste products created in reactors by turning tritium into non-radioactive helium. "In the Phoenix Nuclear process, every nuclear fission that occurs is contributing to moly production, reducing waste creation by a factor of three hundred," Piefer says. The waste will also be cleaner and easier to dispose of properly.

Top scientists from Los Alamos and Argonne National Labs have endorsed the project with confidence. The Department of Energy is convinced that the partnership garners the breakthrough technology that they anticipated.

A board faculty from UW—Madison and other universities will conduct an independent safety analysis on the technology. "We would like the board to resemble the Nuclear Regulatory Commission. We will present to them a description of our technology and safety concerns. The board will tell us what we failed to think about, ensuring it is made absolutely



The SHINE (Subcritical Hybrid Intense Neutron Emitter) Technology: Deuterium gas is first ionized by microwaves. A simple DC accelerator then pushes the ions with a force of 300keV. The accelerated deuterons enter a target chamber, where they strike tritum gas and create neutrons. The beam strikes a uranium target that provides futher multiplication of the neutrons.

The accelerated beam of deuterium ions enter a target chamber filled with tritium gas. The deuterium and tritium atoms react and neutrons are created.

safe," Piefer says. Various other aspects of the project will be analyzed in research facilities on the UW-Madison campus.

The success of the project will ignite a new innovative industry in the state of Wisconsin with remarkable economic potential. "Our facility alone will create the need for around 120 nuclear engineers and highly technical workers," Piefer says. SHINE is considering Janesville, Chippewa Falls, and Stevens Point for potential building sites for the production facility. Once built, it will be an anchored, exclusive establishment; hence job opportunities for this industry will remain within Wisconsin's borders.

"The Phoenix Nuclear process for producing medical isotopes is advantageous because it does not require a nuclear reactor. It uses a machine called a subcritical hybrid-intense neutron emitter, or SHINE."

- Dr. Greg Piefer

The cooperation and coordination involved in implementing this project is astounding. Incredible scientific resources are offered by UW-Madison. The Wisconsin technical college system provides a fantastic workforce. The state has provided SHINE with the tax credit incentives needed to offset various costs. Local utilities in possible production sites have been extremely cooperative. In addition to having the right people and skills, the essential technologies have been demonstrated. Moreover, the federal support necessary to achieve commercial scale production has been garnered. The unique collaborative effort between scientific experts, government, private sector and UW-Madison faculty emphasizes the state's exceptional talent and ability to create strong, lucrative partnerships. The partnership is truly epitomizes the character of UW-Madison and the Wisconsin Idea. WE

Article by: Melly Meyer
Design by: Tom Bernath
Photography by: Phoenix Nuclear Lab

Social UW

News at the Tip of Our Thumbs

It is the weekend of the concrete canoe competition and you are stuck in Madison studying for an exam-packed week after spending the last several months preparing for the competition. You have no idea how the team is doing and the anticipation is killing you, so you decide to check your Twitter account. Suddenly, one of your teammates tweets that the team came in 1st place! Even though you're on the 1st floor of Wendt Commons, you can't help but let out a loud, "Yeeesss!" You think to yourself, "Thank goodness for Twitter!"

Social networking has grown exponentially in recent years, making our global community feel much more local. Since the birth of Facebook and Twitter, more and more companies and organizations are using these social networks as a way to communicate with others. Most UW students already have Facebook and Twitter accounts and know how to navigate their way around. What most students might not know about is the vast amount of social media networks on campus that are maintained and updated by UW staff and students. In fact, UW Madison was recently ranked 2nd in the nation for its use of social media as a means for communication with it students, faculty and alumni.

The College of Engineering has been involved in social media on campus since the beginning of the social media craze. Engineering External Relations Science Writer Sandra Knisely puts much time and effort into maintaining social networking sites such as Facebook and Twitter for current engineers, engineering alumni and the entire UW community. Knisely says she likes to think of Facebook and Twitter as a way to instantaneously interact with students campus-wide as well as the wider Madison community. Knisely also says Twitter is a great way to amplify news and events because of the connection between various followers. The engineering Twitter account (@UWMadEngr) interacts with everyone from student organizations around campus, to peer institutions, to national labs around the country.

Several other organizations around campus have developed a variety of social sites where students can learn about on-campus events, recent news and much more. The UW Visitor and Information program (UWVIP) currently maintains a twitter account (@UWVIP) and is in the process of developing a Facebook page. UWVIP Marketing Specialist Matt De Re says UWVIP is focusing on reaching out to prospective students and their parents, as well as current students to let them know about events happening on campus, academic deadlines approaching and other resources for students to gather information. Matt also says he would like to see the Facebook account become a central location for students to learn about student organization's kick-off meetings and speakers on campus.

With such a broad variety of social media sites on campus, it is no surprise that UW is at the forefront of a new era. UW students, faculty, staff and alumni can look forward to easy access to information and instantaneous interaction no matter what their interest is in the UW community and beyond. WE

Article by: Michelle Trunk
Design by: Jessica Braun

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What are You Going to Be When You Grow Up?

As kids, we were all repeatedly asked what we were going to be when we grew up, and in the early years most of us didn't mind the question. At age three we were going to be a princess or a king. At age seven, after discovering we had no royal blood, we dreamed of becoming the next Michelle Kwan or Michael Jordan. But after icy falls, broken bones and coming up a few too many inches shy of 6'7," these dreams were relinquished. In high school we avoided answering the question, politely replying that we were going to college. Yes, growing up we always had a creative answer to the formidable question. It is when the question transforms from "what you are going to be" into "what are you," that we find we are at a loss for words. It is during those final years of college when you must face the music, and realize you have grown up. It is time to move on to...da..da...dum... life after college.

According to Engineering Career Services, the outlook for graduating UW-Madison engineers is bright, despite the overall downturn in the job market. In 2009, 56 percent of graduates reported accepting full-time positions prior to graduation. Another 27 percent had been accepted to graduate schools and planned to continue their education. As Matt Wessale, a recent UW-Madison graduate says, "Becoming a scholar at Wisconsin will open so many doors for you in the future...Badgers are desired by many employers." Wessale graduated in December 2011 with degrees in geological engineering and geology. During his last semester, Wessale interned at RMT Inc., a renewable energy consulting firm, and prior to graduation had accepted a full-time position with RMT. As a Renewable Energy Engineer, Wessale spent his first several months working in RMT's Madison office designing wind and solar farms. Recently, he has temporarily relocated to New Jersey to oversee the construction of four new solar farms. Wessale is hard at work from 8-5, but then is able to leave the office without the worry of homework and exams hanging over his head. "Having no responsibility in the evenings provides me with way more free time," Wessale says. "I have caught up on many of my favorite television shows and movies." Wessale loves that his job allows him to travel and be outside while doing something that will benefit society, but a renewable engineer is not what he thought he would grow up to be. "I always aspired to become a professor studying volcanoes," Wessale says, "I never would have foreseen my job being this badass."

Anna Mielke graduated from UW-Madison in May 2010 with a degree in biological systems engineering. She had secured a full-time position with Nestle following an internship with the company in the summer of 2010, but chose to wait until August to being working. She took the summer to spend time with family and friends before moving 1,500 miles away to Utah to begin a five-year rotational program with Nestle. Unlike Wessale, Mielke says she is busier now than she was during school. "I typically work a ten hour day, and with my commute, I am pushing about twelve hours a day," Mielke says. "However, the freedom of weekends is wonderful." Mielke's current position for Nestle involves developing, implementing, and maintaining Total Productive Maintenance, which is a form of lean manufacturing. She says she spends a majority of her time interacting with and coaching operators. "Winning the hearts of people and getting them in engaged is challenging, but certainly worth the effort," Mielke says. In a matter of months Mielke will be moving again to a different Nestle facility to tackle a new position at the company. Though she will work in four very different roles within five years, she knows one thing will remain a constant - communication will be an important element. "It doesn't matter if you're an engineer in a lab or on a production floor, or if you never use your engineering degree - communication, or rather, effective communication is key," Mielke says.

Mark Misun agrees with Mielke on the importance of effective communication. "I didn't get any certificates with my degree but the one I

wish I had is the Technical Communications Certificate." Misun says. "I feel like that one is a good one to have." Mark Misun graduated from UW-Madison with a degree in civil engineering in May 2010. Misun began working for MSA Professional Inc. just two weeks after graduation. Misun works at the Madison location so he was fortunate to not have to go through the relocation process. He lives on the West side of campus so is still able to enjoy many aspects of campus life, though says he feels like he has less free time than he did during school. "When you are in school you have a week where you are really busy but then the next week you have a lot of free time," Misun says. "Whereas when you working full-time, it's a daily grind, day in and day out." That said, Misun says he really enjoys his work. He works mainly in rural communities improving roads and drainage systems. Working full-time has forced him to become a lot more organized and structured. "In college, I used to plan my weekend that Friday night, everything was very spur of the moment." says Misun. "Now I find myself planning my weekends three weeks in advance." Misun says he is proud of how he has grown as a person since first coming to UW-Madison as a freshman and even since graduation, though he jokingly advises to never graduate. Honestly, he advises to enjoy college, work hard but be social; make connections and get an internship.

Paul Ambuehl followed a similar path as Misun, transitioning from UW-Madison to a position in the Madison area. Ambuehl graduated from UW-Madison in May 2008 with a degree in electrical and computer engineering. Upon graduation, Ambuehl was already an employee at Extreme Engineering Solutions (X-ES), a company based out of Middleton that designs embedded computing solutions. Ambuehl did a co-op with X-ES in May of 2007 and continued to work there part-time as he finished school. Within the three years since graduation Ambuehl has become a husband, a homeowner and built a foundation of knowledge through his work. Ambuehl has every intention of continuing to be part of the growth and success of X-ES. Ambuehl did his co-op at X-ES only five years after the company's start, so it is as though he has grown along with the company. Ambuehl stresses the importance of gaining internship or co-op experience. He says, "These are great ways to gain experience in the field as well as become more marketable and better prepared for a job once graduated."

"As graduation nears, the classic question transforms from 'what are you going to be?' into 'what are you?' Will you have an answer?"

Although many students have positions secured before graduation there are a number of students that graduate with less certainty about their future. Carrie Boecher accepted her UW-Madison civil and environmental engineering degree in December 2010 with sadness, anxiety and excitement. "I found college graduation to be much sadder because I loved every aspect of my college career so much," Boecher says. "It was also a little more stressful because the future is so much more uncertain than it was after high school." Boecher did not have a full-time engineering position lined up for after graduation so she got a waitressing job, though one week into waiting tables she received and accepted an offer from an engineering firm in Chicago. So within two months of graduation she began working full-time as an Environmental Project Manager. "If you're having trouble finding a job, as I was, don't lose heart. Something will come along as long as you continue searching," Boecher says. "After months with no luck and a week working in a restaurant, I received two offers within four days of each other." Working for a small firm has allowed Boecher to experience every part of the business from traditional engineering tasks, office administration, marketing and laboratory work. Boecher travels around the Chicago area two to three days a week supervising environmental projects in the area. Though Boecher says she likes engineering, she is unsure if it is her calling, and she plans to keep her options open claiming, at this point, finding something she really likes is more important than establishing a career.

Whether it was through the help of Engineering Career Services, an internship experience or an inspiring class, these graduates have figured out who they are. And although they no longer have childish dreams of becoming ballerinas, movie stars or the next Aaron Rodgers, they have become something greater. They are UW-Madison graduates, so at graduation do not fear the question what are you...instead proudly answer, I am a Badger!

Article by: Kelsey Coleman
Design by: Tom Bernath
Photography by: Elizabeth Ulmer

If your town has an equal number of bars and churches, you might live in Wisconsin.

"[I recommend]... bread, meat, vegetables and beer."

- Sophocles (Philosophy of a moderate diet)

"Fermentation may have been a greater discovery than fire."

- David Rains Wallace

"He was a wise man who invented beer."

- Plato

"Good people drink good beer."

- Hunter S. Thompson

BEER

If it weren't for milk, beer would be the state beverage!

Wisconsin is known as the most historically influential brewing state. Today, according to WisTravel, there are 56 active breweries in the state and it is also home to the Beer capital of the World: Brew City, Milwaukee. Moreover, even the state's baseball team is called the Milwaukee Brewers.

Pabst, Schlitz, Miller, Blatz...

On average in the United States, 21.56 gallons of beer are consumed per capita annually. In Wisconsin this number is 38.2. That's 77 percent more beer consumtion per Wisconsinite than that of the average American!

Sprecher, Leinenkugel, New Glarus, Heileman's Old Style...

The start, expansion and continual growth of this enterprise stemmed from the knowledge and passion of German immigrants, the availability of lumber for barrels, access to shipping routes, and, most importantly, the good business sense of the Milwaukee workmen. In 1890, beer brewing provided over 3,200 people with jobs. The passion, hard work and dedication structured the mentality of the Wisconsin community.

Capital Brewery, Aisle Island, Rhinelander, Stevens Point...

Yet, is the meticulous and artful creation of beer a thing of the past? Does UW-Madison's continuous ranking as one of the "top party schools" indicate a different mindset and attitude towards beer drinking?

In short, no. The tradition and craft of careful brewing is still very alive in Wisconsin, and particularly in UW-Madison students today.

You are a true Wisconsinite when you think of the major food groups as beer, fish, and venison.

Victoria Yakovleva, a chemical engineering student, nicknames herself Beer Geek. She has made it her goal to tour every American brewery, acquire a sophisticated and critical taste for beer and to perfect her own brew. She comments: "Sure, when you receive that gentle pour into your pint glass, you might appreciate the swirl of color and smells; and when you gulp down the contents you might appreciate the refreshing and soothing nature of this sublime liquid. But it's understanding the hard work, motivation and history that came together to bring you that beer that grants you that exquisite next-level experience of your senses and a fonder appreciation."

Fritz Prehn picked up the hobby of brewing in the fall of 2009 with his good friend Jon Jaeger, also known as Brewmaster Jaeger. Both Prehn and Jaeger are engineers, Material Science and Electrical respectively. They call their "operation" RANDAVE Brewing and have created over thirteen different kinds of beer.

Beer is composed of water, a starch, hops and yeast. All four are essential. Brewing is no simple task. It is as much a science as it is an art. Steps include: sanitizing, boiling, mixing, fermenting, conditioning, filtering and bottling. It takes precision, patience and an understanding of microbiology.

Places such as "The Wine & Hop Shop" on Monroe Street sell kits that are designed to guide beginners or advance the skills of experienced brewers. The employees are friendly and very willing to explain the different methods and processes, as well as give you recipes and hints on how to make different kinds of beer.

Prehn and Jaeger began with these kits but now experiment with their own recipes. This may be the reason for three versions of Cranbeery, made from cranberry ale. Prehn has let me taste both the latest version of Cranbeery and his darker Taste of Essen, a heiffeweizen. Both had a unique depth to their flavor.

Kiernan Tim McGowan, a Chemical and Computer Engineering student as well as President of the Professional Engineering Fraternity Theta Tau, started brewing at home about a year ago. He invited me to his home to show me the brew process in action. He says "brewing really appeals to my engineering sense, in that you can experiment with different grains and hops to make many different kinds of beers."

I also visited the Great Dane Pub and Brewery. Not only will the workers show visitors around, but one can purchase a sampler of their homemade brews. This sampler is called a flight and consists of four-ounce cups which range from coffee dark beers to amber ales to light wheat brews. It's definitely worth stopping by and is an effective way to try many different brews.

UW-Madison does not frown on brewing; in fact, it is encouraged. Brewing relies heavily on the process of fermenting which is the conversion of carbohydrates to alcohols by microscopic organisms: yeast, which is a type of fungi, is the fermenter used for beer. The process of fermenting is essential to the production of many foods such as bread, yogurt and wine. It is also crucial in many drugs such as antibiotics and insulin. The University understands the importance of educating students in these practices, and offers a class on beer brewing through the bacteriology department.

In order to promote brewing education, MillerCoors has made two very generous donations to the University. Firstly, they donated a complete set of pilot-scale brewing equipment to the bacteriology department; this provided the equipment necessary for the aforementioned fermentation science class. The second gift of three fermenters, located on the second floor of the Microbial Sciences Building, was given to the College of Agriculture and Life Sciences. They are also intended to promote the study of fermentation and brewing sciences.

MillerCoors also teach their company's brewing techniques to UW faculty and students. Job seekers for careers in brewing, food companies, or biotechnology are partial to graduates that have an understanding of the fundamentals of the brewing process and the pertaining technology. Engineers, in particular, can find jobs that range from helping design or revise brewing equipment, to modifying the chemical composition of the yeast.

Although brewing and tasting is a challenging and rewarding task, it is still important to be aware of the damaging effects of alcohol. The University Health Care website states that: "The UW-Madison community has experienced problems caused by underage and binge drinking. Alcohol is the most commonly abused drug on the UW campus." It is important to be informed and aware of what alcohol does to the body. The National Institute on Alcohol Abuse and Alcoholism has thorough articles about the alcohol's destructive effects. In particular it's destructive effects on the brain from simple memory lapse to common disorders due to alcohol-related brain damage. The Wisconsin Engineering Magazine encourages that students use alcohol in a responsible manner.

Article by: Alex Beletic
Design by: Tom Bernath
Photography by: Victoria Yakovleva

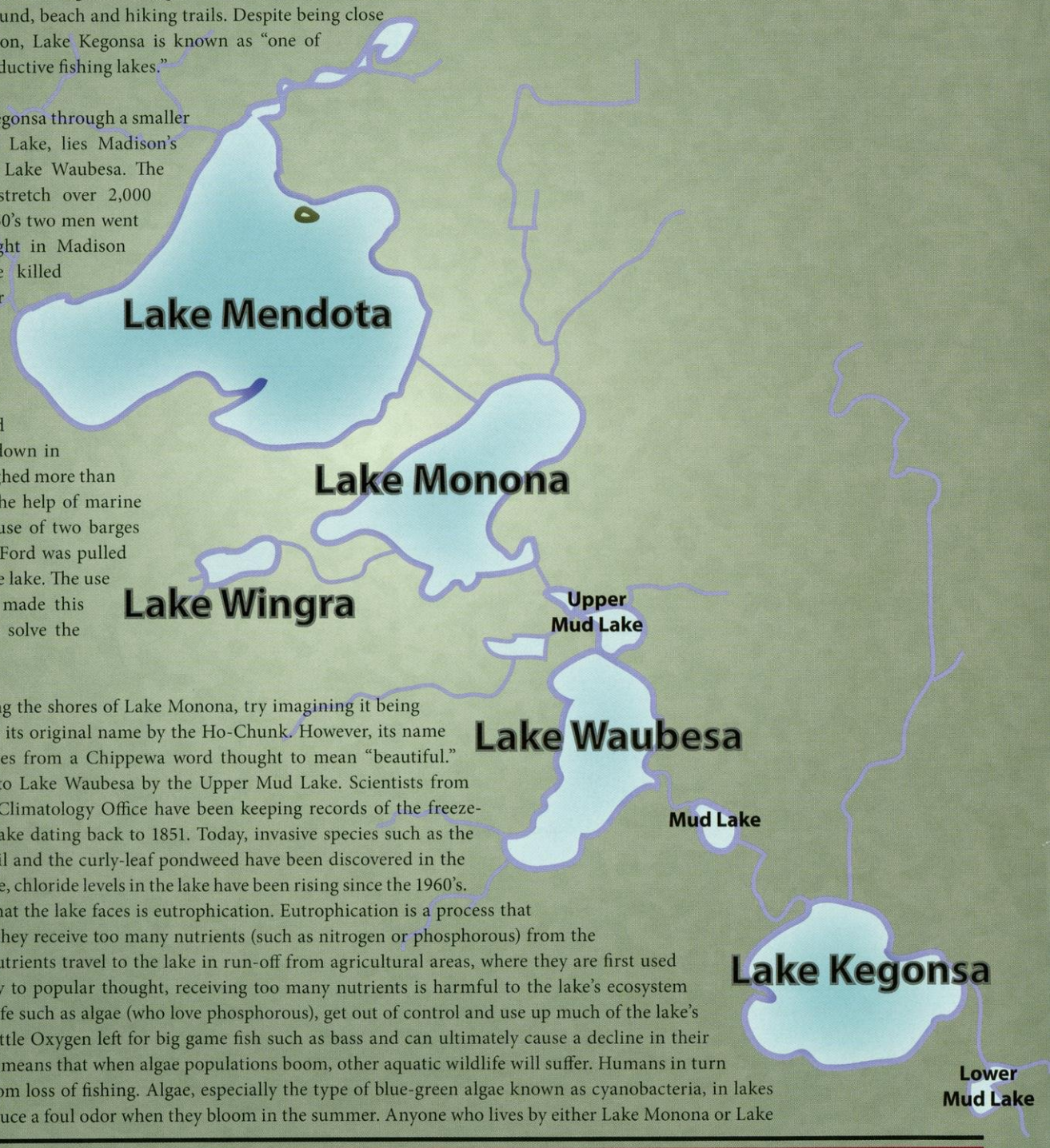
You can order a sampler which consists of various beers.

Diving into the Myth of the Four Lakes

Madison goes by many nicknames: Madtown, Mad City, or even "The Berkeley of the Midwest" but did you know it's known as "The City of Four Lakes"? Whoever came up with the nickname "City of Four Lakes" to refer to Lake Kegonsa, Lake Waubesa, Lake Mendota and Lake Monona forgot one. Lake Wingra, which is just south of the UW- Madison campus, right off the shores of Edgewood and the Arboretum is the fifth Lake.

Unless you're from Madison, you've probably never heard of Lake Kegonsa. Lake Lake Legonsa is sandwiched in between County Road 51 and Highway 90, south-east of downtown Madison. Covering 3,209 acres, this lake was created by a glacier during the last ice age. Lake Kegonsa has its own state park which is home to a campground, beach and hiking trails. Despite being close to the City of Madison, Lake Kegonsa is known as "one of Wisconsin's most productive fishing lakes."

Connected to Lake Kegonsa through a smaller lake known as Mud Lake, lies Madison's second famous lake, Lake Waubesa. The waters of the lake stretch over 2,000 acres. Back in the 1960's two men went bar hopping one night in Madison and reportedly were killed after driving their 1950's Ford into the icy waters of Lake Waubesa. Over 45 years later, in 2006 authorities discovered the car over 30 feet down in the mud. The car weighed more than 2700 pounds. With the help of marine contractors and the use of two barges with boat hoists, the Ford was pulled from the depths of the lake. The use of sonar technology made this discovery possible to solve the mystery.



Next time you're along the shores of Lake Monona, try imagining it being called "Teepee Lake," its original name by the Ho-Chunk. However, its name today, 'Monona' comes from a Chippewa word thought to mean "beautiful." Monona is attached to Lake Waubesa by the Upper Mud Lake. Scientists from the Wisconsin State Climatology Office have been keeping records of the freeze-thaw periods of the lake dating back to 1851. Today, invasive species such as the Eurasian water milfoil and the curly-leaf pondweed have been discovered in the lake. On a similar note, chloride levels in the lake have been rising since the 1960's. The major problem that the lake faces is eutrophication. Eutrophication is a process that lakes undergo when they receive too many nutrients (such as nitrogen or phosphorous) from the surrounding land. Nutrients travel to the lake in run-off from agricultural areas, where they are first used as fertilizer. Contrary to popular thought, receiving too many nutrients is harmful to the lake's ecosystem because the aquatic life such as algae (who love phosphorous), get out of control and use up much of the lake's oxygen. This leaves little Oxygen left for big game fish such as bass and can ultimately cause a decline in their population. This also means that when algae populations boom, other aquatic wildlife will suffer. Humans in turn suffer, but not just from loss of fishing. Algae, especially the type of blue-green algae known as cyanobacteria, in lakes such as Monona produce a foul odor when they bloom in the summer. Anyone who lives by either Lake Monona or Lake

Mendota can testify to the noxious smell. This brings back the main point, controlling nutrients in the water going into the lake is important to keep the lakes healthy.

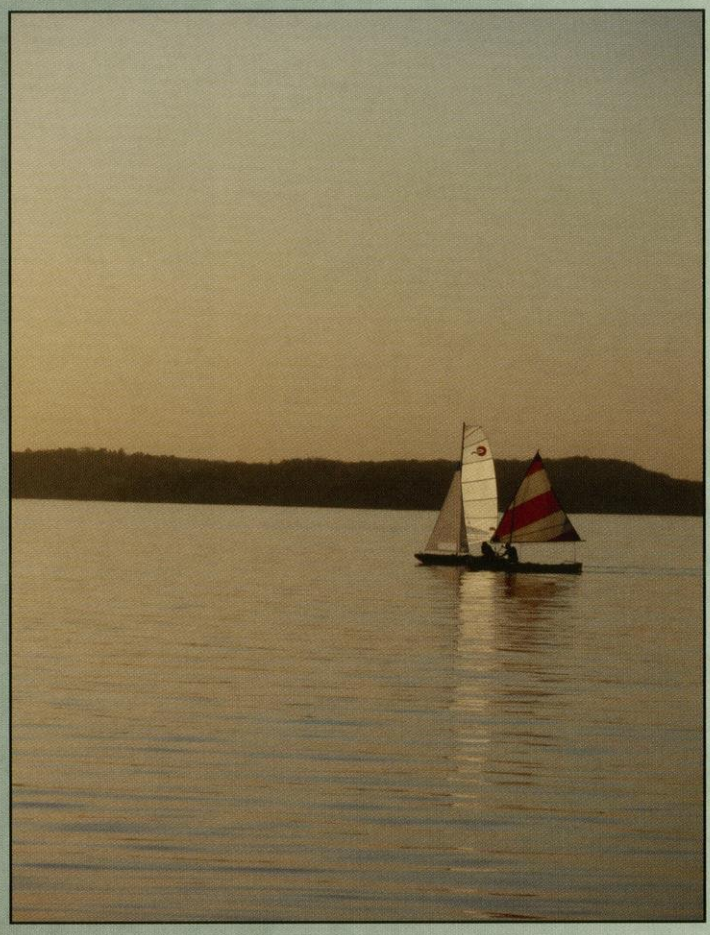
Everyone loves Lake Mendota; it's Madison's last official fourth lake. The largest of the four lakes in Madison, Lake Mendota has been called the "most studied lake in the United States" with the UW-Madison Limnology Department doing most of the work. Exciting discoveries have been made in its waters. Back in 2009, the spiny water flea, which is an invasive species only found in two other lakes in Wisconsin, was discovered by a limnology class. Lake Mendota faces the same nutrient loading problem as Lake Monona. Eutrophication is well studied in Lake Mendota with the Stockholm Water Prize winner of 2011, limnologist Stephen Carpenter at the front. Carpenter who is a recent recipient of the award is accredited with contributing "broadly to the conservation and protection of water resources and to improved health of the planet's inhabitants and ecosystems."

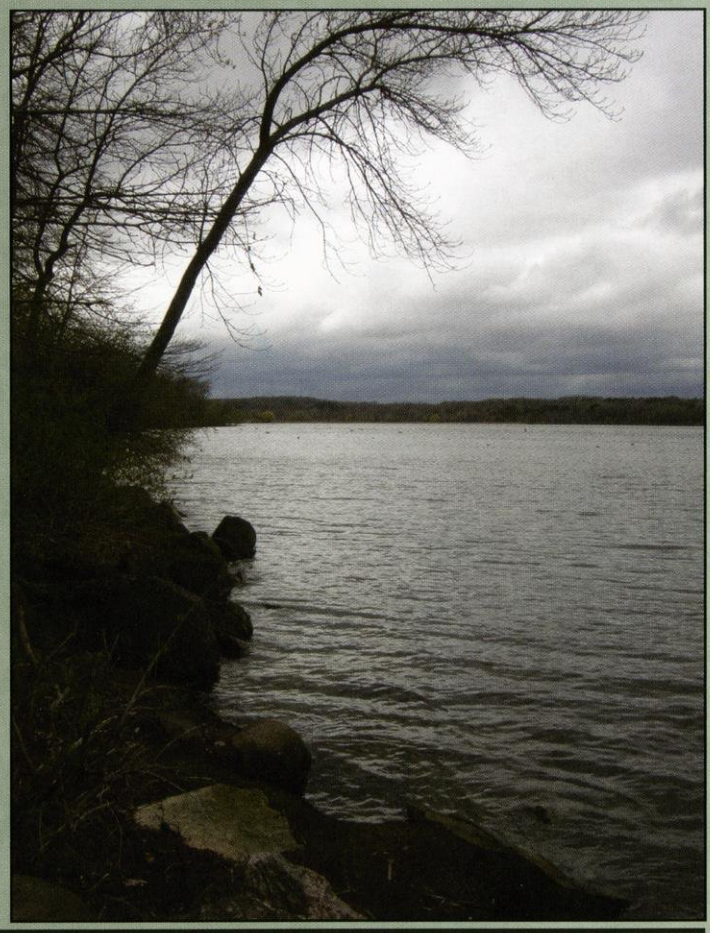
Even the CEE Department has a stake in the research going on in Lake Mendota. Trina McMahon, who is an Associate Professor in the Civil and Environmental Engineering Department says that they are using "high-resolution measurements of temperature, dissolved oxygen, phytoplankton pigments and meteorological variables captured by Lake Mendota buoy" to study drivers of bacterial communities and populations. Understanding these bacteria such as cyanobacteria (mentioned earlier), is key to understanding eutrophication.

Last, but not forgotten, residents near the South side of campus are probably familiar with Lake Wingra. Anyone who has been to the Arboretum has likely caught a view of this now well-kept and healthy lake. Lake Wingra is an ecological success story. Carp, which have been found in Lake Wingra since the 1970's, stir up the bottom of the lake, making silt more available to algae and invasive weeds at the top of the lake. The population of the carp became too great, causing unclear water, explosive populations of algae and invasive species. To combat the degradation done by the carp, a storm water management plant was adopted, removing 7,000 carp from the lake over the duration of two winters. Limnologist Dick Lathrop says that, "not only is the water clearer, but native plants are doing better and outbreaks of blue-green algae have been minimal." Carp still reside in the lake, however, in small numbers so the harm that they do is minimal.

Madison is sometimes known by its four lakes, but there are really five major ones: Lake Kegonsa, Lake Waubesa, Lake Monona, Lake Mendota and Lake Wingra. These beautiful lakes are part of the Yahara River and were created from the meltwaters of the last glaciers 12,000 years ago. Humans have impacted them all and it's best to be aware of the affects we have on these great resources. Citizens, scientists and engineers all come together to collaborate on improving our lakes in the Madison area. Henry David Thoreau sums it up best by saying, "A lake is the landscape's most beautiful and expressive feature. It is earth's eye; looking into which the beholder measures the depth of his own nature." WE

Story by: Rachel Feil
Design by: Tom Bernath
Photography by: Sara Karraker





Turn up the HEAT

As an essential component of machines used in everyday life, combustion engines represent one of the crowning achievements of mechanical engineering. Generations of mechanical engineers have worked to improve engines through optimization of such parameters as injection timing, air-to-fuel ratio and piston configuration. However, the next major advancement in engine design may come from outside the realm of mechanical engineering. John Perepezko and Ridwan Sakidja, professor and assistant scientist in the materials science and engineering department at UW-Madison, have recently developed coatings for molybdenum-based alloys that offer superior high-temperature performance compared to current nickel alloys, this has the potential to revolutionize applications ranging from engines to space shuttles.

The fundamental limitation posed by the current nickel alloys is the melting point temperature of 1450 degrees Celsius. Below 1150 degrees, nickel alloys possess favorable properties such as high tensile strength, ductility, and resistance to fatigue and oxidation. In order to preserve these desired properties above 1150 degrees, thermal diffusion coatings reduce nickel surface temperatures by 300-400 degrees. Though effective, thermal diffusion coatings remain susceptible to corrosion by particulates such as sand. The U.S. Department of Defense has witnessed this problem firsthand, and for this reason funds research into increasing the longevity of turbine blades on fighter jets in the Middle East. "The basic requirement of a structural material is that it needs to stay solid," Perepezko says. In addition to corrosion problems, thermal diffusion coatings severely restrict the efficiencies of high temperature applications. For example, removal of the thermal diffusion coatings and other types of auxiliary cooling at 1300 degrees would produce a 50 percent increase in engine power. Since a typical engine contains four hot stages each with more than 50 blades that cost hundreds of dollars apiece, this represents an enormous opportunity to enhance system performance.

As a potential replacement for nickel alloys, molybdenum has a higher melting temperature of 2623 degrees and better thermal conductivity. With improved heat transfer properties, molybdenum can withstand more extreme temperature gradients than nickel. However, molybdenum presents a new set of problems. The oxide scale of MoO3 that molybdenum forms at high temperatures sublimates at 700 degrees, exposing the inner layers of molybdenum to oxygen and resulting in material loss. To isolate molybdenum from exposure to molecular oxygen, a molybdenum silicide compound that forms a SiO2 layer could be applied to the surface of molybdenum, but the mismatched coefficients of thermal expansion cause the coating to flake away during rapid temperature changes. A feasible formulation of a molybdenum coating requires a metal phase structure between the glass layer and the molybdenum substrate in order to create layers of compatible mechanical properties and prevent the dissolution of the surface layer into the molybdenum substrate.

Formation of a phase structure with the desired properties is the most difficult aspect of the coating process. "One of dilemmas you face is that you want a material that is stable at high temperature. This means that it doesn't change at high temperature. At the same time, you want to manipulate its structure to get better properties. You have a dilemma – you want the material to change, but you can't change it. So you need to figure out a way to predict what properties a material will have at high temperatures and find a way to synthesize it at low temperatures," Perepezko says. The ratio of silicon to boron represents the most important factor in determining the high temperature resistance of the resulting material, where an excess of boron causes the coating to evaporate while an excess of silicon produces a viscous glass with bubbles at lower temperatures. Extreme care is needed to achieve the proper ratio of silicon to boron that enables high performance at a wide range of temperatures.

The coating process developed by Perepezko and Sakidja consists of pack cementation followed by thermal conditioning to form phases of Mo5Si3 and Mo5SiB2 in between the molybdenum substrate and the outermost borosilica layer. In the pack cementation process, boron and silicon are transported to a molybdenum surface, forming a layer of molybdenum silicide and molybdenum boride on top of the substrate. When conditioning the sample in air at high temperatures, the molybdenum silicide and molybdenum boride layer partitions into the Mo5SiB2, Mo5Si3, and borosilicaand borosilica phases from bottom to top upon the metal substrate. The resulting material has varying rates of silicon diffusion through the different phases: silicon moves through the Mo5SiB2 layer 1000 times slower than it does through the Mo5Si3 layer.

The Mo5SiB2 layer acts as a diffusional barrier to prevent dissolution of the coating into the substrate, while the Mo5Si3 layer acts as a source of silicon to replenish the borosilica layer should damage occur. As Perepezko explains, "What is the perfect coating? It should stay on the surface, it shouldn't contaminate the substrate by dissolving, and in the best case it would be self-healing. Our coating has all of these characteristics."

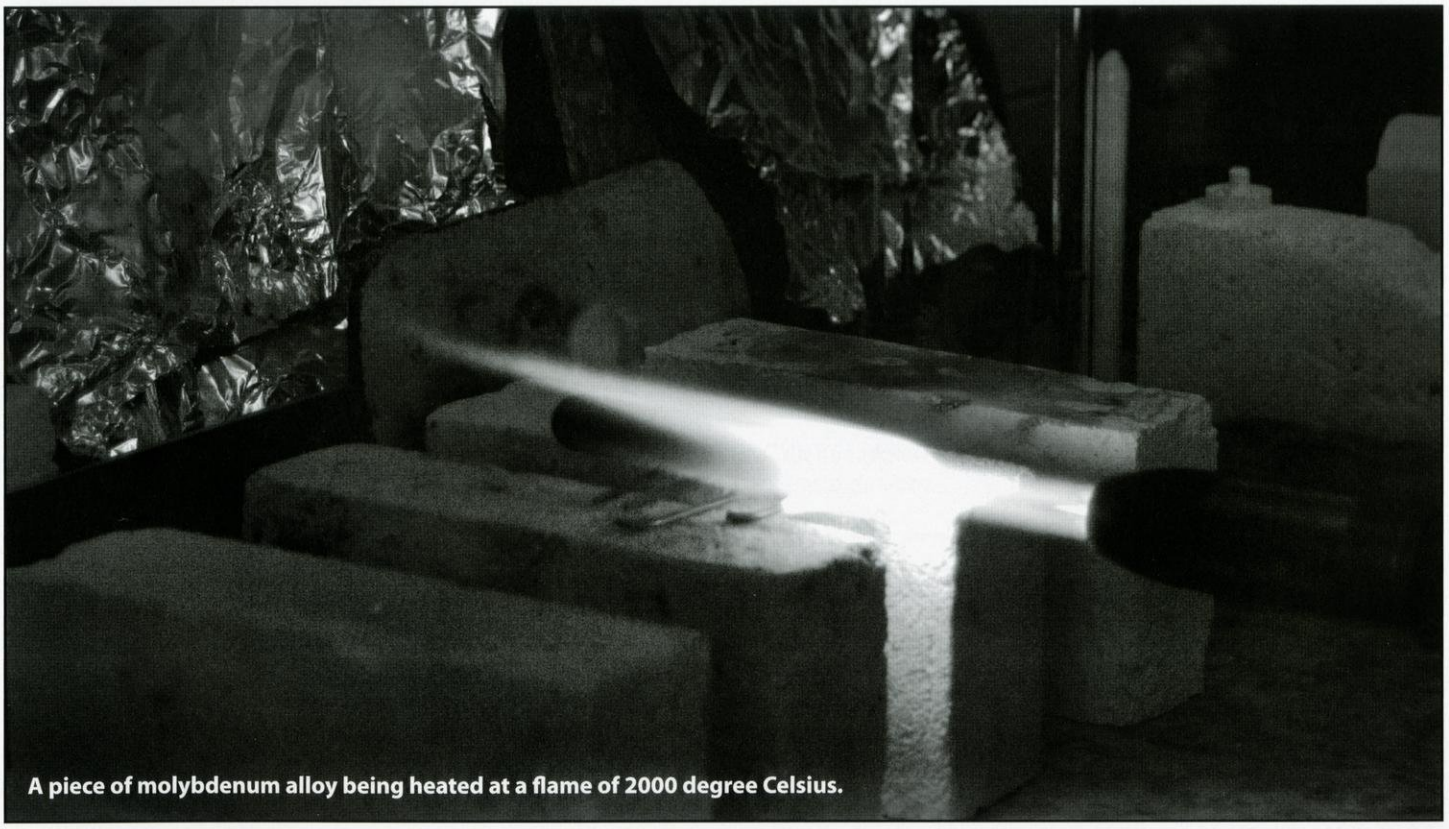
The resulting molybdenum alloys offer dramatic improvement over nickel alloys. According to Perepezko, the molybdenum alloys have endured hundreds of hours at 1600 degrees as well as several hours at 2000 degrees. In fact, Perepezko has encountered limitations not in the alloy's capacity to withstand high temperatures but in his laboratory's capacity to generate sufficiently high temperatures to cause

the alloy to deteriorate. To establish the upper temperature limit, Perepezko has sent samples to a special facility that simulates reentry temperatures. Perepezko proudly declared the results: "Our sample survived better than the sample holder. They had to stop the test because the holder for the sample destroyed itself. The technician said to me, 'We may need to use your material for our sample holder.'" Perepezko envisions a wide variety of applications for the molybdenum alloys, including engines, glass melting electrodes and high temperature heat exchangers.

Future work includes examining the effect of adding various dopants as well as expanding the types of possible substrates beyond molybdenum. Alumina (Al2O3) has shown promise in increasing the resistance of the molybdenum alloy to water vapor attack, an important consideration because fuel combustion produces a local concentration of around 10 percent water vapor in the atmosphere. However, an excess of Al2O3 disrupts the isotropic nature of the amorphous coating by introducing a directionality which causes the coating to flake off. A different type of challenge is to adapt the coating to different substrates by matching the coefficient of thermal expansion between the new substrate and a thin layer of molybdenum. Perepezko's group has successfully applied the coating to ceramic substrates, which has attracted the interest of NASA for space shuttles. The wings of space shuttle encounter large amounts of aerodynamic heat due to the radiation of plasma molecules. To withstand the resulting temperature increase, shuttles have blunt edges on their wings that dissipate heat as well as nose-cones that evaporate a small amount of material. Ceramic coatings could eliminate the need for these measures, resulting in sharp edges that improve maneuverability and avoiding the material loss incurred by nosecones.

The economy represents one current barrier to the widespread adoption of molybdenum alloys and the coating technology. "There's momentum in industry. They don't like to change when they have a good thing going. When the economy is poor, industry is not interested in radical changes," Perepezko says. However, a few more years may lead some companies to reconsider. The higher temperatures afforded by coating molybdenum and other substrates gives more power and better economy to engines, as well as a range of benefits for other applications. Perepezko remains excited about the prospects of the coatings and has already obtained a patent with the Wisconsin Alumni Research Foundation. He closes with the sentiment shared by many people who have witnessed his work: "It is so cool."

Article by: Melissa Dettmann
Design by: Linc Han
Photography by: Robin Kraidich



A piece of molybdenum alloy being heated at a flame of 2000 degree Celsius.

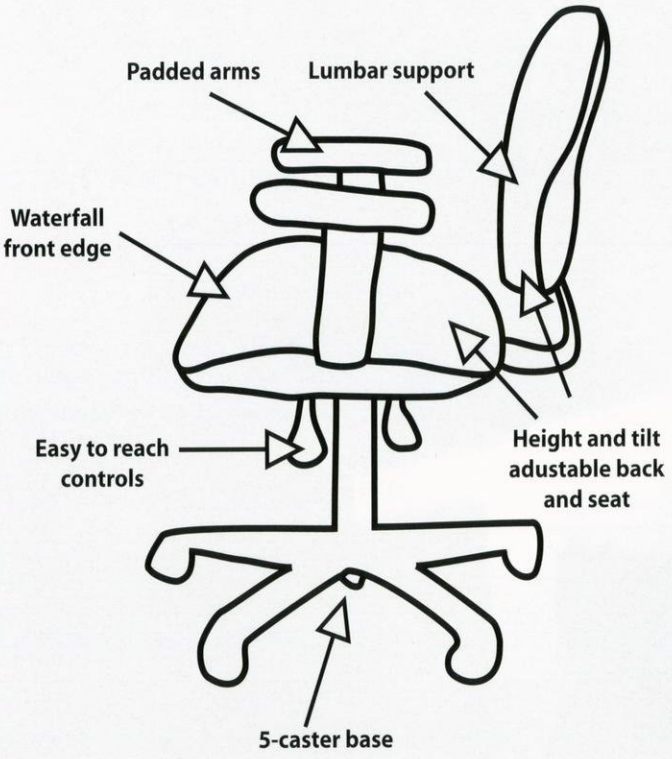
Neck strain, lower back pain, carpal tunnel syndrome, oh my! The way we lift, twist, turn and even position our bodies in the course of completing everyday tasks at work or in school can, if done incorrectly, cause serious injury. There is an interesting science behind the routine movements required for people's work. Luckily, a field called ergonomics offers many strategies for avoiding these and other work-related injuries.

Ergonomics

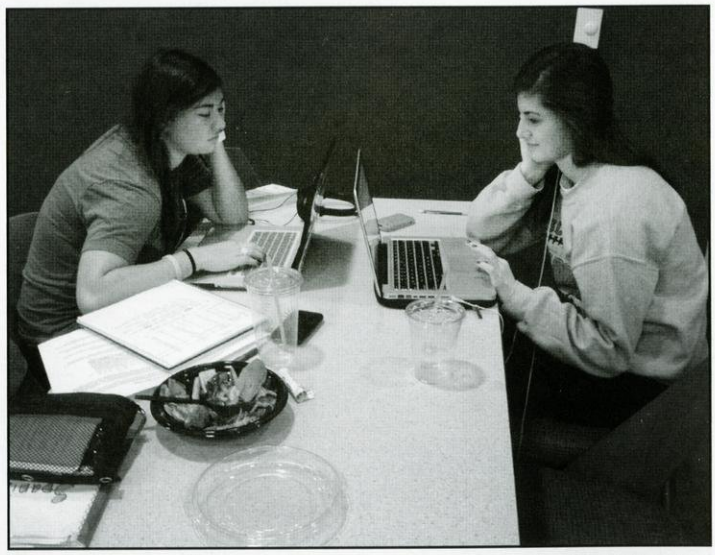
>> Everyday movements required for peoples' work have the potential to cause great harm, but the field of ergonomics offers insights into help. <<

In the workplace or classroom, repetitive or unnatural tasks have the potential to cause a class of injuries called Work-Related Musculoskeletal Disorders (WMSD's). WMSD's are injuries to the soft tissues of the body including muscles, tendons, nerves and blood vessels. Symptoms of WMSD's include the following: pain, fatigue, numbness and stiffness. According to the Washington State Department of Labor and Industries, across the United States, WMSD's are responsible for 70,000 lost work days per year and about 60 percent of worker-compensation claims pay for treating WMSD's. For the Washington State Fund, a worker-compensation agency, WMSD's cost over $12 million per year. Furthermore, the increasing amount of time employees and students spend working on computers is causing an increase in the prevalence and severity of WMSD's. Given this trend, and the negative effect these injuries have on productivity, work quality and absenteeism, the implementation of ergonomic principles in the workplace and classroom is extremely important for the general health of employees and students. Since a healthy workforce or student body is essential for the success of companies and schools, providing ergonomically sound places to work has the potential to provide companies and schools with significant returns on their investments.

Minimum features of an adjustable task chair:



Before solutions can be devised, the root causes of WMSD's must be fully understood. Four common risk factors found in most work environments and classrooms can lead to the development of WMSD's, they are outlined at the upper right:



Slouching is the most common cause of Work-Related Musculoskeletal Disorders.

Repetition: Performing similar motions repeatedly, without allowing time for rest, can cause damage to the joints. Some examples of activities that can lead to WMSD's caused by repetition are:

>> *Typing on a keyboard,*
>> *Moving and clicking a mouse,*
>> *Writing by hand.*

Static Loading: When muscles are used to hold the body in a fixed position or for exerting a constant force for long periods of time, a reduction in circulation can occur and lead to injury. This risk factor is increased substantially in the computerized workplace because employees must hold a posture (often an unhealthy one) for hours at a time. Some examples of static loading conditions are:

>> *Holding the head still while reading from a computer screen,*
>> *Holding the arms in place above a keyboard or mouse,*
>> *Sitting upright without back support,*
>> *Carrying loads long distances, whether the load is carried with the hands or in a backpack.*

Unnatural Postures: In the workplace or classroom, when employees or students attempt to multitask, they often bend their joints in ways that increase joint tension, which can result in joint injury. Some examples include:

>> *Holding a phone between the ear and shoulder,*
>> *Reaching over the keyboard in order to use a mouse,*
>> *Slouching in a chair,*
>> *Turning the head to view a computer monitor.*

Mechanical Contact Stress: When hard surfaces or edges of surfaces press into soft tissue, damage to the nerves, tendons and/or blood vessels. Common situations include:

>> *Resting the wrists on the edge of a desk while typing,*
>> *Sitting in a chair that presses on the backs of the thighs,*
>> *Supporting the weight of the head on the elbows, while resting them on a hard surface.*

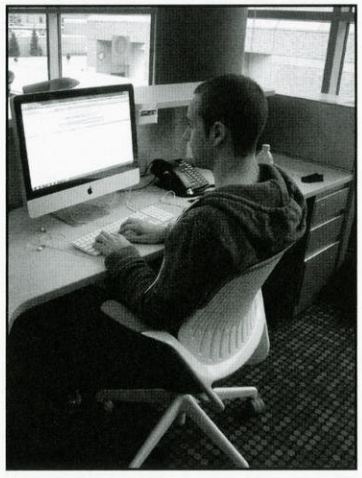
Treating WMSD's can be extremely expensive, both because the care required is costly and because it results in loss of productivity. For this reason, a proactive approach to fixing the underlying causes of injuries is most effective. For most workplaces or classrooms, there are a variety of simple solutions to ergonomically incorrect behavior. Each of these solutions seeks to limit the extent to which employees or students are exposed to the risk factors for WMSD's.

Invest in Adjustable Task Chairs: According to the Washington State Department of Labor and Industries, the most common health complaint by office workers in the U.S. is back pain. Remaining seated for long periods of time in chairs that do not encourage proper posture is the leading cause of back pain for office workers and for students. One simple and effective solution to this problem is to invest in high quality office chairs that can be adjusted to suit the individual needs of the user. In order to fully adapt to the user's needs, a chair should have a minimum set of adjustments, as depicted below.

In addition to simple investing in adjustable task chairs, employees should be trained in how to properly adjust their chair. Adjustable task chairs can be a significant capital investment, but the return will also be significant. They can limit the number of injuries suffered by employees and thus reduce worker-compensations costs and lost productivity.

Sit in a Neutral Position: A neutral position is one that minimizes the static loading and mechanical contact stress experienced by a person. Additionally, a neutral position will reduce the tendency of employees to work in unnatural positions. When sitting in front of a computer, it is especially important to sit in a neutral position. As described by the Washington State Department of Labor and Industries, there are several important components of a seated neutral position:

>> *Place the computer screen so that it can be viewed with the head level or tilted downward slightly.*
>> *Use the chair's backrest to support the lower back.*
>> *When the hands are placed on the keyboard, the shoulders should be relaxed and the elbows should be bent at roughly a 90 degree angle.*
>> *When typing, the wrists should be straight relative to the forearm. If necessary, specialized cushions are available to support the wrists while typing.*
>> *The knees should be at the same level as the hips in order to reduce pressure on the backs of the thighs.*



A neutral way to sit: back support used, wrists straight, elbows at a 90 degree angle, knees at same level as hips.

Organize Workstations: Workstations or desks should be organized in a way that eliminates long reaches for commonly used items and it is especially important to limit long reaches for heavy items. Additionally, computers, keyboards and other items should be positioned in order to limit the need to lean forward in the chair. Common tasks performed in the workplace and classroom can cause serious injury and by implementing ergonomic principles and solutions, a reduction in the occurrence of Work-Related Musculoskeletal Disorders can be achieved. This, in turn, will improve productivity and quality of work while reducing worker-compensation costs and absenteeism. The above solutions are only a few of the easiest to apply; there are many other solutions available to administrators. WE

Story by: Scott Hatfield
Design by: Akhilesh Dakinedi
Photography by: Sara Karraker

The Physics of Game-Day

You can't run from it, even on Saturdays in September. Physics is everywhere.

It's Saturday morning. It's the first weekend in September and the weather is perfect: a comfortable, and surprising, 70 degrees. It's only 8 a.m. but the smell of brats and burgers fill the air, breakfast is not necessary. Everyone is wearing red and everyone who isn't feels completely lost. Students, parents, alumni, and wanna-be Badgers flood the streets as the crowds progress from one pregame party to the next, eventually ending at Camp Randall stadium. This day is game day. "Game day", in its official definition as described previously, is a unique experience, which only seems to occur in Madison, and sometimes in Pasadena, California. But amidst all of the early morning pregame celebrations, there is something lingering that no one wants to admit is partying with them: physics. Yes, as in the scientific subject. Whether you love it or loathe it, physics will always be there. It will never give you a break, even on game day.

Jump Around

In 1998 a great tradition was created in college sports. The song "Jump Around" was played over the loud speakers for the first time during the Badgers Homecoming game against Purdue. Since then, students have enjoyed the time between third and fourth quarter as they jump around like popcorn while the song plays. However, there has to be some repercussions of this ritual, right? For example, if all 14,000-student seats were filled and every student jumped at the exact same time, the force the building would have to endure is about 21,000 kN, which is almost 500 times the thrust of a modern jet engine. In 2003, UW officials decided to cancel the playing of Jump Around due to concerns of the buildings stability. After various student protests and an inspection from some structural engineers, the Chancellor approved of the tradition. It's been going strong (and safe) ever since, no matter how forceful we jump.

Band Marathon

The band is an essential part of game day. They get the crowd and players pumped up when we need it most. But these band members aren't just sitting in the stands playing upbeat music, they are on the move! Each band member marches a total of 2,025 steps during halftime, and given that their steps are supposed to be 22.5" exactly, they are walking about 3,800 ft. If the distance was totaled for every member of the band, the group would walk a total of 148 miles, which is equivalent to walking from Camp Randall to the Kohl Center 135 times. The band totals 206 members and practices about 9 hours a week during football season.

Sacked

Every time a Badger defensive tackle sacks the opponent they feel various forces. The average player can produce about 1,600 pounds of tackling force. During a game there is an average of 100 tackles, so, on average, any one player could absorb a total of 16,000 pounds of force in a game. This is almost two times the amount of force exerted on a driver in a car crash. And you wonder why moms always scream and worry during middle school football games.

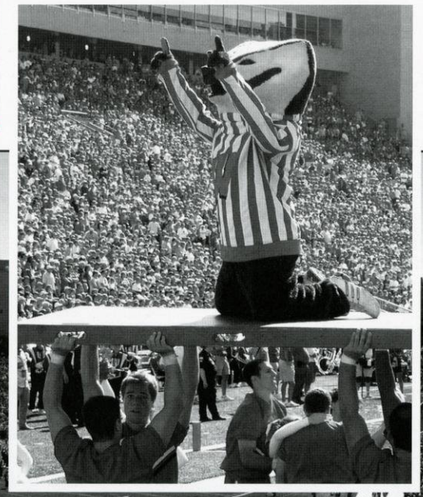
Disclaimer: The modern football helmet can absorb almost 600 pounds of force alone, not to mention a variety of other safety equipment which helps absorb and distribute the forces. Safety first!

Cheering Fans

Given that cheering is meant to amp the players up, it's worth considering the effects of 80,321 cheering fans on the players and on the rest of the stadium. The average person's yell is about 80 dB and the total crowd can produce about 6,425,680 dbs if everyone screamed at once. Now, given the shape of Camp Randall stadium, some of the sound will bounce back, but a lot of it will be heard by the players. Even if only a quarter of the stadium was cheering and the players only absorbed one tenth of the the total sound, it would still be over 1,000 times the decibels produced at a rock concert. No need to worry though, considering the cheers only last for a matter of 10-30 seconds so hearing damage would not be a concern.

Bucky's Pushups

Doing pushups is an extremely effective work out and of course helps to develop upper body muscles that ladies just can't resist. Bucky, our faithful and sexy mascot, get's a healthy dose of push ups at every game as the Badgers rack up points. Every pushup Bucky does requires 8 times the energy it requires to stand still and each minute of push ups burns about 10 calories. Every touchdown the Badgers score he has to do seven additional pushups which could result in a expontentially increasing curve of calories burned. During the Wisconsin-Austin Peay victory last season, the Badgers scored an incredible 70 points resulting in Bucky performing 385 pushups.



The idea of students recognizing physics in everyday life is something that physics professors have been trying achieve through-out their careers. "I try to help my students see that engineering isn't only about designing things to improve our quality of life." says Professor Matt Allen of the Engineering Physics and Mechanical Engineering departments here on campus, "The physical principles that the students are learning also help to explain the world around them, such as why a football sometimes wobbles when not quite thrown properly, or the path that it follows after a kickoff." But physics on game day? Is that legal? These calculations might have presented you with a new mentality about game day, maybe positive, maybe negative. At the very least, you hopefully have a new respect for the players, the stadium, Bucky, the band, and of course the faithful fans. Go Badgers!

Story and Design by:
Christina Wallhausser
Photography by:
Brian Mogen

Green Roads

The newly formed UW-Madison Modified Asphalt Research Center is contributing valuable research in new asphalt technologies

Last winter break, Badgers everywhere packed up their suitcases, coolers and trunks and hit the road to Pasadena to watch our football team compete in the Rose Bowl. Those who drove covered around 4,000 miles round trip, giving passengers more than enough time to marvel at the expansive road system that they were riding on.

In the US alone, there are about 4 million miles of roads with about 2.3 million miles of paved roads. About 90 percent of these pavements are done with a material called asphalt and aggregate. Roads have been around forever, how much research do they really need, right? Wrong. With worries of energy and environmental problems on the minds of many, most industries are looking for ways to develop more 'green' products and practices. The road pavement industry is no exception.

"The term 'green roads' means looking at the life cycle of asphalt materials and reducing the emissions and energy required at every stage, from the delivery to the performance of the road. One of the most essential components of green roads is reducing emissions and energy required," Hussain Bahia says, a professor in the civil engineering department and director of UW-Madison's Modified Asphalt Research Center (MARC).

Developing green roads is one of the major areas being researched by MARC at UW-Madison. "We started to look at these issues in late 2006 when crude oil prices soared very high," Bahia says. Asphalt is a byproduct of crude petroleum refinery and therefore the regular sources of asphalt were being impacted the same way fossil fuels were for Americans. "Since the crude oil market cannot be controlled, the fix to this is to take the asphalt from the refineries regardless of their properties and modify them," Bahia says.

Bahia and a few colleagues put together a business plan saying this area of study needs more research and submitted it to the University. In 2009, their business plan was approved and MARC became an official recognized center of UW-Madison. Despite the youth of MARC, the team has just finished up their first year of research with many new and exciting things happening.

In 2006, Congress allocated funding for a very large project called the Asphalt Research Consortium (ARC) which was to be managed by the federal highway administration. UW-Madison's MARC is connected with the ARC in addition to asphalt modification research programs at Texas A&M, the University of Wyoming's Western Research Institute, the University of Nevada at Reno and a large consulting firm called Advanced Asphalt Technologies (AAT).

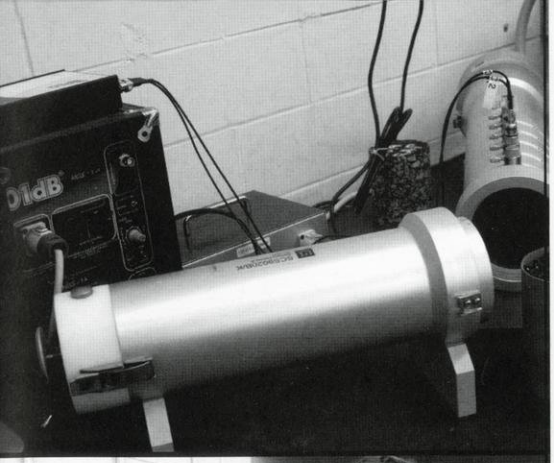
UW-Madison's contributions focus on the modification of materials for paving applications, looking not only at the modification for the purposes of traffic resistance, but also at sustainability and reducing the environmental impact of road construction.

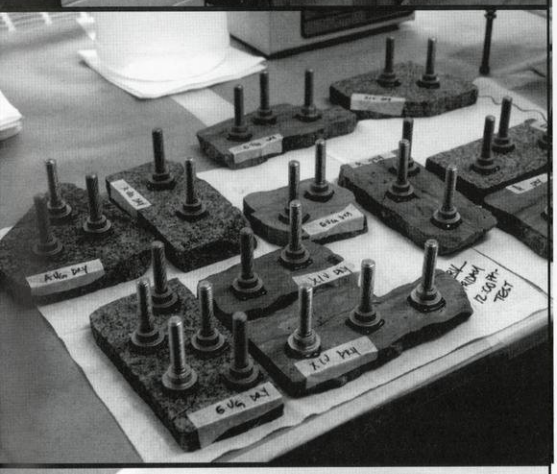
In addition to its great connection with other federal programs, MARC collaborates with many international organizations for asphalt research. "We meet at least twice every year with International Society for Asphalt Pavements (ISAP) to share information and research we are working on," Bahia says.

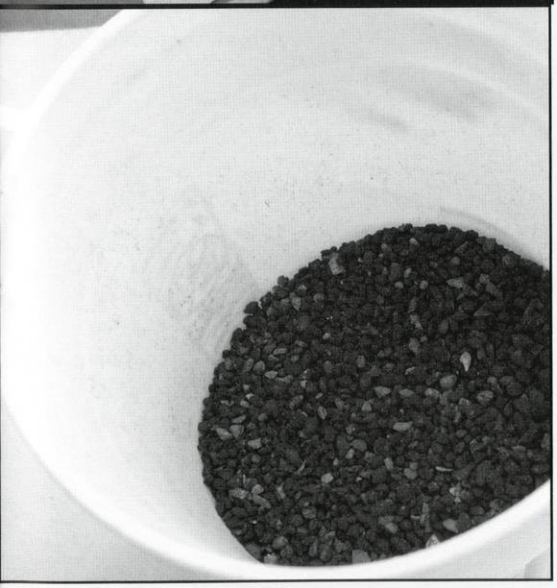
Towards the end of March 2011, members of UW-Madison's MARC attended a conference in Kansas City to share ideas and different research projects. "We developed a test called the lubricity test that will evaluate the workability of warm mix asphalts and we introduced this test and a few papers we published on it at the conference," Bahia says.

Warm mix asphalt is an example of some exciting projects MARC has been working on recently. "When you produce warm mix asphalt, you have to introduce some additives that will liquify the asphalt at lower temperatures," Bahia says. Instead of going very high in temperature, the pavement techniques MARC is developing will reduce the temperatures of asphalts during pavement and construction.

The challenge with asphalt is, although readily available and a very good natural adhesive, it is not a very good engineering material. Its properties cannot be controlled because it is a natural byproduct of crude petroleum refineries. "Our focus is to test the asphalts that are produced for paving purposes and then improve them if they lack some of the properties," Bahia says. One of the major weaknesses of asphalt is that it is extremely sensitive to temperature. It is very soft in the warm summer months yet very hard and brittle in the cold winter months. As a result of its temperature sensitivity, roads accumulate ruts and deformations on the surface due to the climate and heavy traffic.







Working with asphalt at lower temperatures has two main impacts on the environment. First of all, energy is required to heat the asphalt. Heating asphalts to higher temperatures for pavement purposes consumes more energy than paving at lower temperatures. As the world becomes more energy conscious, the less energy consumed the better.

The second major impact of being able to work with asphalt at lower temperatures involves emissions. By reducing the application temperature of asphalt, the amount of emissions released into the atmosphere also decreases. "If we can control and introduce new ideas to pave at lower temperatures and make pavements last longer, we will see positive environmental impacts in the form of reduced emissions and reduced energy required to maintain and construct our roadways," Bahia says.

By introducing materials that can be applied at lower temperatures and qualifying asphalts for different climatic regions in Wisconsin, we will begin to notice a decrease in the wear of our roadways after long summer months and a decrease in the number of potholes each spring. "Our hope is the need for construction and improvements of our roads will decrease in the future," Bahia says. Being able to keep our roads in good condition for longer periods of time results in paving our roads less frequently which means using less energy and releasing fewer emissions into the environment.

Another important impact MARC is having on current asphalt paving practices includes validating new custom developed testing methods and training different members of the asphalt industry on these testing procedures. "We are a very young organization and we hope that this center will be an international training and education center," Bahia says. "The hope is that we will contribute to the knowledge of longer lasting roads which will impact the environment less than they are now."

In its short existence, the team of engineers working at MARC, which includes twelve plus graduate students and eight plus undergraduate students, has already released three patents for testing equipment, created one international testing standard which is already being widely used, and are working on many more standards for asphalt pavement. For example, last April an engineer from Brazil's top petroleum company came to Madison to be trained in a testing procedure for asphalt pavement.

"Working in the laboratory is a very interesting and demanding experience," says Sebastian Puchalski, a current undergraduate researcher at MARC. "I had a chance to learn a great deal about asphalt, how it behaves and by how many different factors it is being affected. This made me aware of how important it is to take a proper care of our infrastructure," Puchalski says.

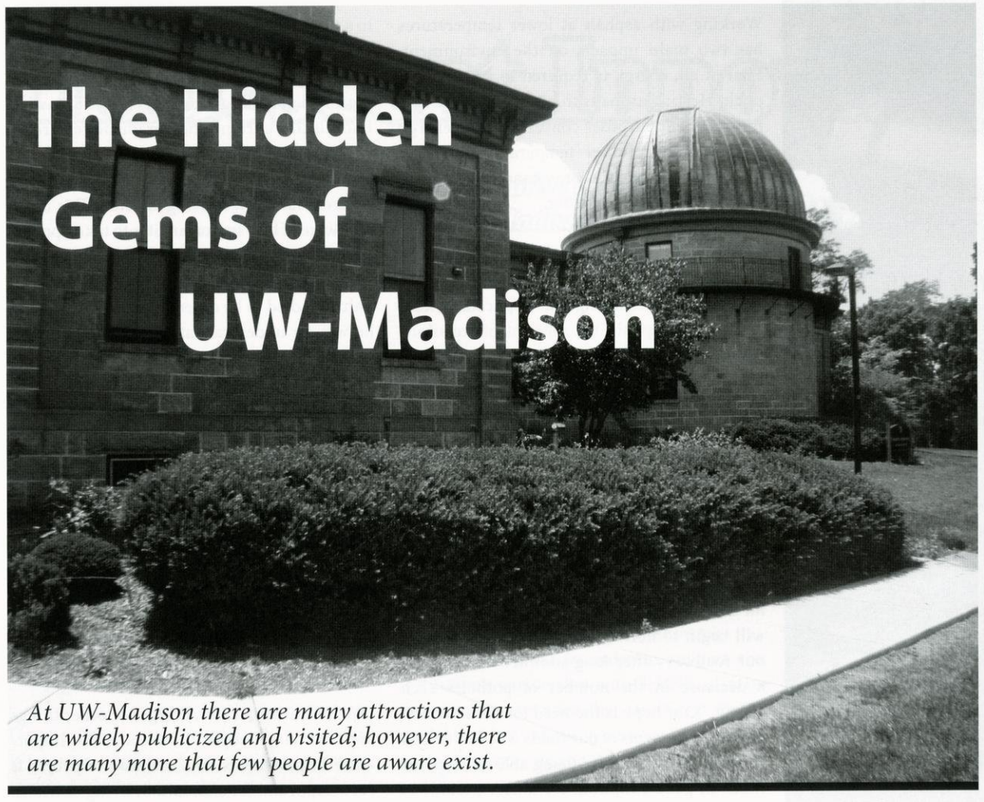
Bahia studied to be a structural engineer when he was an undergraduate student at the University of Baghdad in Iraq. First working on bridge designs, Bahia switched his interest to pavement engineering after realizing he was really interested not in the bridges, but the actual paving material. "While structural methods have advanced, we still suffer from trying to understand this natural pavement material. Most people don't know how to pick materials and how to qualify them for different projects," Bahia says. After his undergraduate education, Bahia studied at Georgia Tech, finished his Ph.D. at Penn State, and then moved to Wisconsin where he has been a professor ever since.

"We look at structures, bridges or other things but not many people know about the importance of pavements. The mobility of people is very important for standard of living or health safety. We need more engineers paying attention to this very narrow field of pavement engineering," Bahia says.

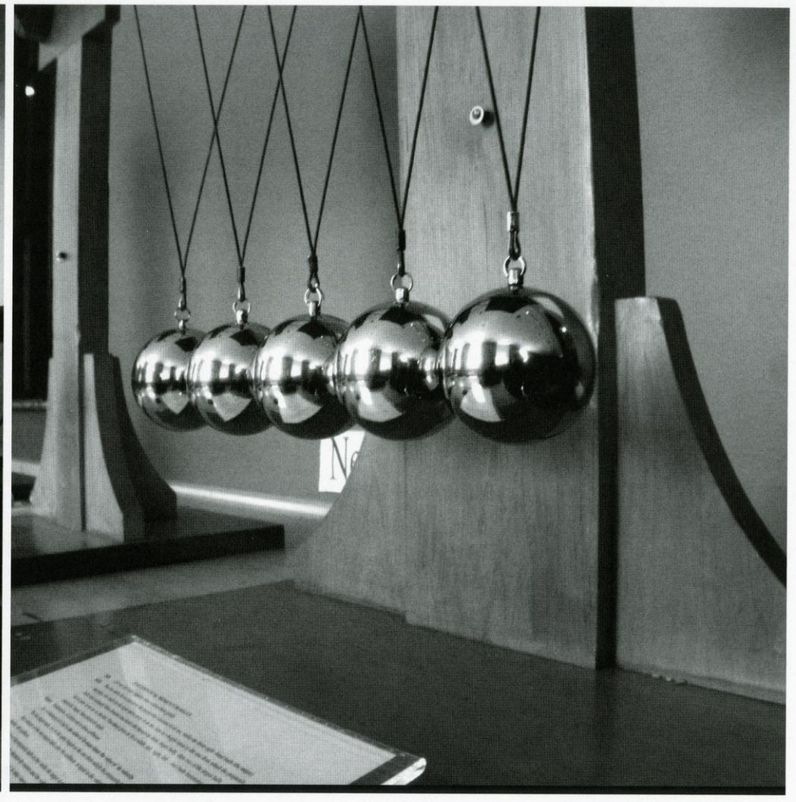
Currently, the top engineers in many federal organizations are retiring and people who are properly trained in the field are difficult to find. Bahia works with many departments in America and has noticed they are all suffering from this problem. "I encourage engineering students to look at this area carefully and consider it. It is not only exciting, but there are many job opportunities and I think it's important for our community, country and the world," Bahia says. WE

Article by: Elly Underwood
Design by: Tom Bernath
Photography by: Danny Hwong

The Hidden Gems of UW-Madison



At UW-Madison there are many attractions that are widely publicized and visited; however, there are many more that few people are aware exist.



Washburn Observatory

Location: 1401 Observatory Drive
Hours: Open occasionally: check website or twitter feed at http://twitter.com/intent/user?screen_name=Washburn_Obs
Description: Washburn Observatory was completed in 1881. For over 50 years it was a major research facility and even today the observatory's 15-inch refracting telescope provides a clear view of many celestial bodies, in spite of significant light pollution from the UW-Madison campus and the greater Madison area. The telescope is primarily used in introductory astronomy courses and for public viewings during open houses, which are run by UW-Madison graduate students.
Additional Information: The website for the Washburn Observatory provides information about the schedule for open houses.

UW-Madison Botanical Garden

Location: 1100 University Avenue
Hours: Dawn to dusk, daily
Description: The UW-Madison Botanical Garden features over 500 species of plants from around the world representing more than 100 families and over 50 taxonomic orders. The Botanical Garden is an important tool for teaching and research. It also provides an example of the incredible diversity of the plant kingdom. The UW-Madison Botanical Garden is also home to a grafting of the tree under which Isaac Newton sat as he was allegedly inspired to derive the Law of Universal Gravitation.

Babcock Hall Observation Deck

Location: Babcock Hall, at 1605 Linden Drive
Hours: Monday-Friday 7:30 a.m. - 5:30 p.m.
Saturday 11 a.m. - 4 p.m. (10 a.m. - 5 p.m. Football Saturdays, except for night games)
Description: Babcock Hall contains a dairy plant, a dairy store and many food science/engineering research labs. The Babcock Hall dairy store is one of the most popular attractions on the UW-Madison campus. The dairy store offers a wide selection of ice cream, cheese and other dairy products that are produced on-site in the dairy plant. The dairy plant produces new products on most weekday mornings. There is an observation deck on the second floor of Babcock Hall that overlooks the dairy plant where visitors can observe the process of ice cream and cheese production. The observation deck also offers many interactive displays and a video presentation describing the how the dairy products are made.

UW-Madison Geology Museum

Location: Weeks Hall, at 1215 W. Dayton Street
Hours: Monday-Friday 8:30 a.m. – 4:30 p.m.
Saturday 9:00 a.m. – 1:00 p.m.
Description: At the first meeting of the Board of Regents held for the establishment of the University of Wisconsin- Madison, the desire was expressed to create a museum to display geological and mineralogical samples from around the state. Twenty-eight years later, the first Geology Museum was founded in Science Hall. However, the museum was destroyed in the fire of 1984, taking countless, priceless specimens with it. Once Science Hall was rebuilt, the Geology Museum was also reestablished. Eventually, the museum was moved to Weeks Hall, where it can currently be visited by the public.

UW-Madison Arboretum

Location: North Wingra Drive and South Mills St
Hours: Visitor Center open weekdays from 9:30 A.M. – 4:00 P.M. and weekends from 12:30 to 4:00 P.M.
Description: Widely recognized as the site of historic research in ecological restoration, the Arboretum includes the oldest and most varied collection of restored ecological communities in the world, including tallgrass prairies, savannas, several forest types and wetlands. It also houses flowering trees, shrubs and a world-famous lilac collection. Educational tours for groups and the general public, science and nature-based classes for all ages and abilities, and a wide variety of volunteer opportunities for groups, families and individuals are available.
http://uwarboretum.org/

L.R. Ingersoll Physics Museum

Location: Chamberlin Hall, at 1150 University Avenue
Hours: 8:00 A.M. until 4:00 P.M. Monday through Friday
Description: The Physics Museum provides a hands-on experience of physical concepts ranging from mechanics and electricity, to the behavior of waves. Admission to the Physics Museum is free and no reservations are required, but guided tours can be arranged.
http://www.physics.wisc.edu/museum/index.html

Article by: Scott Hatfield
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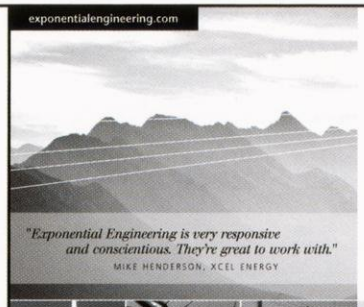

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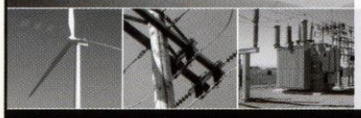

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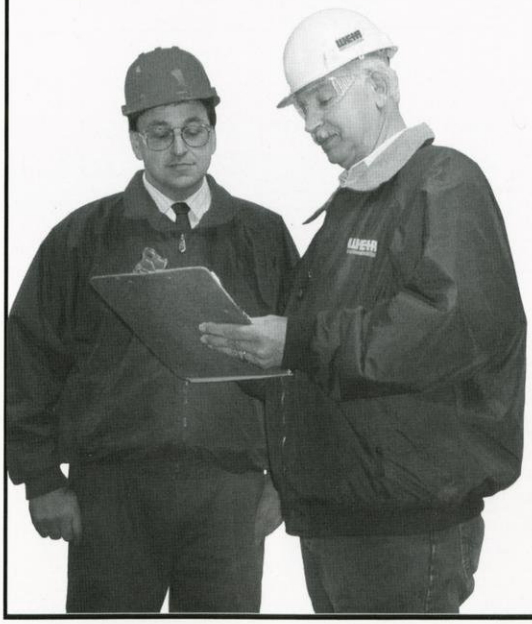

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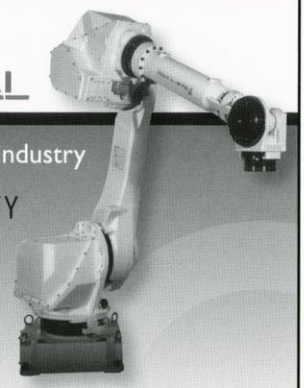

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