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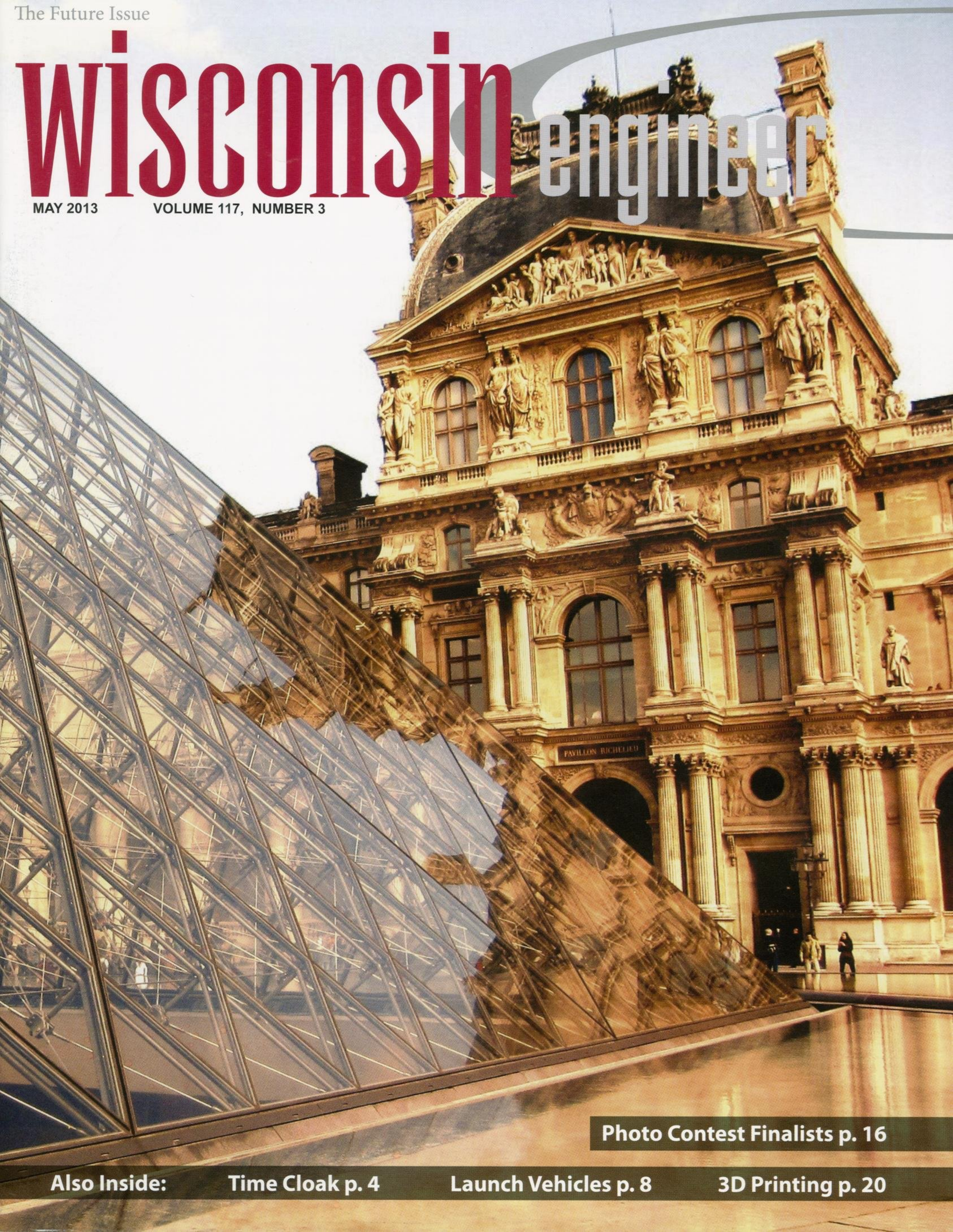
The Future Issue

# wisconsin engineer

MAY 2013 VOLUME 117, NUMBER 3



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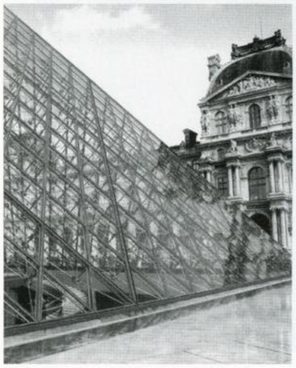

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# Looking to the Future

*Letter from the Editors*
by Danielle Shepard and Jackie Hill

As the University of Wisconsin-Madison is constantly working to maintain its world-class reputation, we at the *Wisconsin Engineer* magazine chose to focus our May 2013 issue on the many components that are moving us forward in the fields of science, engineering and technology.

In our "Looking to the Future" issue, you will find a wide variety of articles pertaining to the advancements occurring not only at UW-Madison, but across the nation. Whether it's our innovative student organizations like the Concrete Canoe Team (page 26), our dedicated professors (page 10) or our new rapid prototyping technologies (page 20), UW - Madison is always at the forefront of ground-breaking endeavors. Our writers also found it important to highlight other accomplishments happening across the nation, including research on the potential for invisibility and reusable launch vehicles (pages 4 and 8).

In this issue, along with our future-focused articles, we feature the winners and runners up of our sixth annual photo contest. Every year we ask the students and faculty of UW-Madison to submit photos under the categories of portrait, landscape, still life or miscellaneous. The featured photos range from an Indian dancer in Singapore to a balloon rally in Austin, Texas. Thanks to all of our readers who took the time to submit their photos, and we encourage all of you to participate in next year's contest!

Since the late 1800s, we have been able to produce this magazine through the support of our advertisers and subscribers around the nation. We hope to continue to provide our readers with an informative science and technology focused magazine for decades to come. As you are "Looking to the Future," be sure to check in with the Wisconsin Engineer for subscription and advertising opportunities (for more information visit wisconsinengineer.com). With that, we extend our thanks to our advertisers, readers and staff. We could not produce this magazine without you. It has been a joy working with you all, and we hope you enjoy the May 2013 issue! WE

*Editorial*
by Jackie Hill

We all remember our first day of college; we recall moving in to our dorms or apartments, meeting our roommates for the first time and finding our way around campus to ensure that we were prepared for our 'first day of school.' It's not unlike the first day of grade school or high school, except in college we are all alone- ready to become adults and see what the next few years will hold.

Once our college career begins, we are thrown into a whirlwind of knowledge and new experiences. As we labor through countless hours of studying, all-nighters, exams and projects, it is easy to be swept up in the moment and forget why we are here in the first place: to ensure ourselves a brighter future.

The University of Wisconsin-Madison's mission is "to provide a learning environment in which faculty, staff and students can discover, examine critically, preserve and transmit the knowledge, wisdom and values that will help ensure the survival of this and future generations and improve the quality of life for all." So how can we, as students, ensure that this mission is achieved? We must not expect careers and other opportunities to fall into our laps. Once our University provides us with this world-class education, it is up to us to determine our own future.

UW-Madison provides us with ample opportunities to help us move forward into the 'real' world after graduation. There are several career advising services that help students find jobs and internships in their field of education. Engineering Career Services offers both a fall and spring Career Connection where students hand out their resumés and talk with employer representatives about what job, internship and/or co-op opportunities are available. The College of Letters and Science (L&S), similarly, hosts career fairs (also at the beginning of the fall and spring semesters) that are open to all students on campus. The College of Agricultural and Life Sciences also teams up with L&S and the College of Engineering to host a STEM (Science, Technology, Engineering and Math) job fair. Here employers and undergraduate research labs on campus are able to share information with students about full-time, intern and research lab positions. The university also offers mock interviews, resumé and cover letter writing workshops and other job search tools.

(To learn more about the career services offered at UW – Madison, visit https://ecs.engr.wisc.edu/ or http://www.lssaa.wisc.edu/careers/.)

UW-Madison prepares its students for the 'real' world by not only providing them with an exceptional education, but by offering countless career fairs and advising services. Yet, those aids can only bring us so far. It's up to us to do something with the skills and preparation that our University has supplied us with. We must find our own way to "transmit [our] knowledge, wisdom and values" so that we can ensure society and ourselves a better future. Just as we began the new chapter of our lives on our first day of college, after graduation, we begin yet another chapter. Best of luck to all graduating seniors, and good luck with your future endeavors! WE

# TIME CLOAK

## Science Brings Magic to Life

## Researchers at Cornell make events invisible in time

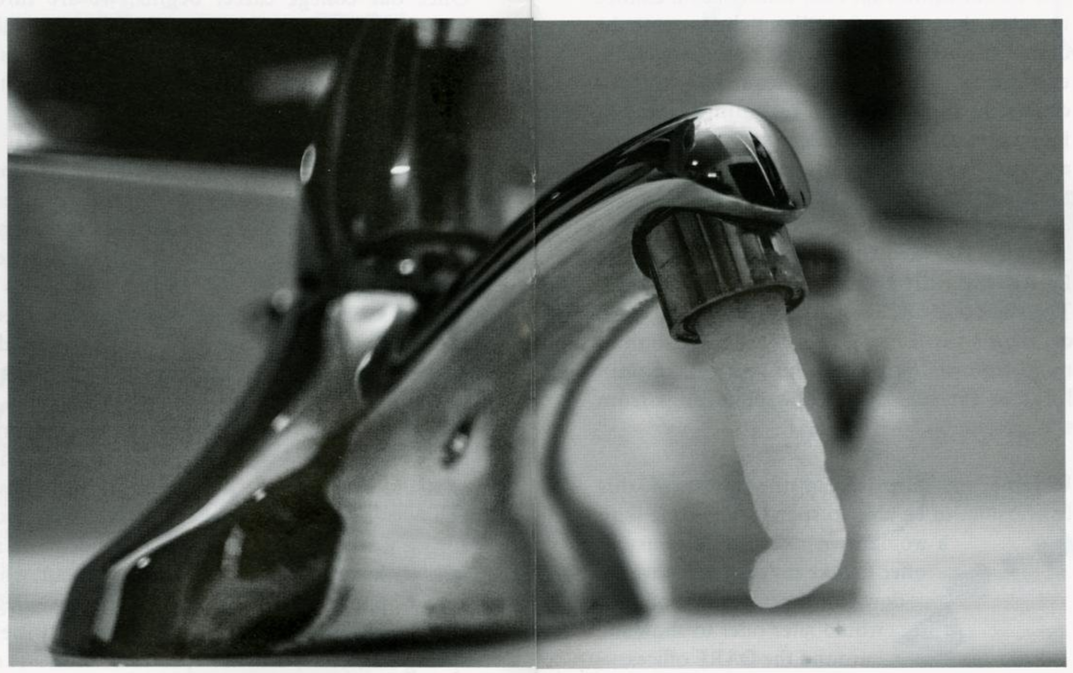
For Harry Potter enthusiasts, one of the most well-known magical devices is Harry's invisibility cloak, a resource he utilized in situations throughout the book series to escape danger. Scientists at Cornell University have been experimenting with different technologies in pursuit of making invisibility a reality. The research team of Yoshi Okawachi, Moti Fridman, Alessandro Farsi and leader of the group, Professor Alexander Gaeta, has come closer than ever.

Invisibility is not necessarily a 'new' topic of study. In the past, researchers experimented with bending light around objects in order to make them appear invisible in space, as the only way to see objects is from the light that bounces off of them. If one were to bend light around an object, it would seem as if the object was not even there. The researchers at Cornell did not experiment with bending light and manipulating its route. Instead, the variables they changed to 'create' invisibility were time and the speed of light.

**If something passes through a temporal gap in a beam of light, it will not be detected. The event will appear to never have happened.**

Professor of Theoretical Optics at the Imperial College of London, Martin McCall, initially published the idea of what is dubbed a 'time cloak'. He described how theoretically, one can create a 'temporal cloak,' or a sort of invisibility cloak by inducing a temporal gap in light. His theory required an immense amount of optical power, and at the time, there was no way of proving his theory. At Cornell, a team of researchers had already been experimenting with something called a 'time lens' and found that it was possible to apply Professor McCall's theory in an actual experiment, utilizing the lens.

"The whole experiment relies on the time lens," says Okawachi, a graduate research assistant for the team at Cornell. The time lens can be described in an analogy to a common optical lens, also known as a sptial lens. A spatial lens manipulates the way light diffracts and disperses through space. The same mathematics behind the spatial lens can be applied to a time lens, such that a temporal pulse in time is similar to the way light spreads out in time in a medium. "Sunlight through a magnifying glass gets very strong and focused on one point. Similarly, you can focus a temporal feature in different ways," says Okawachi. By changing the curvature of the time lens in a specific way, light can be either slowed down or sped up. The time lens initially slows a portion of the light and subsequently speeds it up, reconnecting the split beam. In the moment between decreasing and increasing the speed of the light, there is a temporal gap – a break in the beam of light. If something passes through that gap in the light, it will not be detected. The event will appear to never have happened.



Moving from theory to experimentation, a continuous beam of light passes through the time lens with a sensor on one end that detects disturbances in the beam. When the time lens is off, the sensor detects the disruption when a laser is sent through the beam. However, when the time lens is on, the sensor detects no disruption. In heist and crime movies there are often lasers that are set off if something passes through them. With the time lens, one could hypothetically walk through the time gap in the beam and be completely undetected. "It is like running across the street through a gap in traffic, but instead of traffic, it is a continuous beam of light you have to get through," says Okawachi. The event hidden from time only happens on the order of picoseconds, which is 10–12 of a second, so no one can actually 'run through the gap,' but with more research and more powerful equipment, the gap could be developed to become larger.

The applications of this technology are still pending. Some have said it could be a useful tool in computing – to insert and take out data without disrupting the continuous flow of information. "Since it is all so new, we cannot say much about what it can be used for," says Okawachi, "but the great part about science is that now, we have a concept. It is up to others to continue the research and find more uses for the technology."

In the experiment, the light is run through very small optical fibers, meaning the cloaking is happening in only one dimension. Cloaking an entire event is not currently feasible, but it is theoretically possible. As the technology continues to develop, it may be possible for an art gallery to be robbed in a time gap and not be detected by cameras, similar to events in movies like *Ocean's Eleven*. One moment Picasso's masterpiece is sitting peacefully in the museum and the next it is gone. Despite being far off from essentially deleting entire moments in time, the concept can only grow from here. "Usually scientists are the only people interested in experiments we conduct, but with the invisibility factor, it draws a lot of attention – even from the youth, which is always great to see," says Okawachi. "The next step is making the gap bigger and then going from there." In time, maybe even Harry Potter's invisibility cloak will become a technology of the past.

**Cloaking an entire event is not currently feasible, but theoretically possible.**

Written by: Charlie Duff
Photography by: Nate Hartung
Design by: Akhil Dakinedi

# Beyond Zydeco: The Future of DARE

***The Dictionary of American Regional English, containing more than 60,000 entries and ending with zydeco, published its sixth and final volume earlier this year, but for the researchers on the DARE project, the work has only just begun***

A civil engineer located in northeastern Ohio may need to know what the locals mean when they talk about the *devil strip*, a mechanical engineer in the southern Appalachians may need help if residents say his work is *antigodlin* and a construction crew in Maine may wonder how to find the *tote road*. Thankfully there is a resource, compiled right here at UW-Madison, to help all the above people know about the strip of grass between the sidewalk and the street, an object that is lopsided, askew or slanted, and a road used for transporting supplies to a remote work site. That resource is a six-volume set entitled the Dictionary of American Regional English.

The Dictionary of American Regional English (DARE) began as an idea to study the dialectal differences throughout the United States, first proposed by the American Dialect Society in 1889. After running a pilot program in Wisconsin in the late 1940s, Frederic G. Cassidy, a professor of English at UW-Madison, was made chief editor of the project in 1962.

The research began with 80 fieldworkers from UW-Madison traveling throughout the United States from 1965 to 1970. On their voyage around the country, they asked locals to respond to a questionnaire of over 1,600 questions covering everything from, "What hangs below the edge of the roof to carry off rain-water?" to what you call "a person who is thoroughly drunk." The results of the research make up a collection of 2.5 million responses, as well as audio recordings from over 1,800 people.

One of the unique challenges of this project was to visually represent the differences in American word usage and dialect in a way that could be easily compared. Cassidy and the DARE project team solved that problem by compiling the data and applying it to a map of the United States, which had been manipulated to reflect population density.

The publication of this project has spanned decades, with Volume I having been published in 1985. Cassidy oversaw the publication of the first three volumes of DARE, up to letter O, before his passing in 2000. After his death, Joan Houston Hall, who had been working as the associate editor on volumes II and III, was named chief editor of DARE. Hall has overseen the publication of the rest of the project, including Volume VI, which was released earlier this year. This final volume contains nearly 1,700 maps, an index by region, usage and etymology, as well as the full DARE questionnaire and the responses to many of the questions.

**The research makes up a collection of 2.5 million responses, as well as audio recordings from over 1,800 people.**


**Joan Houston Hall was named chief editor of DARE in 2000.**

Now that the complete set has been published, one would think that Hall finally has a chance to relax, but there is still much more to be done. "It's been a really hectic time," says Hall, explaining that the DARE team had finished digitizing all of the audio recordings from the interviews and was preparing them for internet access. The next step in the process is creating an entirely electronic dictionary.

Through Harvard University Press, the entire DARE text will be available online in 2013. The digital DARE will be searchable by word or region, will include all the distribution maps from the print versions and will contain links to the digitized audio recordings from the interviews.

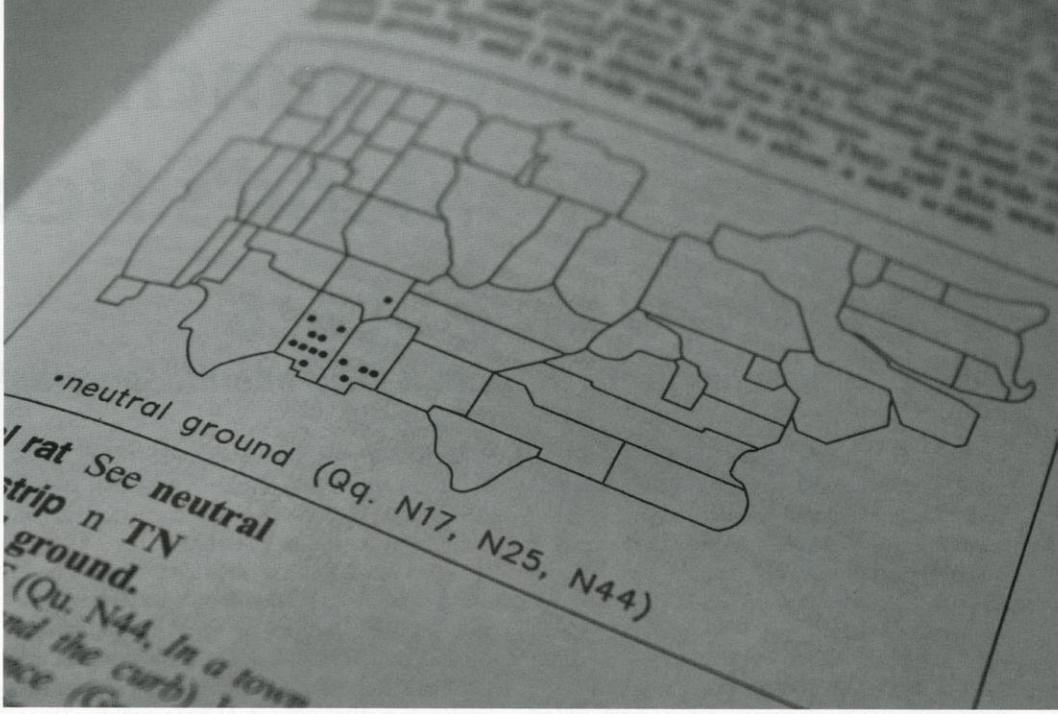
Imagine my surprise, in the midst of this conversion, to be able to spend some time with a woman who was not too busy to offer to take my coat when we sat down for the interview and who would later offer to show me around the DARE offices.

As I was escorted through the room containing all the research data, I noticed the labels on the sides of the paper questionnaires. Some of them were recognizable, "OK" for Oklahoma and "TX" for Texas, but others were not, such as "MG" and "MP." Hall explained that the preparations for data collection were made before the United States Postal Service created the two-letter abbreviations for the states. The DARE project team had to create abbreviations for the materials they would be collecting from states: so Michigan was called "MG" and Mississippi was designated "MP."

Although it may seem the project is complete due to the fact the final volume has been published, the original research was conducted long ago, and Hall asserts that an updated questionnaire is needed.

The DARE project team is currently hard at work making preparations for the digital edition. In addition, the team has already started working on a new questionnaire, as certain phrases did not exist or were not prevalent in the mid-60s. Examples of modern and updated questions include "what do you call the electronic device you use to change the channel on the television?" and "if you need to get some cash from a machine, you might say, 'I have to find a[n] [blank].'"

The method by which the responses will be gathered has been updated. The proposed new questionnaire, in a joint venture between the DARE project team and the UW Survey Center, will take the form of an online survey. The audio recordings taken from the face-to-face interviews in the past will become recorded phone interviews.




**The shape of the DARE maps are based on settlement history, and on population density as of the 1960s. The size of the states are skewed due to population but the general geographical relationship of the states to each other is maintained.**

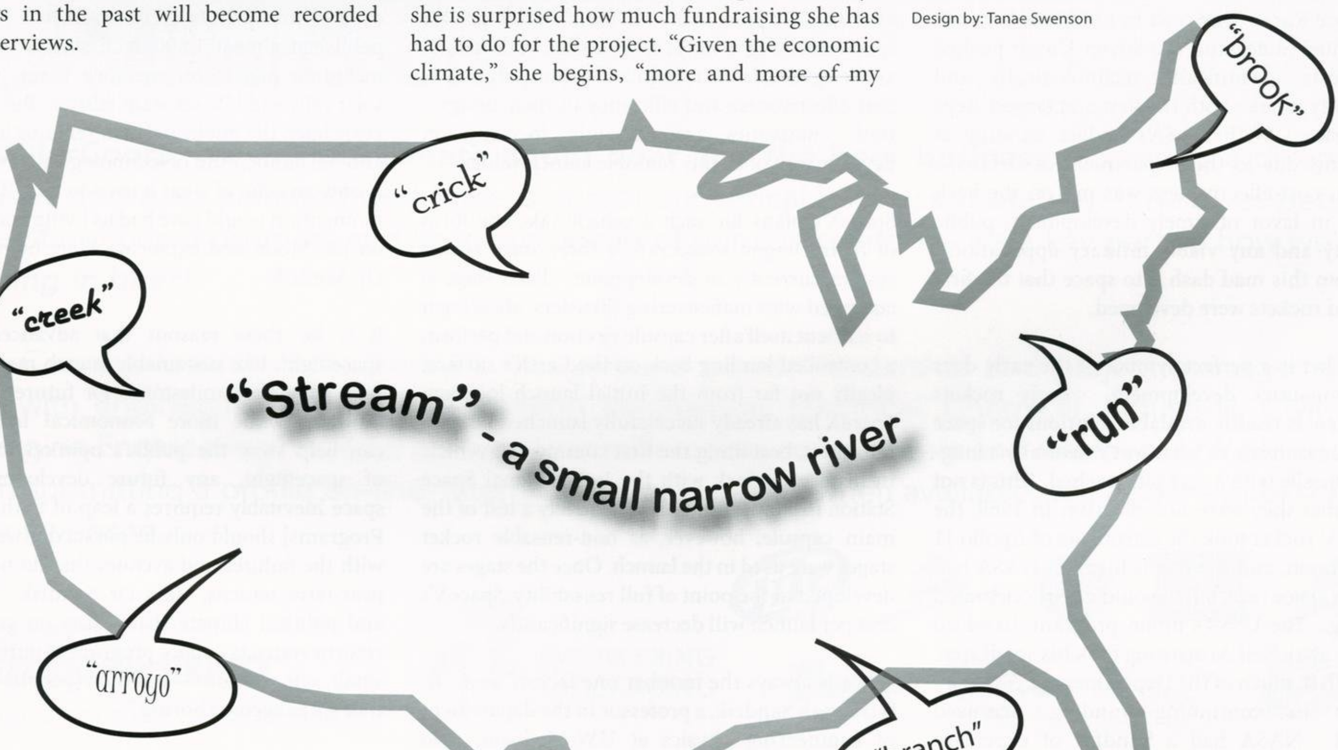
One would think that Hall—who was born in Ohio and lived in California, Idaho, Georgia, Oregon and Maine before coming to UW-Madison to work on DARE—would have heard it all, but she admits, "There are always things that surprise me."

While she was most certainly referring to the actual research, there are parts of the job, as chief editor, that she didn't anticipate. Hall says she is surprised how much fundraising she has had to do for the project. "Given the economic climate," she begins, "more and more of my time has had to go to finding financial support." Trying to raise funds anywhere they can, the DARE website includes a "Donate" button on the front page. You may even want to donate, because someday, someone may have a crow to pick with you, and if so, you'd better call a king's ex if you want to feel your keeping.

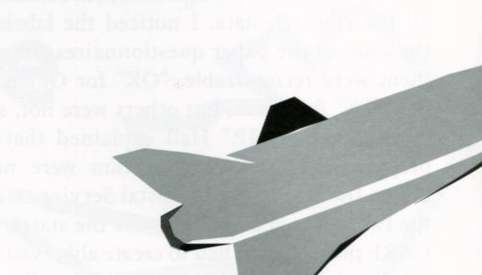
Written by: John Steeno

Photography by: Nick Lepak

Design by: Tanae Swenson



# The Reusable Launch Vehicle – Mankind's Next Step into the Stars



***Private companies begin the search for economic spaceflight***

Reaching outer space is not easy. To completely escape Earth's atmosphere and its gravitational influence requires a lot of effort in science and engineering. The raw power and economic investment required to send even the smallest payload into orbit is, quite literally, astronomical. Ever since the inception of the first space program, the race to find a better means to leave the Earth's surface has produced some of the most impressive technological feats humankind has ever accomplished. We are fortunate that the race continues today, with companies like SpaceX and Virgin Galactic announcing their plans for developing completely reusable launch vehicles. These new advances in launch vehicle technology will hopefully be the latest addition to mankind's illustrious fifty year history in spaceflight.

Ever since Russian cosmonaut Yuri Gagarin became the first human to leave the earth's surface and enter outer space, manned spaceflight has been a topic of science and speculation in global culture. One of the most iconic progressions of technology in human history took the form of the Space Race. This rush in the 1960s between the United States and the Soviet Union pushed the limits scientifically, technologically and nationally to take both the first and largest steps into space. With NASA's budget bursting at the seams due to the Department of Defense's interest, cost-effectiveness was put on the back burner in favor of timely development, public visibility and any viable military applications. It is from this mad dash into space that the first manned rockets were developed.

The rocket is a perfect symbol of the early days of astronautics development. Early rockets were seen as readily available solutions for space travel, amounting to what was essentially a long-range missile with a cockpit attached. This is not to say that they were not effective; in 1969, the Saturn V rocket took the astronauts of Apollo 11 to the moon, and the rest is history. NASA had won the space race, but it would not be celebrated for long. The USSR's moon program dissolved quickly after Neil Armstrong took his small step, and with it, much of the Department of Defense's interest in continuing funding dissolved as well. NASA had a handful of expensive technology to use and service without the means necessary to do so. Thus, "cost-effectiveness" was begrudgingly added to NASA engineers' vocabulary. This led to the development of the space shuttle, introduced in the early 1980s and used extensively for space missions, seeing regular use as a workhorse in the construction of the International Space Station in Earth's orbit. However, the use of the shuttle was not without drawbacks. The shuttle, along with its boosters, was reusable, but its massive fuel tank was discarded after each launch. Two shuttles, the Challenger and the Columbia, were lost in the continuing development of spaceflight. These high-profile and jarring catastrophes combined with an increasingly tight budget forced NASA to formally discontinue the shuttle program in 2011. Fortunately, mankind's taste for outer space was not lost.

Even before the discontinuation of the shuttle program, entrepreneurs like Elon Musk began to look into the commercialization of the space travel industry. In 2002, Musk formed the Space Exploration Technologies Corporation, known as SpaceX, in hopes of capitalizing on continued interest in space travel and exploration. Other companies, like Virgin Galactic, formed soon afterward. While many of their initial private spacecraft designs were rocket-based, both SpaceX and Virgin Galactic recognized the importance of cost-effectiveness and efficiency in their designs. Both companies are currently focusing on development of a truly reusable launch vehicle.

SpaceX's plans for such a vehicle take the form of their Dragon spacecraft, a three-stage rocket system currently in development. Each stage is equipped with maneuvering thrusters, allowing it to reorient itself after capsule ejection and perform a controlled landing back on the Earth's surface, ideally not far from the initial launch location. SpaceX has already successfully launched Dragon into orbit, becoming the first commercial vehicle in history to dock with the International Space Station in May 2012. This was merely a test of the main capsule, however, as non-reusable rocket stages were used in the launch. Once the stages are developed to the point of full reusability, SpaceX's cost per launch will decrease significantly.

"Cost is always the number one factor," says Dr. Suzannah Sandrik, a professor in the department of engineering physics at UW-Madison, who has worked on projects with NASA in the past. "The cost of recovering and reconditioning a reusable launch vehicle needs to be competitive with or better than the cost of building a single-use launch vehicle." This is especially true in the private sector of the space industry. While government projects can stay afloat for years in development when supplemented by taxpayers and other funding, individual companies and corporations must live by the balance sheet. Sending a vehicle into space and back again safely is a monumental task, with past manned launches pricing out in the millions of dollars per launch. The most economic and sustainable option is a launch vehicle that minimizes waste and operates as efficiently as possible.

Even with cost-saving measures, however, there are people who still doubt the usefulness of a space program, government-funded or otherwise. Even in the midst of the space race, support of a publically-funded space program was mediocre at best. People did not see the benefit of spending taxpayer money for what seemed to have little or no rate of return. In response, NASA began publishing the yearly journal *SpinOff*, which contains reports of many technologies developed by NASA, aerospace and otherwise, that have evolved into private sector markets. NASA has published almost 1,800 such stories since 1976, including papers on memory foam, improved solar cells and UV-resistant fabrics. But now, fifty years later, the public opinion remains lukewarm, and the momentum of technological development is only an echo of what it used to be. "That [past] momentum would have had us living and working on the Moon and exploring Mars by now," says Dr. Sandrik.

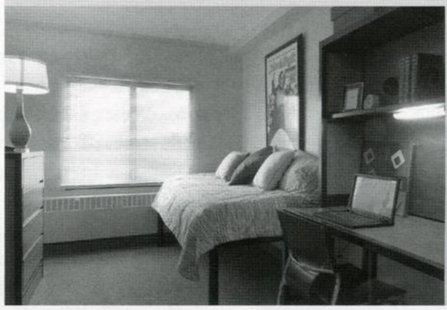
It is for these reasons that advancements in spaceflight, like sustainable launch methods, are such important milestones for future prospects; however, while more economical technologies can help sway the public's opinion in support of spaceflight, any future development into space inevitably requires a leap of faith. "[Space Programs] should only be pursued if we are okay with the failures and avenues that do not lead to near-term returns," says Dr. Sandrik. "A social and political climate that insists on guaranteed returns restricts a space program to pursuing only small, safe missions – and then [people] complain that it has become boring."

Perhaps sustainable launch vehicles will not turn the tide of public opinion overnight. Indeed, even with cost-effective solutions for space travel, it is expected that citizens will still lack the interest in space exploration necessary to refund NASA to more effective operating levels. But these reusable launch vehicles are certainly a start to, once again, boost public interest in space travel. Sustainability is the key to revitalizing technological developments into a second space race – only this time with dozens of companies on track instead of world powers. If that is indeed the case, then SpaceX and related companies have a strong advantage and are well on their way to victory where it matters most – on the balance sheet.

Written by: Richard Zuern

Design by: Sukhwinder Kaur





*Professor Profile:*

# Jake Blanchard

## *The chair of the engineering physics department talks fusion reactor design, micro machines and why you should have an internship*

Professor Jake Blanchard, chair of the engineering physics department, did not know what he wanted to be when he grew up. There were no engineers in his family, and as an undergraduate at UCLA, Blanchard did not so much discover engineering as it discovered him. "I did not know any engineers. I really did not know what engineering was when I went to UCLA. Most of the kids I hung around with were either in engineering or pre-med, and I didn't want to go into pre-med, so I kind of just picked something," says Blanchard.

**Professor Blanchard is very family oriented with more pictures of his children than technical accolades on his office.**

Blanchard gives the impression of being perpetually at ease. He drove to Wisconsin from West Los Angeles in the summer of 1988, one of the hottest on record, having accepted a faculty position in what was then the department of nuclear engineering. It was Blanchard's second time in the state, the first being his interview for the position several months earlier. For a native of southern California, Wisconsin's climate was something entirely new.

Originally from Orange County, Blanchard did not plan to spend his career in academia, or even in the Midwest. "I never planned to be a faculty member... it was the first time I had set foot in Wisconsin, to interview here, so I had no idea what I was getting into," says Blanchard. He was introduced to the position through a personal connection at UCLA almost entirely by chance. "He asked me if I was interested in the position, and I said, well, I'm willing to try anything."

Blanchard's professional history is a case study in serendipity. As a junior at UCLA, he was hired by a faculty member in nuclear engineering to perform curve fitting, perhaps one of the most tedious mathematical tasks an undergraduate can undertake. Opportunity knocked, however, and upon his graduation, Blanchard was offered a graduate position in the same lab, working more directly with the professor's research. Research assistantship turned into research fellowship, and despite briefly toying with the idea of entering industry after receiving his Master's degree, Blanchard found himself in for the long haul. A week after completing his Ph.D, he packed his life into a car and made for the great Midwest.

Blanchard is both typical and atypical of a professor in a sophisticated engineering discipline. He is not quick to speak, but has a casual diction which implies frankness that many faculty members in the college have yet to master. He is a family man and his office is filled with more pictures of his children than technical accolades. But he is a technical expert, and artifacts of his profession cover the shelves and conference table in his office. When he speaks of his work there is a latent excitement in his speech yet he maintains clarity and directness in his explanations.

The focus of Blanchard's work, like his connections with the faculty at UCLA and his arrival at UW-Madison in the heat of 1988, is as much the product of chance as design. Put simply, he designs fusion reactors. "We hope to someday build fusion reactors to make electricity. What I work on is the structural design of fusion reactors," says Blanchard. "It goes all the way back, to when I got hired as an undergrad for this professor in nuclear engineering." Although his focus during his undergraduate time was in mechanical engineering, Blanchard changed course and pursued nuclear engineering in his upper level work. "What I did for my Master's thesis, and my Ph.D., was kind of applying what I learned as a mechanical engineer to nuclear engineering," says Blanchard.

Much of Blanchard's work pertains to the structural and metallurgical aspects of fusion reactor design, often described as a pressing obstacle preventing the realization of a fully operational reactor. "There are issues like radiation damage...neutrons from the fusion reaction, they hit the materials and mess


**Blanchard's pin collection is a snapshot of his experiences since coming to Wisconsin. Pins from Russia, Canada, his Curling club and, of course, the UW-Madison line his board.**

them up pretty good, changing the properties. So that is what I did my Ph.D. on, and since coming here I have worked on stuff like that the whole time," says Blanchard.

Blanchard's second interest is micro machines, or more specifically, their power sources. "I have also branched out into different things. I would say the next biggest thing I work on is the design of these little power sources. The idea is, when radioactive materials decay, they emit radioactive particles. If you can convert that energy to electricity, you can make a little battery. There are dozens of ways you can do this conversion of the energy of that particle to electricity, and we have looked at several of these technologies to do that conversion, and our niche initially was small scale," he explains. In cooperation with faculty in the department of electrical engineering, Blanchard has assisted in the development of small scale power sources. "The advantage of these power sources is that they can be designed for a long life," says Blanchard, "so we can make these small scale power sources for [micro machine] devices and they would last decades."

The ability to divide his time between multiple research projects is one of the perks of UW-Madison, according to Blanchard. "It's been fun to branch out, you learn some new things. Not all universities do research the way we do... so that does open up the opportunity to interact with a lot of others on campus. For the kind of stuff I do, this is the perfect place to be."

When asked what advice he would have for undergraduates in engineering, Blanchard stressed the value of internships. "I think that these days, undergrads should be doing as many internships as they can do, and even be looking at co-ops. They help connect what we do in our courses to the real world, and students sometimes have a hard time making that connection." Blanchard has even considered making internships a requirement of the curriculum, although the likelihood of a sudden change anytime soon is unlikely. "I have toyed with the idea of requiring something like that, but we do not know how we would ensure every student a spot."

Professor Blanchard is a study in happenstance. Once an undergraduate without a plan, he now manages one of the principle departments in the College of Engineering at a Carnegie Tier 1 research university. The tale of how he converted a part time job with a professor at UCLA into a successful career in academia is one which could bring hope to an entire generation of undecided underclassmen. Blanchard, however, underplays the significance of this achievement.

In his words, "I kind of just fell into it." WE

Written by: Casey Sennott
Photography by: Sommer Ahmad
Design by: Xiaoshen Zheng

**Books on programming, rocket propulsion, and everything in between line Blanchard's shelves.**

# Green Cleaning in UW-Housing

## *How UW-Housing uses technology and innovation to save money and the environment*

As a cutting-edge research university, UW-Madison is proud to offer technology that makes life simpler and safer for its students. Laundry trackers that send email alerts when the washer is done, campus dining hall menus posted online and announcements that play on big screen televisions in residence hall lobbies are just a few of many advancements. Beyond these little conveniences, UW-Housing uses technology to protect the health of residents, including aqueous ozone, HEPA-filtration products and microfiber cloths. This is not the supplies list for a Chemistry 104 lab; it is the toolbox that hardworking custodians use every day, the future of clean.

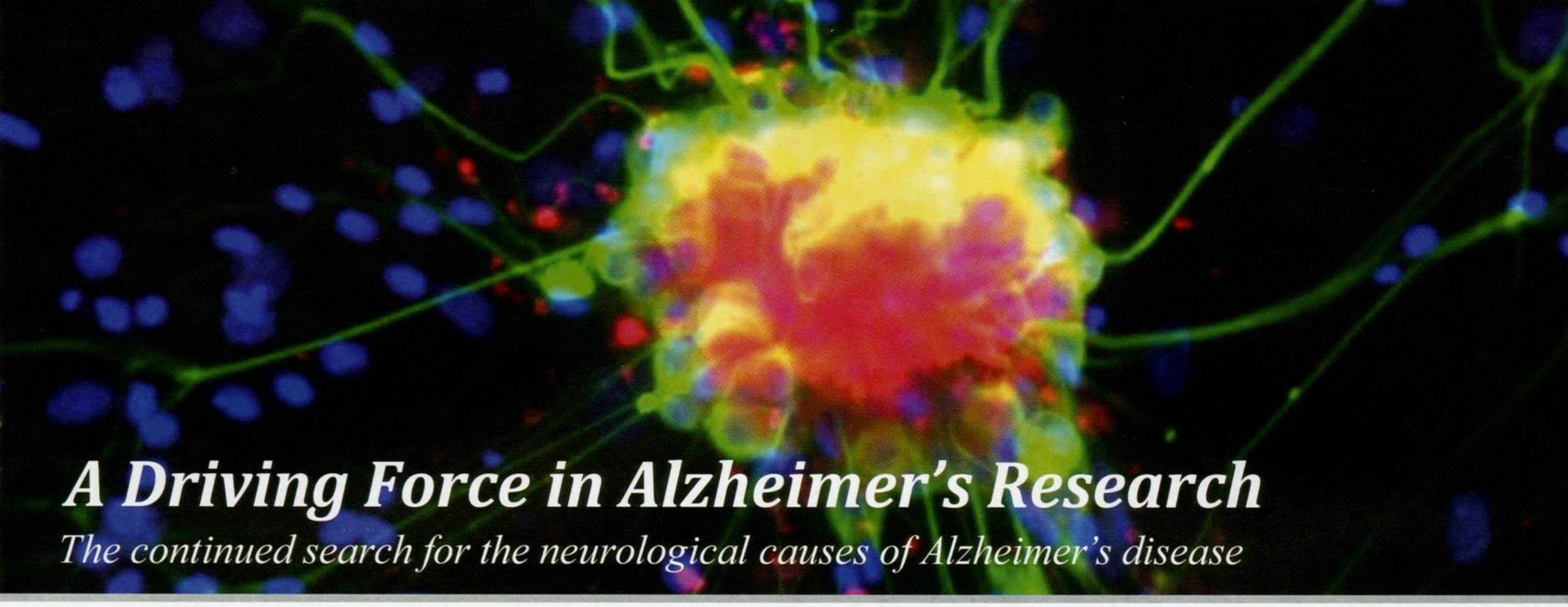
Aqueous ozone brings the fresh, clean smell of the outdoors after a thunderstorm to everyday cleaning. Lightning during storms naturally produces ozone; now, hand-held spray units, purchased through a collaborative effort between UW-Housing and the Office of Sustainability, change oxygen ($O2$) into ozone ($O3$) and then infuse the ozone into ordinary tap water. This safe, high-tech and essentially natural cleaning agent kills 99.9 percent of common bacteria, viruses and microorganisms in just fifteen seconds. By comparison, most traditional chemical disinfectants must remain on a surface for ten minutes to actually "clean" the surface. Carolyn Bell, the Assistant Director of Residence Hall Facilities and pioneer of green cleaning at UW-Madison Housing, says, "There is a lot of user error with a disinfectant; if you spray and wipe it, that is no different than using water and in some ways, it is worse because you are leaving a chemical on the table." By contrast, aqueous ozone disinfects without chemicals and the excess ozone converts back to oxygen, making ozone the safer choice for both residents and staff.

In addition, the green cleaning revolution focuses on cleaning smarter, not harder. University Housing utilizes microfiber cleaning cloths and mops while currently working to expand microfiber use. Microfiber reduces costs and limits the harmful side effects of chemical use by cleaning pathogens from surfaces mechanically, compared to just chemically. Microfiber mops give superior performance over traditional cotton string mops and have a lifetime of up to ten times longer. Another way of working smarter is to stop contaminants at the source by strategically placing matting at entrances. Products from the Waterhog Eco Elite brand used in UW-Housing consist of fibers made from recycled drink bottles with rubber backing, which is composed of fifteen percent recycled tires.

Federal regulations do require chemical disinfectants be used in restrooms and touch-points like door handles and stair rails, so using strictly "natural" cleaners is not possible. To comply with regulations while keeping the green goal in mind, UW-Housing primarily uses cleaners that are Green Seal or EcoLogo certified, meaning they pass inspection for being environmentally friendly products. The primary bathroom cleaner used on campus from Warsaw Chemical is made from edible sea salt. Furthermore, chemicals are purchased in concentrate and diluted, eliminating packaging waste in the process. UW-Housing recently began providing the same cleaning products to residents for their individual use.

**Article Continued online at wisconsinengineer.com**

Written by: Lori Bierman

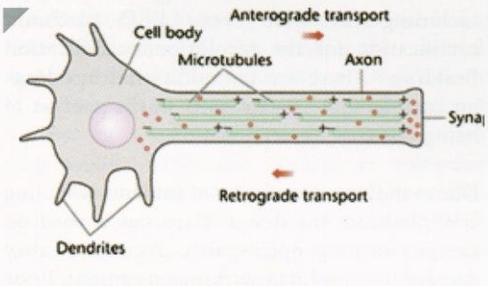


# A Driving Force in Alzheimer's Research

*The continued search for the neurological causes of Alzheimer's disease*

The first decade of the 21st century saw scientific and technological advances far-fetched for even the most imaginative science fiction plot. Stem cell researchers modified regular ink-jet printers to produce living human tissue and organs. Magnets were used to treat depression by sending tiny electrical currents to certain brain regions. Even the formidable threat of breast cancer may soon wane, as scientists have developed drugs dubbed 'smart bombs' that target cancer-aiding enzymes and dodge healthy cells. However, one disease still lingers in the shadows behind the glow of these extraordinary medical advances – Alzheimer's.

With 36 million people diagnosed with Alzheimer's disease worldwide, it remains the only top-ten cause of death in the United States that cannot be prevented, cured or even slowed. Alzheimer's is a neurodegenerative disease; it causes a deterioration of nerve cells in the brain that is irreversible and progressively worsens. Alzheimer's inflicts its victims with severe memory loss, impairs cognitive function, and ultimately leads to death. Scientists from an interdisciplinary array of fields seek to understand the biology, chemistry, physics and mechanics that Alzheimer's and other neurodegenerative diseases possess.




One such researcher is Jill Wildonger, assistant professor of biochemistry at UW-Madison. Professor Wildonger leads novel research to understand our nervous system at the level of individual neurons. Specifically, her lab focuses on the role of microtubules and motor proteins involved in neural signaling.

Microtubules are long, hollow cylinders built from a globular protein called tubulin. Neural cells have a cytoskeleton composed of microtubules, which not only give the cell structure but also serve as a highway for protein transport. The vehicles that actually carry the proteins, however, are the motor proteins dynein and kinesin. These motor proteins drive along the microtubule cytoskeleton, delivering proteins and organelles to either the neuron dendrites or to the synaptic terminal (see figure below).

Protein trafficking is critical in nerve cells because specific proteins must be present at their designated site in order to regulate the signals received and sent by the neuron. As a result, Professor Wildonger is interested in how dynein and kinesin navigate the neural highway system. "These motors don't have eyes, so how do they know whether they are at the axon or the dendrites?" she inquires.

Based on her research, Professor Wildonger hypothesizes that these two motor proteins respond to molecular changes to tubulin that occur after the protein is made. These changes are referred to as post-translational modifications (PTMs), and include the dynamic addition and substration of special functional groups such as phosphate or acetyl, by enzymes. The axon and dendrites have different levels and types of PTMs. These chemical differences likely act as sign posts that direct dynein and kinesin to their desired destinations. As she begins to understand the effect of PTMs on motor protein function and response, Professor Wildonger's next question was only logical: given the importance of dynein and kinesin, what happens if the PTMs are changed and the motor proteins break down? "If proteins are mislocalized or are not present where they should be in a nerve cell, it is likely that this will result in decreased neuronal function and contribute to neurodegeneration," Professor Wildonger says.

Without specific PTMs, Professor Wildonger hypothesizes that dynein and kinesin cannot distinguish between the two ends of the neuron; their highway system no longer has signage. Without correctly functioning motor proteins, signaling proteins are driven to inappropriate locations. The neuron will then be unable to signal within the nervous system network. Such defects disrupt critical processes such as the formation of distinct layers within the brain and the development of brain folds called "gyri." Classical lissencephaly (lissencephaly literally means "smooth brain") is a brain formation disorder that results in undeveloped brain folds and is associated with abnormal motor activity. Children with lissencephaly suffer from severe neurological impairment and often die shortly after birth.

Fortunately, scientists like Professor Wildonger are gaining significant insight into the causes of neurological pathology. Her research has vast implications for understanding and treating neurodegenerative diseases such as lissencephaly and Alzheimer's. Her lab uses modern genetic engineering techniques to manipulate the nerve cell DNA to code for different PTMs. She performs these experiments in vivo, or inside living animals, and employs live-cell imaging techniques to observe how the motor proteins respond to these chemical changes.

A comprehensive understanding of the microtubule development and PTM-motor protein interactions will open a vast realm of possibilities for drug targeting and other treatment. Perhaps the next decade will boast of one of the greatest advancements yet: a cure for Alzheimer's. WE

Written by: Alice Huang

Design by: Bo Zhang

# A Master Plan for UW-Madison's Future

Over the years, UW-Madison has built many structures to be proud of. In an effort to continue a rich tradition of excellence, Daniel Okoli, the University Architect, and a group of designers created the UW-Madison campus master plan. The plan aims to renovate, expand and construct sustainable buildings and quality open spaces in an effort to create a place where both students and faculty experience high achievement and enjoyment.

Due to the rapid growth of the UW-Madison campus after World War II, many of the buildings on campus now need to be renovated, expanded or completely rebuilt. For example, within the next two years the Chemistry, Babcock Dairy and Meat Sciences buildings will undergo the needed renovations and/or expansions due to their heavy use. In total, the renovations will cost approximately $179 million. In addition, future projects that are being discussed, yet have not achieved full funding, include a new music and performing arts facility located to the east of the Chazen Museum of Art and renovation options to Sellery and Witte, among other residence halls.

UW-Madison's campus design team, lead by Okoli, created the current master plan for campus renovation and development in 2005 in order to meet the needs of the aging infrastructure. When first creating the 2005 master plan, the team recognized it was imperative for them to evaluate each building on campus, new or old, individually as well as within the campus as a whole. With the future of the campus in mind, the team identified seven broad goals for project: sustainability, community, academic and research connections, student life, buildings and design guidelines, open space and transportation and utilities.

A campus master plan, however, is not a static concept map; it is quite flexible. Many of the buildings on the original master plan of 2005 had outcomes that differed from their depiction in the original design. In addition, not every building renovation will be completed by the time the next master plan is released. According to Okoli, the current master plan will be reevaluated in 2015, with an extra emphasis on the landscape of UW-Madison. At that time, what has been left unfinished from the 2005 plan will be reevaluated.

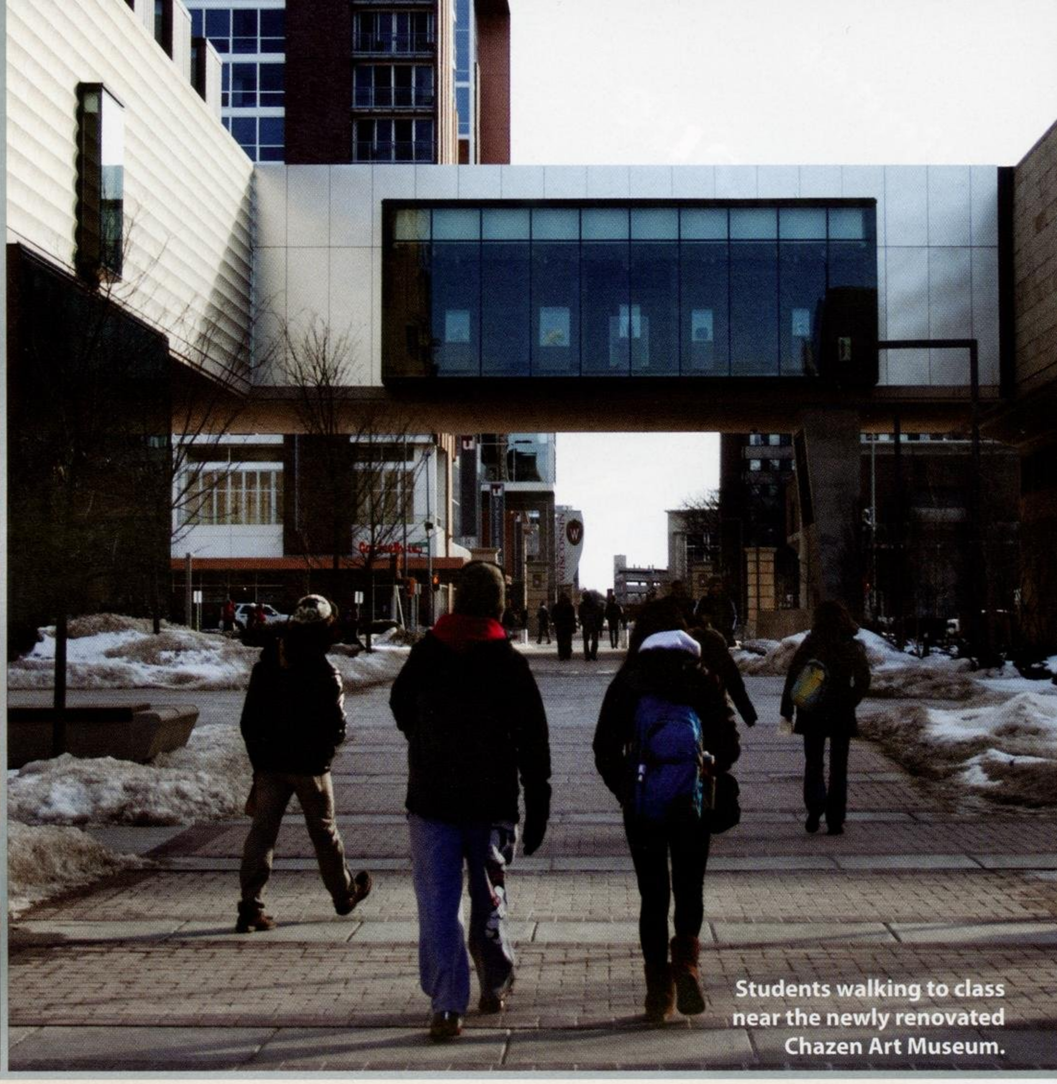
Sustainability was a major component of the discussions surrounding the campus renovations. The sustainability conversation included aspects like storm water management, energy use reduction and improvements in indoor air quality, which were assessed extensively. Also, in order to create a sustainable campus, it was important to reduce costs by purchasing materials from local suppliers, recycling unused materials and reusing old materials that were still functional.

Leadership in Energy and Environmental Design, or LEED, is an internationally recognized green building inspection program that awards buildings with a certain level of certification based on their environmental impact, or the lack thereof. Okoli says that when designing buildings, the design team "chases sustainability and the LEED certification follows." In other words, the certification is merely the reward of a well-designed building.

As a result of reaching the sustainability goals, UW-Madison has received LEED certification on a total of four buildings on campus, including the first ever LEED platinum certification for the revolutionary Education Building. There are ten additional buildings on campus that are currently in the process of being assessed for certification.

Due to the large population of students attending UW-Madison, the design team saw a need on campus for more open spaces. As a result, they decided to consolidate parking on campus. Prior to the master plan, 97 acres of land on campus were devoted to parking. In the 2005 plan, the design team called for a reduction of 20 acres of land that were devoted to parking by converting it to open spaces. To compensate for this, many parking structures were built in years following the 2005 plan.

The rubble next to the new Gordon Commons will soon be transformed into an open green space.



Students walking to class near the newly renovated Chazen Art Museum.

In the upcoming year, phase one in the renovation/ expansion project of Memorial Union will conclude. Phase one has primarily focused on the addition of a new theater wing and the renovation of the entire western side of the building. In the next three to five years, for phase two, the construction shifts to the east side where the interior will be renovated and the outdoor space will be changed. The loading dock will be moved underground, allowing the space above to be converted to an open space called Alumni Park. Alumni Park will serve as the ultimate culmination to East Campus Mall and will overlook Lake Mendota.

Creating such a magnificent space that overlooks Lake Mendota, while still keeping the essential loading dock, is an example of how Okoli's team of architects and engineers have revolutionized the use of space. Such a design epitomizes sustainability while also creating an enjoyable park that enhances the experience of the UW-Madison campus. This is just one example of future green spaces that will begin to surface all around campus. In a project currently in progress, similar to Alumni Park, a new green space is currently being added alongside the new Gordon Commons Dining Hall.

One of the most difficult steps when creating the plan was deciding what buildings needed to be added and which ones needed renovation and/or expansion. With the future in mind, the design team generated an idea for a building that did not belong to any particular department. Strategically located among buildings heavily geared towards science on campus, the Wisconsin Institutes for Discovery has quickly become the epitome of future building design. This building provides a place for both professors and students of various disciplines to come together and work in harmony.

The world around us is changing every day, and as a result it has become increasingly important to conduct interdisciplinary research. This tendency toward interdisciplinary work has been aided by design experts like Okoli that believe in the future of education. Constructing facilities like the Wisconsin Institutes for Discovery enable learning and collaboration that may not have been possible before. The evolution of UW-Madison research, for that reason, will remain ahead of the curve for years to come.

By updating and maintaining campus buildings, the learning environment is improved for all current and future Badgers. Conveniently located across the street from the Wisconsin Institutes for Discovery, Union South offers a wide array of food and entertainment options as well as study spaces and large rooms for banquets and meetings. Creating multifunctional spaces where students, faculty, alumni and members of the community want to spend their time accomplishes many of the plan's original goals.

UW-Madison has constructed, and will continue to construct, renovate and expand, buildings that are increasingly sustainable. The increasing sustainability of each building ensures that UW-Madison will withstand the test of time. Open spaces serve as the perfect oases for students and add beauty to the campus, something that will also be considered in the next master plan. By revolutionizing the expansion of our campus, UW-Madison creates an environment that enables current and future Badgers to continue the rich tradition of excellence alumni have bestowed onto the university. WE

Written by: Justin Alt

Photography by: Alex Steinhauer

Design by: Tom Bernath

Winner
Landscape

# Terraced Fields

Michelle Bay

This photo was taken in Sapa, Vietnam while walking among the rice terrace fields with the Hmong people. Vietnam was one of the most beautiful places I have ever been and cannot wait to go back and experience it again.

Winner
Portrait

# Day at the Beach

Lauren Lynch

This photo was taken outside of Ghiradelli Square. Despite the brisk spring weather, there were several young children playing in the sand.

SIXTH ANNUAL PHOTO CONTEST

# Reflections in the Lake

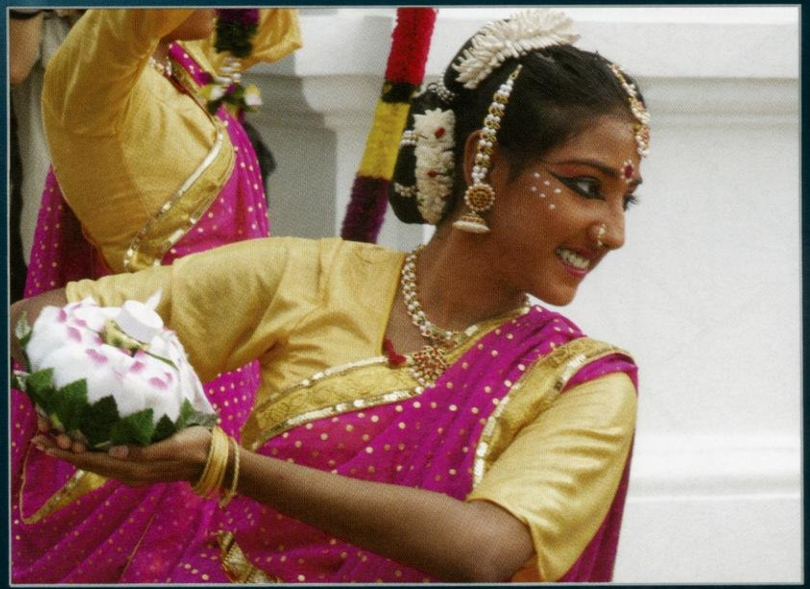
Muhammad Shoaib Bin Altaf

Taken during a visit to Milwaukee city. The reflections of trees and buildings looked so cool.

LandScape
Runner Up

# Deepavali Dancer

Michelle Bay



This is an Indian dancer performing at the President's house in Singapore to celebrate Deepavali. Deepavali translates into "row of lights" and involves the lighting of small clay lamps filled with oil to signify the triumph of good over evil.

Portrait
Runner Up

SIXTH ANNUAL PHOTO CONTEST

Winner
Still Life

## The Balloon Ride

Muhammad Shoaib Bin Altaf

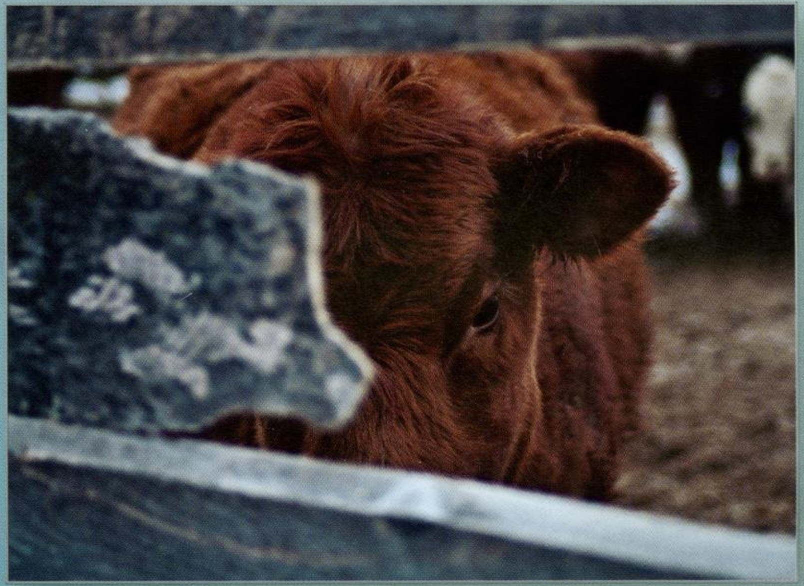
Taken during the annual Balloon rally in Austin, Texas during the summer.

Winner
Miscellaneous

## Shy

Hailee Von Haden

As I was photographing a farm in Baraboo, WI, this cow came right up to me, almost looking to come and play or get out of the fences. But the cow's demeanor was like a shy little child. It made me want to let it out and really created a relatable personality.

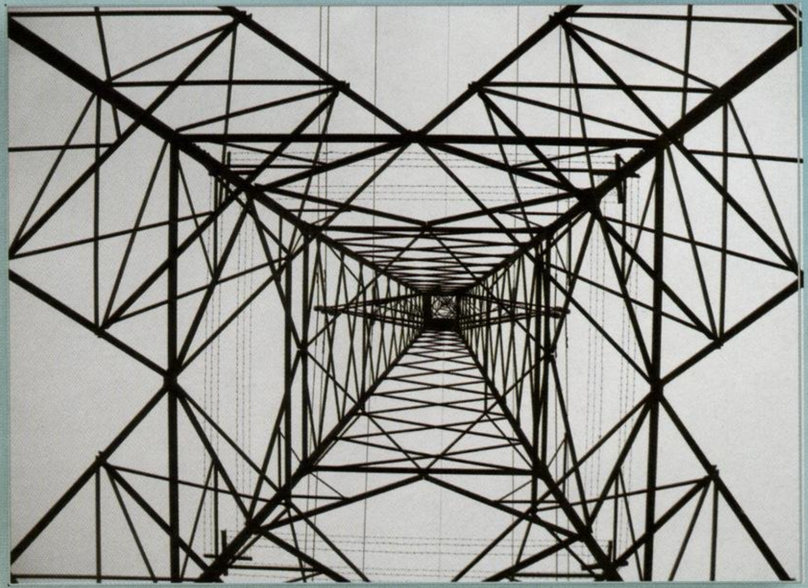


Still Life
Runner Up

## Tower Lines

Kyiaki Chatzikyriakidou

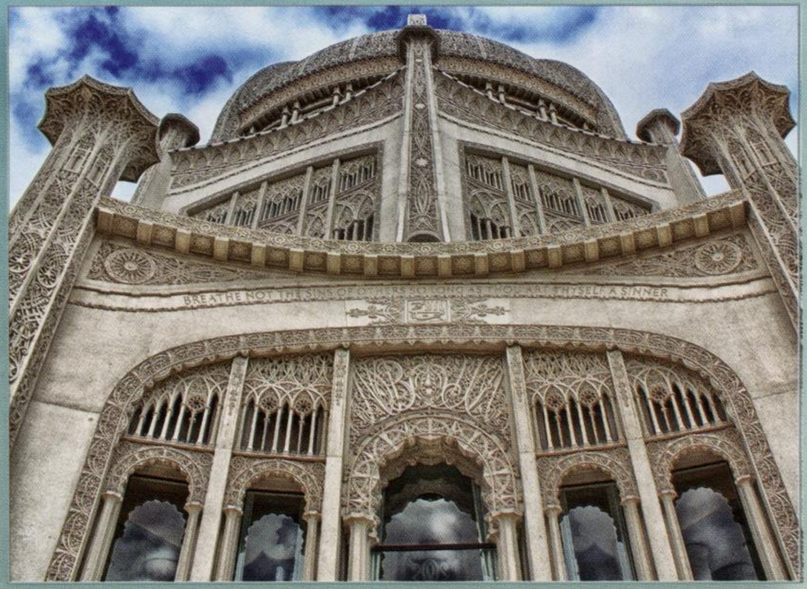
When I saw the sunset taking place behind the tower, while I was driving by, I took my camera out and captured this photo. A close-up of an electric towers, has always been something interesting to me, as it makes it enormous and superior to human, even if it is built by them.



Miscellaneous
Runner Up

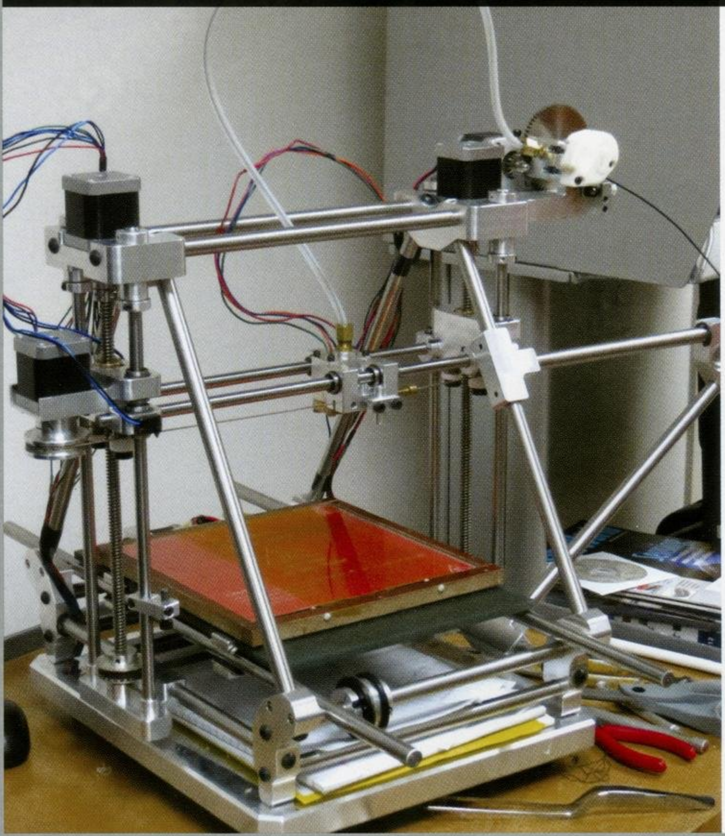
## Bahaei's Temple

Mehdi Maragheh



Last week, on St. Patrick day I went to Chicago to visit one of my friend. After parade we had a lot of time. We went to Wilmette city and visited Bahaei's temple, such a wonderful architecture that I've ever seen. The Bahá'í writings state that human beings have a "rational soul", and that this provides the species with a unique capacity to recognize God's station and humanity's relationship with its creator.

Design by: Yuli Liu & Cara Sandlass



# The Gateway into the Future of Design

*A look into the 3D printers at UW-Madison and what the surrounding area offers to aspiring designers*

What is one of the most unproductive things an engineering student can do in the five minutes before class starts? Opening up Facebook or Twitter may seem like obvious answers. However, a search for "3D printing" will return a plethora of fascinating articles, making this choice the best tool for procrastination. It is not difficult to become absorbed in an article featuring plans for 3D printing on the moon using lunar dust or the University of Tokyo's work on printing customized replaceable bones. Incorporating 3D printing into design has become a facet of research labs, design studios, hackerspaces and home workshops over the past decade. It is no surprise that 3D printing is predicted to become a $3.1 billion dollar industry by 2016 with all of the applications this manufacturing process offers.

When computer-aided design (CAD) was invented in the 1980s, the invention of rapid prototyping soon followed. This technique allowed designers to create physical parts generated from digital models in a fraction of the time that standard manufacturing required. The first 3D printer was patented in 1993 by MIT professors Michael Cima and Emanual Sachs. Their design introduced the ability to create 3D models made from ceramic, plastic and metal using additive manufacturing to produce parts layer-by-layer.

Multiple types of 3D printers evolved from this initial design, with models designed for both commercial and domestic use. The printer that a designer uses depends on the desired printing material, the cost of the machine and the accuracy of the printing method. The most popular types of 3D printers are explained below, as well as their locations in the Madison area.

## Stereolithography

**Viper si2**

*Morgridge Institute for Research-Medical Devices Lab*

This high-end 3D printer uses stereolithography to print parts with extremely accurate detail. The machine works by polymerizing a 0.02 – 0.1 mm thick ultraviolet photopolymer resin onto a base and curing this layer with a UV laser. Once the liquid resin solidifies, the base plate sinks down and the next layer of resin is added on top.

## Selective Laser Sintering

**Z corporation Z310**
*UW-Madison Mechanical Engineering Advanced Manufacturing Laboratory*
**Z corporation Z406**
*Morgridge Institute for Research- Medical Devices Lab*

A SLS machine creates a part by fusing together ceramic powder particles with a high-powered laser. This is done by directing the laser at a bed of powder that has been heated just below the powder's melting point. The laser heats up the powder to the melting point at selected points, forming a layer of fused material. Once this layer is complete the powder bed moves down in the vertical direction and another layer is fused on top by the laser. This is done until the final ceramic part is complete.

## Fused Deposition Modeling

**Dimension Elite 3D Printer**
*UW-Madison College of Engineering Student Shop*
**Stratasys FDM 1650**
*UW Mechanical Engineering Advanced Manufacturing Laboratory*
**Ultimaker and Makerbot Cupcake and Replicator**
*Sector67*

A Fused Deposition Modeling (FDM) machine works by feeding a plastic filament into a nozzle where it is heated to its melting point and then injected into a base. By keeping this base stationary and moving the nozzle in the x and y-directions, the machine is able to print a 0.04 mm thin layer. Once this layer is complete the base moves down in the vertical direction and prints the next layer. More expensive FDM machines, such as the one in the Student Shop and UW-Madison Mechanical Engineering Advanced Manufacturing Laboratory, have the capability of printing with two materials. Acrylonitrile Butadiene Styrene (ABS) is used for the prototype material, but the machine also offers the capability of printing a support structure from a water-soluble material. Once the part is complete this material is dissolved in a sodium hydroxide bath, resulting in a more complex final part.

For students that are interested in incorporating 3D printing into their design projects, the UW-Madison College of Engineering Student Shop can print low-cost parts from student's CAD models. Another way to gain experience with this manufacturing process is to take Mechanical Engineering 514: Rapid Prototyping and Advanced Manufacturing. This course is taught by Professor Xiaochun Li and gives students the opportunity to work in teams to design and print their own parts in the Mechanical Engineering Polymer Lab. Professor Li's enthusiasm for rapid prototyping has inspired students to make parts ranging from a beer gun to multi-level high heeled shoes. He defines this process as "speeding up the creative idea to the model" and emphasizes how manufacturing processes can be reduced from three to six months to only a few hours with rapid prototyping.

Sector67 offers another option for designers in Madison that would like to create their own prototypes at a low cost. By buying a monthly membership, one will have access to a wide assortment of machines, including the FDM 3D printers listed above. This workspace would also be beneficial for a designer that is interested in buying or building a personal 3D printer and would like to test out some of the options available to consumers.

For designers in the Madison area, there are many ways to gain experience with 3D printing. With the rise of this prototyping method in multiple sectors of production and design, learning this skill is an asset for engineering students and local entrepreneurs who are interested in remaining competitive in today's market.

Written by: Kate Slattery
Photography by: Ruihao Zhu
Design by: Ashley Bauer

# Radioisotopes: Not the dangerous materials you might think they are

## *A look at Molybdenum-99 and how the Morgridge Institute for Research wants to manufacture it*

Though the price of nuclear power is currently having a tough time competing with prices for electricity with natural gas, advances in another practice of nuclear science are still in high demand. As more uses for radioisotopes such as Molybdenum-99 are found in medical diagnostics, funding and research are being shifted across the globe to keep up with the demand for these radiopharmaceuticals.

Finding new ways to efficiently and safely produce these materials is a great concern. The Morgridge Institute for Research (MIR), UW-Madison's College of Engineering and SHINE Medical Technologies are working in collaboration to create a process that will produce Molybdenum-99 in a safer, more efficient way within the United States.

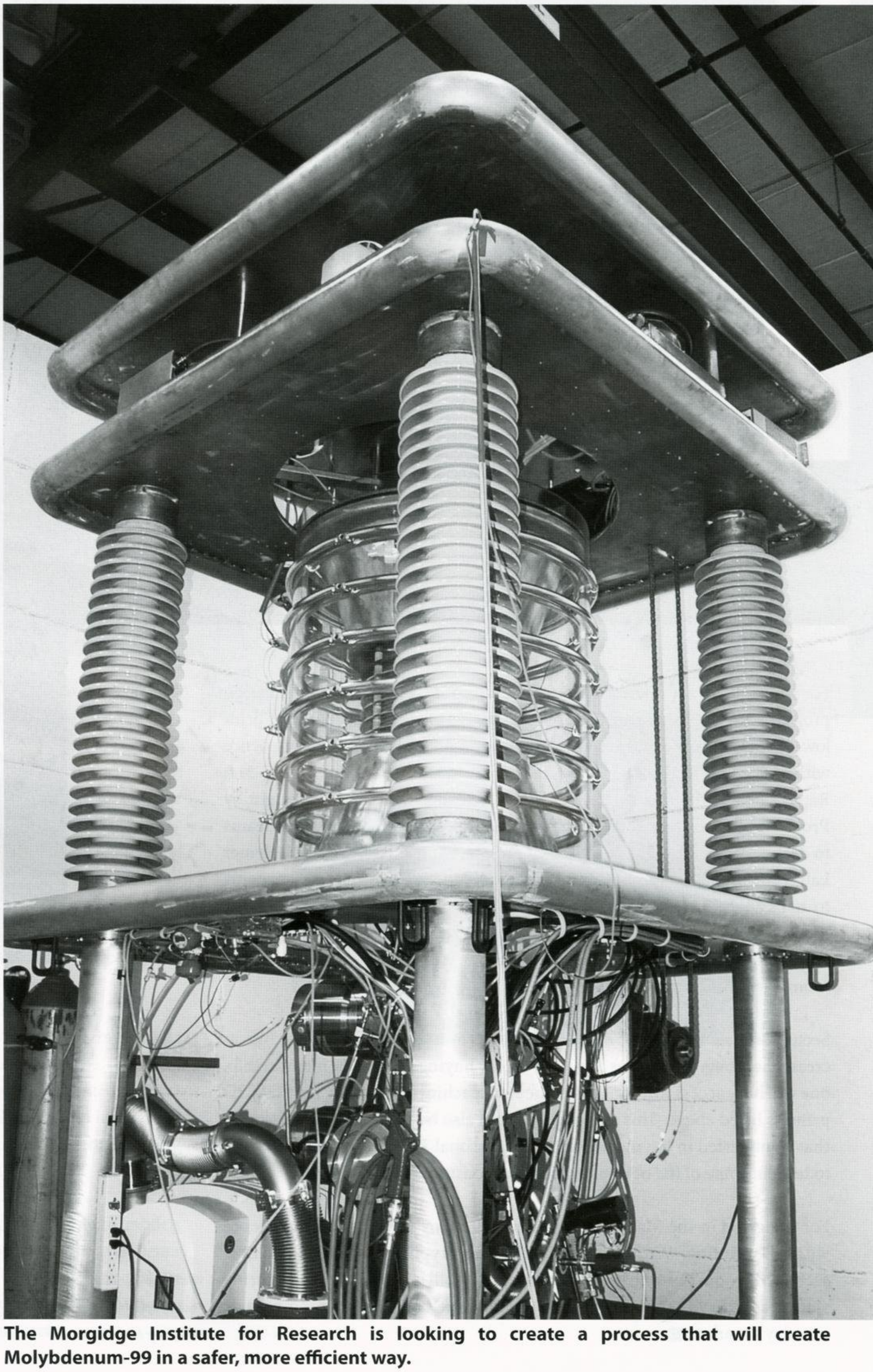
To obtain an appreciation for why this research needs to happen, one must first understand the science behind the medical application of radioisotopes. Radioisotopes are used on a daily basis for diagnosing cardiac disease, cancer and other life-threatening complications. They are placed in the body, either as small capsules or in a liquid form and can be traced using radiation measuring equipment.

After the procedure is finished, the remaining radioactive substance naturally decays with no harm to the recipient. Doctors around the globe perform this type of procedure thousands of times a day, so naturally there is a high demand for these radioisotopes. The production of Molybdenum-99 (Mo-99) helps satisfy this demand.

Radioisotopes are the products of irradiation, which is the process where nuclei are bombarded by subatomic particles. They are also found in the products of fission, or the splitting of an atom, typically performed for the production of nuclear power. These radioisotopes will eventually become stable through radioactive decay, which is governed by what is known as its 'half-life,' the time required for half the amount of radioactive substance to decay and reach stability.

Usually, radioactivity is dangerous and should be avoided when possible; however, in correct dosages, it can be used to destroy cancer cells when the body is incapable of doing so. When a radioactive isotope has a fast half-life, such as Technetium-99m (Tc-99m), which forms from the decay of Mo-99, it can be placed in the body to pinpoint areas of concern, and it also quickly stabilizes.

Tc-99m is used in diagnostic procedures because it decays to an inert and very stable isotope. Its very



**The Morgidge Institute for Research is looking to create a process that will create Molybdenum-99 in a safer, more efficient way.**

short half-life of approximately six hours makes it a great material for usage in medical practice, but it is nearly impossible to transport without losing the majority of the useful material. About 90 percent of the initial quantity will decay in just 24 hours. The parent nuclide, or nucleus that decays into Tc-99m, is Mo-99, which has a much longer half-life of about 66 hours, making it easier to transport. In addition, it decays into the material that is desired instead of a stable, useless isotope. Tc-99m emits gamma rays while decaying with the energy equivalent of standard x-ray imaging equipment, but since it decays so quickly, the patient's total radiation dose is kept quite low and with no intentional harm.

The driving force behind the research into new ways of producing Mo-99 stems from three different factors: the reactors producing most of the world's Mo-99 are going offline in the next few years, domestic production would make the supply more reliable, create jobs at the production site and allow the production to steer away from using weapons-grade Highly Enriched Uranium (HEU) to safer, cheaper Low-Enriched Uranium (LEU).

Right now, the majority of the world's Mo-99 is produced in just a few nuclear power plants in Canada and the Netherlands. In these nuclear power plants, Mo-99 is produced through the fission of HEU in nuclear reactors, and then retrieve the Mo-99 after a designated period of time. However, these plants are reaching the end of their operational lives and will soon be offline, cutting off almost all of the world's supply.

Currently, the Morgridge Institute for Research is trying to find a way to eliminate the need for an entire reactor array, allowing Mo-99 to be produced under more efficient and financially reasonable conditions. This would remove power plants completely from the picture and bring the production into the United States, creating a domestic supply.

**Doctors around the globe perform this type of procedure thousands of times a day, so naturally, there is a high demand for these radioisotopes.**

Domestic production is an important aspect of radiopharmaceuticals because if the products are closer to the user, less material will be wasted during transport. A domestic supply of Mo-99 would also create jobs in nearby communities, as SHINE has decided to build the plant that will produce this Mo-99 in Janesville, Wisconsin.

Having a domestic supply will also allow United States markets to have more control over the distribution of the resource. Since the only large producers of Mo-99 are Canada and the Netherlands, demand may go unsatisfied due to unforeseen complications with the reactors being used, making the current supply chain extremely volatile and unreliable. Domestic production would almost completely remove the possibility of a shortage, meaning every procedure that relies on Tc-99m, and subsequently Mo-99, would almost never be postponed or cancelled, as written in "Iridescent Innovations" from the September 2011 edition of the magazine.

The last piece of motivation for this research is switching from using HEU to LEU. Naturally occurring uranium (U) consists of U-238, a relatively safe isotope of uranium, and U-235, the isotope that drives fission in most conventional nuclear reactors. When the concentration of U-235 is increased from the natural 0.71 percent to above 20 percent, the uranium becomes HEU and it is easier to cause fission; however, this also creates a potential security problem as the enriched uranium can be used in a nuclear device.

There is a fair chance that most people know someone who has gone to the doctor for a diagnostic procedure requiring Technetium-99m, the product of Molybdenum-99. Thanks to the nuclear science behind these radioisotopes and the ability to apply these materials in the medical field, many life-changing procedures are made possible. Due to the efforts of SHINE, the College of Engineering and the Morgridge Institute for Research, a way of producing Molybdenum-99 that is safer and more reliable may be right around the corner. WE

Written by: Nathan Vogel
Photography by: Adam Dircz
Design by: Ryan Butler

# The Future of Print

***With eBooks gaining popularity, will printing companies become a thing of the past?***

In 2007, the world's largest online retailer, Amazon, released the Kindle – the first electronic device that allowed users to carry a library worth of electronic books (eBooks) on the go. It sold out in five hours. In 2009, Apple revealed the first generation iPad, which sold over seven million copies in its first year of production. With trending books available electronically at the click of a button, is the printing industry doomed?

This looming question has been the subject of discussion and debate since the release of electronic devices that provide users with a plethora of print materials on the go. Companies in the printing industry have hired scholars to analyze this question, and a quick online search will return hundreds of results with printers, publishers, readers and writers all weighing in with their opinions on the future of newspapers, magazines and books.

Greg Downey, a distinguished professor and director of UW-Madison's School of Journalism and Mass Communication, is a leading scholar researching and writing about the evolution of communication and technology. As the future of the industry is linked intricately to the students studying under him, Downey leads a graduate seminar course focused on the debate of the future of print.

Before engaging in discussion about the fate of print, Downy is quick to remind his students that, "print does not just mean books and magazines, but it is all types of materials – handouts, fliers and instructions. Once that gets taken away, people again realize the importance of printed materials."

Among articles and internet blogs, it is not widely predicted that the printing industry will disappear. The general consensus is that the problem is not that people are no longer reading or reliant on printed materials, but that the printing industry has not yet figured out how to adapt and evolve with the electronic environment. Without electronics to provide competition, few people thought to analyze the value of print simply because it was the default medium for communication.

The printing industry has seen a drastic decline in its share of GDP in the US market. In 1993, the printing industry was worth $176.2 billion dollars in the United States. By 2009, it was worth only $88.2 billion dollars. Electronic reading, on the other hand, has increased in popularity. In mid-2010, it was estimated that eBooks represented over eight percent of book sales, up from three percent in 2009. Although the increase of the percentage of eBooks accounting for book sales is not expected to sustain this trend of growth, it is expected to continue to see an increase of its share on the market.

To take advantage of this trend, printing companies need to rethink and define what it means to be a "printing" company.

Downey, while leading a discussion about the contrasting characteristics of a printed book

**Students discuss the future of print in a round-table lecture with Professor Downey.**

and eBook and their implications on readers, took one of his student's paperback books, tossed it around in the air to demonstrate its physical presence, and asked a simple question, "Why do you trust this book?"

Looking around the room, Downey answered his own question: "You could argue that books are better than electronics because they warrant the knowledge as well as provide the knowledge. Or you could say, we need our containers to warrant the knowledge. Maybe that did not happen in the 1990s [with electronics], but eBooks and electronic articles are looking for new and better ways to develop that warrant."

The consensus among many university students is that a physical, hard copy of a book is preferable to an electronic version. According to Downey, it is because "books have fixity – yes, it takes longer for updated editions to come out, but you know that it has gone through the review process and that it can be trusted. There is something about a physical book that people just trust."

The crucial element of warrant, or how to make information trustworthy, is central to the discussion on the electronic revolution of reading. Now that eReaders like the Amazon Kindle and Apple iPad have hit the market and have proven to be successful alternatives to hard-printed copies, they must continue to evolve to satisfy the warrant that books provide.

**"There is something about a physical book that people just trust." - Greg Downey**

**Professor Downey provides insight into the future of print in his class held in 4246 Helen C. White.**

If the printing industry, which has been an expert at providing this same warrant for centuries, redefines what 'printed material' means to adapt to the electronic environment, it will be possible for the industry to again find its niche and reverse the past two decades of steady decline. Therefore, the question we should be asking is not when will the printing industry become extinct, but rather, how will the printing industry evolve.

Written by: Amanda Brylski
Photography by: Catie Qi
Design by: Matt Bollom

# CONCRETE LOGIC

## *The UW-Madison Concrete Canoeing Team's quest to make concrete float*

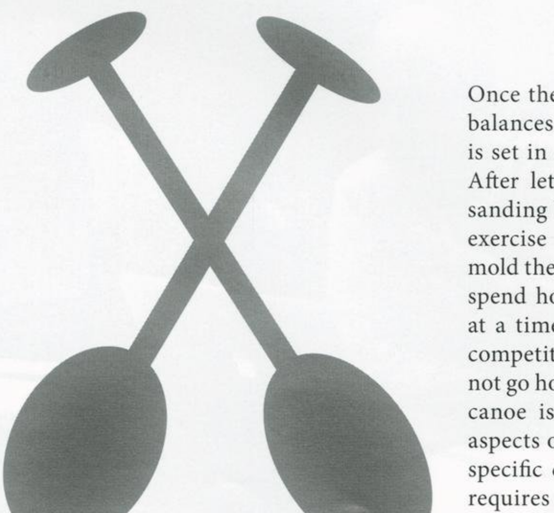
**Elliot Nelson, Aliena Debelak and JJ Blaschke sanding the 2013 canoe.**

For thousands of years, canoes have been a vessel of transportation, entertainment and relaxation. Now, take a moment to consider whether those activities would be possible in a concrete canoe. Canoes are commonly built from wood or fiberglass, so the idea of a canoe made from concrete can be surprising and even frightening to some. Would you be up for whitewater rafting in a concrete canoe? How about fishing a mile off shore, with land hovering in and out of sight? Most people would likely need convincing. This is where the UW-Madison Concrete Canoe Team (UW-CCT) comes in, ready to calm any fears.

Burdened with the dilemma of making concrete float, members of the UW-CCT not only focus on designing a canoe from concrete, but they also compete in the American Society of Civil Engineers' National Concrete Canoe Competition. Beginning with the intercollegiate competition in 1971, teams battle against each other by designing their own canoes from scratch. The annual competition is equally divided into four main categories: a technical design report, a business presentation, the construction of the canoe and races. Boasting a string of five straight national championships from 2003-2007, the UW-CCT has all but perfected each part of the competition. The success extends even further, as the UW-CCT has qualified for the national competition an unprecedented fourteen years in a row.

The impressive success of the UW-CCT, however, comes with months of hard work and detailed preparation. The tradition of victory is fueled by long nights at the team's headquarters in the Engineering Centers Building. Current team co-chair Elliot Nelson described the hours of commitment invested in the team saying, "It's a year round process. Whether we are holding paddling practice or electing new co-chairs near the end of the second semester, something is always being done." The groundwork is laid in the summer when the team first meets to discuss possible designs for that year's canoe. Aided by its tremendous archive detailing the designs of past national champions, the UW-CCT is always looking to improve upon previous designs while incorporating innovative elements that will help their canoe rise above the competition. The entire process of keeping concrete afloat revolves around the idea of buoyancy, which is the force that pushes up on the canoe. An object will float if its buoyancy is greater than its weight, but sink if the weight is larger than the buoyancy. In order to achieve maximum buoyancy, the concrete canoe consists of a mixture of cement, water, and space filler made of glass microfibers.

**"The first time I heard of concrete canoeing, I was as confused as everyone else." - Elliot Nelson**



Once the team decides upon an ideal mix that balances strength and density, the concrete is set in a mold for the canoe to be formed in. After letting the concrete set, the months of sanding begin. This extensive process is a daily exercise that must be completed in order to mold the canoe into shape for competition. "We spend hours upon hours each day for months at a time, making sure the canoe is ready for competition. Rarely does a day go by that I do not go home exhausted," says Nelson. While the canoe is meticulously constructed, the other aspects of the competition come into play. One specific component of the competition, which requires a great deal of dedication, is the design paper. This portion offers a comprehensive overview and analysis of the canoe's structure and construction, of the tests done on the canoes, of the project management and of the sustainability of the canoe. These papers can be around fifteen pages in length and are examined by the judges.

Next are the races. There are five races that each school competes in, with points being awarded to the four fastest teams. The races consist of men's and women's sprint and endurance races followed by a co-ed endurance race. Comprised of ten registered paddlers, each school fields five male and five female members. Regardless of whether the team is working on finishing the canoe or writing the design paper, any member is welcome to volunteer to help. Members can also try out to be a paddler. No experience is necessary. Although this may seem to be the most enjoyable part of the competition, months of training are needed in order to adapt to and succeed in the races. "We typically hold practices in the fall before moving to the NAT in the winter. There we can work on our form before moving back onto the water in late February," says Nelson.

The final element of the competition involves an oral presentation. Lasting no more than five minutes, the presentation is made up of a verbal explanation of the canoe's appearance and design through power point slides, pictures and videos. The presentation concludes with an additional five minute session in which the judges can ask any technical questions that come to mind.

After each part is completed and perfected, the months of hard work finally culminate with a regional competition. This year, the UW-CCT will take part in the Great Lakes Student Conference at Trine University. The three day competition is from April 18-20th, with the winning team advancing to the 26th annual National Concrete Canoe Competition at the University of Illinois Urbana-Champaign on June 20-22nd. Following the competitions, anticipation of the upcoming season will once again begin to build as the teams look back on the year, ready and willing to make any adjustments necessary for victory.

One important source of excitement over the approaching season comes from new members. While the frantic pace of readying for competition might seem daunting to some, the UW-CCT presents a tremendous opportunity for students from all majors, especially freshmen stepping onto campus for the first time. "Joining the concrete canoe team was the best decision I made coming into college. Not only did I get to meet a bunch of people in my classes, but I also became friends with numerous upperclassmen that could give me great advice about being a student," says Nelson. In addition to benefitting students while at UW-Madison, involvement in a club as unique and successful as the UW-CCT can open the door to potential jobs in the future. The UW-CCT also allows its members to travel extensively; in the past four years alone, members have had a chance to visit Alabama, California, Indiana and Nevada.

The work needed to keep the UW-CCT running everyday is certainly difficult. The daily sanding of the canoe and the design paper are merely half the battle. Add that to training for five different races and practicing for an oral presentation. The amount of time invested in building and analyzing the concrete canoe is certainly impressive. All of that hard work is represented by five national championships and 14 straight appearances in the national concrete canoe competition. With all this evidence supporting the safety of concrete canoes, would you dare take the plunge into Lake Mendota? If the answer is still no, do not worry. "The first time I heard of concrete canoeing, I was as confused as everyone else," says Nelson. After all, concrete cannot float, right?


Written by: Matt Latuszek

Photography by: Abby Schaefer

Design by: Brent Grimm

# What's Next: The Future of Vehicle Transportation

***A discussion about the near future of motor vehicles, from alternative fuels to combining current fuel sources in one vehicle***

Transportation technology has seen many innovations in the last ten years, from built-in global positioning systems to electronic vehicle control, even self-parking vehicles have emerged. Yet according to Rolf Reitz, the director of the Engine Research Center at UW-Madison, the biggest advancement in the last ten years is not in the new iPod docking stations many vehicles now contain, but rather the increase in engine efficiency, especially in diesel engines.

The concern over engine emissions has gotten more serious over the past ten years. As more evidence has come out to support the far reaching effects of high carbon dioxide emissions, reducing these emissions has become the top priority of many countries. Even in the United States, home of the oversized vehicle, the government is beginning to push for increased fuel efficiency along with lower emissions. Recent government regulations state that each fleet of new vehicles must have an average of 54.5 miles per gallon (mpg) by the year 2025, a substantial increase from the 28.6 mpg last year. The question now becomes, how will automakers meet standards that ask for almost twice the mpg that vehicles in the United States are currently getting? More importantly, where will the future of vehicles go from there?

**It is a possibility that within the next ten years, it might become standard to drive a vehicle with two different fuels.**

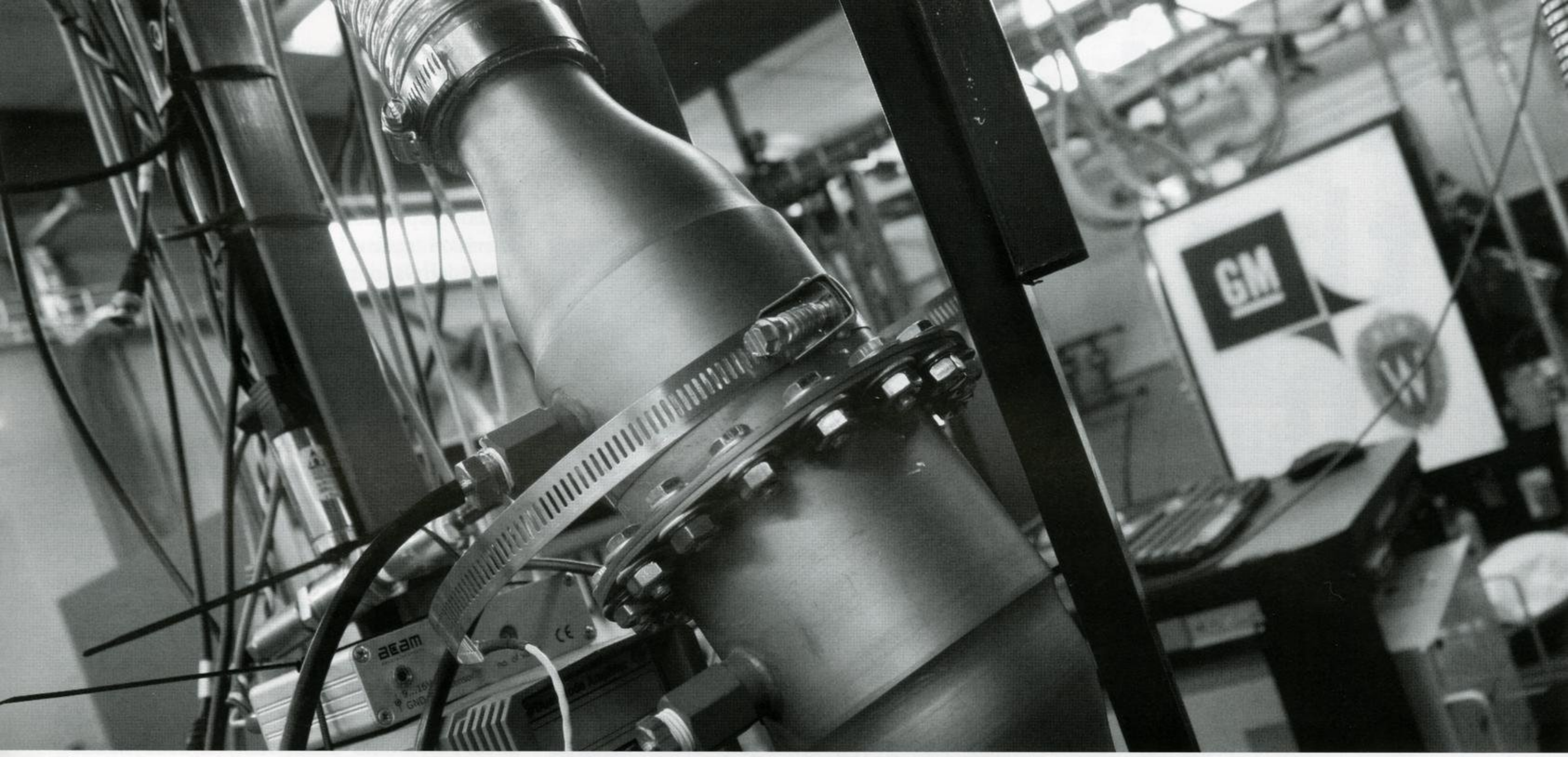
When posed with these questions, Reitz had a plethora of thoughts about what future technologies hold. In order to better understand Reitz's ideas, one must first examine the way modern vehicles work. There are two different types of fuel that vehicles run on: diesel and gasoline. When comparing the two different fuels, it is important to not just consider which has better efficiency, but also what kind of emissions they produce.

**A prototype engine, which uses both diesel fuel and unleaded gasoline will hopefully improve fuel economy while keeping emissions low. Professor Reitz of UW-Madison believes this type of engine will be used in several automobiles in the future.**

In the United States, gasoline-run vehicles are more popular than their diesel counterparts, but this is not the case in all parts of the world. In Europe, diesel vehicles are more widespread because of the lower price of diesel in Europe and the better gas mileage of diesel engines. There is, however, a trade off for the better gas mileage in the increase of emissions. Due to the chemical nature of diesel operations, the relatively simple catalytic converter used in gasoline powered vehicles cannot be used to reduce dangerous levels of diesel emissions. Instead, diesel vehicles require a more complex emissions system called a Selective Catalytic Reduction (SRC). The SRC converts nitrogen monoxide emissions into diatomic nitrogen gas and water. This may seem like a simple process; however, it requires every diesel vehicle to carry an extra tank of urea, which is added to the exhaust stream. It is estimated that the cost of urea needed to neutralize the emissions is somewhere around five percent of what is spent in fuel, which adds a significant cost over the life of the vehicle.

Knowing about the differences in emissions makes it easier to critically analyze what the near future in automotive technologies holds. One of the top future technologies Reitz discusses is hybrids; are they the future of vehicles or just a blip on the road to something better? Reitz was doubtful that the future of all vehicles lies in hybrids due to their major handicaps. For example, the high-powered batteries they contain add a hefty amount of weight. They also require expensive mining to obtain the precious metals that make up the battery pack; disposing of the used battery is also problematic due to its environmental effects. In addition, there is no benefit to driving a hybrid cross-country as there is no way to take advantage of the batteries or the regenerative breaking most hybrids use. This is a large handicap as many people in the United States drive long distances on a regular basis.

Many companies are looking into electric vehicles, but according to Reitz, these have handicaps of their own. Similar to the problem with hybrids, electric vehicles require a large battery pack. The environmental effects are the

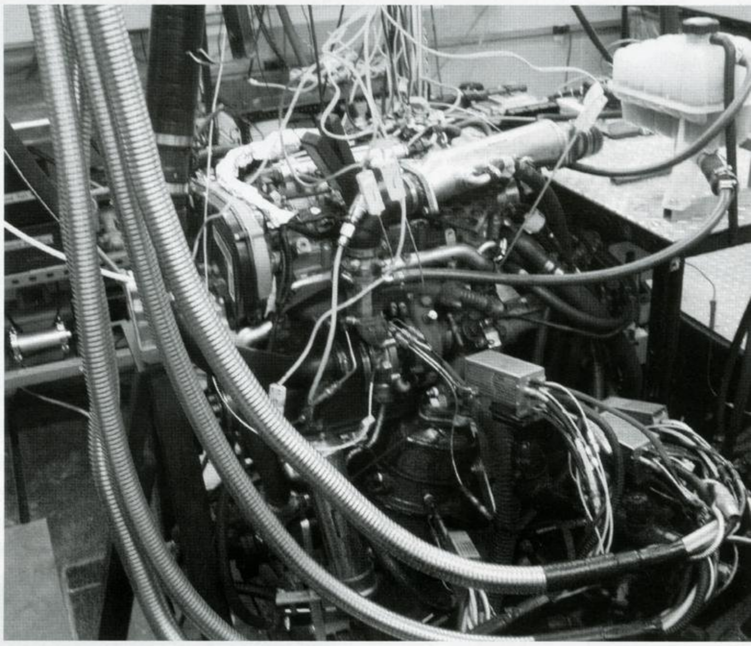



**There are many labs in the Engineering Research Building dedicated to advancing technology in the automobile industry.**

exact same as that of a hybrid; expensive mining is required to manufacture the batteries and the recycling problem still exists. An additional problem comes not from the vehicle itself, but from its power source. When a power plant harnesses electricity, because of the efficiency, only about fifty percent of the energy released is available as useful electricity. Before electricity even arrives at an electric vehicle, half the energy used to get from A to B is already gone.

These statistics make the future of fuel-efficient vehicles look bleak; however, Reitz and the Engine Research Center are studying advanced concepts to discover how to optimize vehicle performance. One of their larger projects is based on the Eco-Car. In order to optimize performance, they have tested the vehicle on gasoline, diesel and surprisingly, a combination of both. The theory behind the combination is to optimize the fuel efficiency performance that comes with diesel, without losing the better emissions that come with gasoline. This new technique would require a vehicle to have two fuel tanks, one for gasoline and one for diesel. The onboard computer system would then mix the fuels in the engine using an optimal ratio of gasoline to diesel. Although people might question the logic of having two fuel tanks, Reitz argues that it would be no different than a diesel vehicle that also must carry a urea tank accommodate emissions.

It is possible that within the next ten years it will become standard to drive a vehicle with two different fuels; however, even this advanced technology is a short-term solution to the long-term problem of sustainable energy. Reitz believes that the long-term solution lies in hydrogen powered vehicles, which is currently being tested with cars. Although this may seem futuristic, the technology for hydrogen powered cars already exists and is just waiting to be refined. Automobile companies such as Daimler AG, Honda, Hyundai and Toyota all have announced their plan to release hydrogen powered cars for sale as early as 2015. The difficult task is finding a cost effective and efficient way to produce the hydrogen gas needed to fuel global transportation. In order to keep the process sustainable, solar energy could be used to convert water into hydrogen gas, says Reitz. The only emissions produced would be water vapor, as the reaction of hydrogen with oxygen produces no greenhouse gasses. This also means that catalytic converters or urea tanks will no longer be needed. A concern that comes with this sustainable energy solution is that the hydrogen tanks on board are highly flammable. However, it is not all that different from carrying gallons of flammable gasoline.



**An expanded view of one of the test engines capable of running on both diesel fuel and unleaded gasoline.**

From a vehicle that runs on both diesel and gasoline, optimizing fuel efficiency and minimizing emissions, to a vehicle that runs on a sustainable source of hydrogen, the field of transportation technology is expecting many advancements in the near future. WE

Written by: Heather Ruhl

Photography by: Nick Lepak

Design by: Yao Mu

# Looking to the Future in Reverse

## *Meet the Badgers who have led the way in science and engineering innovation since 1873 and read what advice they have for future UW-Madison graduates*

As the next round of Badgers gear up for graduation, they will map out their futures and go on to achieve greatness. However, before these future alumni can don their cap and gown, it is wise to reflect upon the accomplishments of Badgers before them. It is known that the College of Engineering at UW-Madison is a well-respected program, but it did not acquire that reputation overnight. When the first class graduated in 1873, it consisted of three civil engineering students. Since then, UW-Madison has produced fourteen Nobel Prize winners, nine astronauts, numerous CEOs and countless game changers. The faces in the photos below are fellow Badgers who have led the way in science and engineering and have walked the halls of UW-Madison.

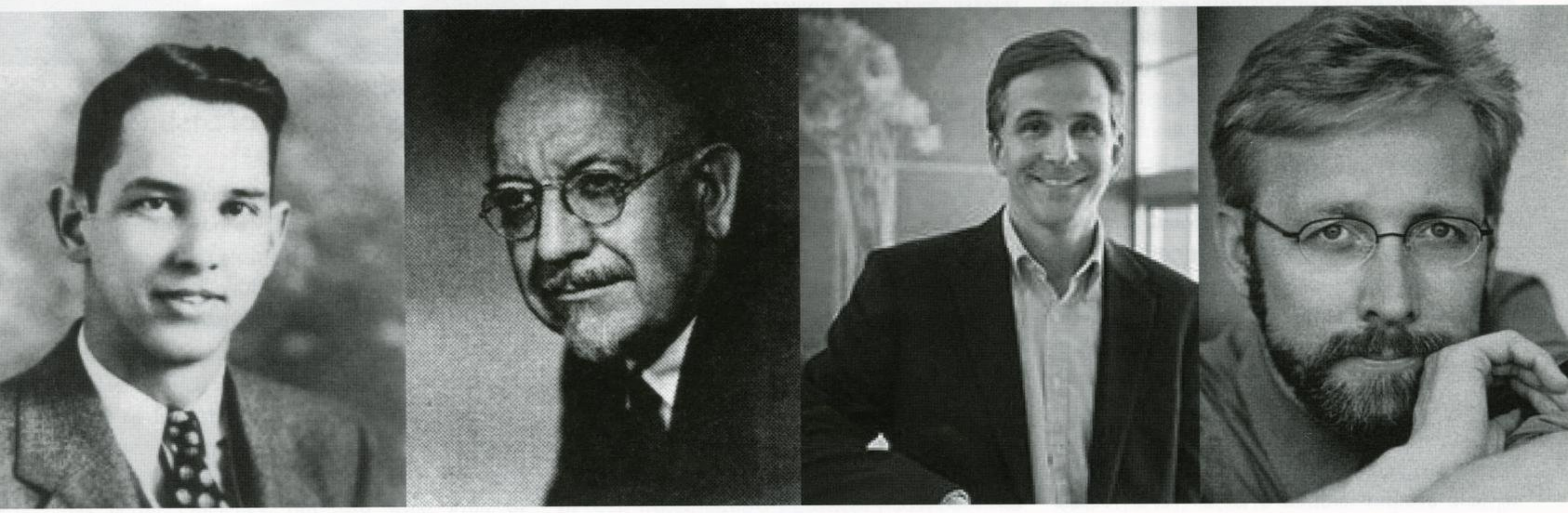
In the early years, these leaders were at the forefront of engineering feats like the creation of the Panama Canal, construction of the Hoover Dam and development of AM radio transmissions. The chief electrical and mechanical engineer of the Panama Canal Project, Edward Schildhauer from New Holstein, WI, graduated from UW-Madison in 1897. Shortly after that, John Lucian Savage, a supervisor for the Hoover Dam, graduated with a degree in civil engineering in 1903. Nine years later, Earle Melvin Terry, developer of AM radio transmissions, graduated with his Ph.D. and continued on as a UW-Madison physics professor.

With several significant accomplishments already under their belt, Badger alumni continued to excel. In 1920, a man who would later become famous for being the first person to fly solo across the Atlantic Ocean enrolled in the mechanical engineering department of UW-Madison. Charles Lindbergh completed two years in the college, then left to train as a pilot. In the same decade that Lindbergh attended UW-Madison, John Bardeen graduated with a degree in electrical engineering. Bardeen went on to win two Nobel Prizes for his co-discovery of the transistor effect, which led to the invention of the transistor and the development of a fundamental theory of conventional superconductivity known as the BCS theory.

Holding strong throughout the 1920s, UW-Madison alumni revolutionized the 1930s. If it was not for George Harold Brown, TV might not be as colorful as it is today. After graduating from UW-Madison in 1930 with a degree in electrical engineering, Brown led efforts by the Radio Corporation of America to develop a color television system, which is still in use today. Television was not the only modern day technology influenced by a UW-Madison grad, as John Vincent Atanasoff invented the first digital computer after graduating in the same year as Brown with a Ph.D. in theoretical physics. Fast-forward fifty years and technology is advanced even further by Michael Joseph Dhuey, who graduated in 1980 with a degree in computer engineering. Dhuey was the co-inventor of the Macintosh II and one of two hardware engineers of the first generation iPod.

Technology is not the only area where alumni have made an impact; Badgers have also had their hands in historical events. After graduating from the engineering physics program in 1934, Robert Serber was brought on to the Manhattan project. He developed the first successful theory of bomb disassembly hydrodynamics, created the code-names for the design projects, and was part of the first American team to enter Hiroshima and Nagasaki to evaluate the outcome of the atomic bomb.

Other historical events, long after the atom bomb was dropped, were the Columbia and Challenger disasters. Brewster Hopkinson Shaw Jr., who graduated in 1968 with a degree in engineering mechanics and astronautics, was a NASA astronaut who flew as the pilot of space shuttle Columbia in 1983. He also served as flight commander on two additional flights. After the Challenger disaster in 1986, Shaw led the space shuttle orbiter return-to-flight team, which was put in place to enhance the safety of space vehicle operations. After working for NASA, Shaw went on to work as the Vice President and Program Manager of International Space Station Electrical Power Systems for Boeing. He is currently the Vice President and General Manager of Boeing's Space Exploration division.



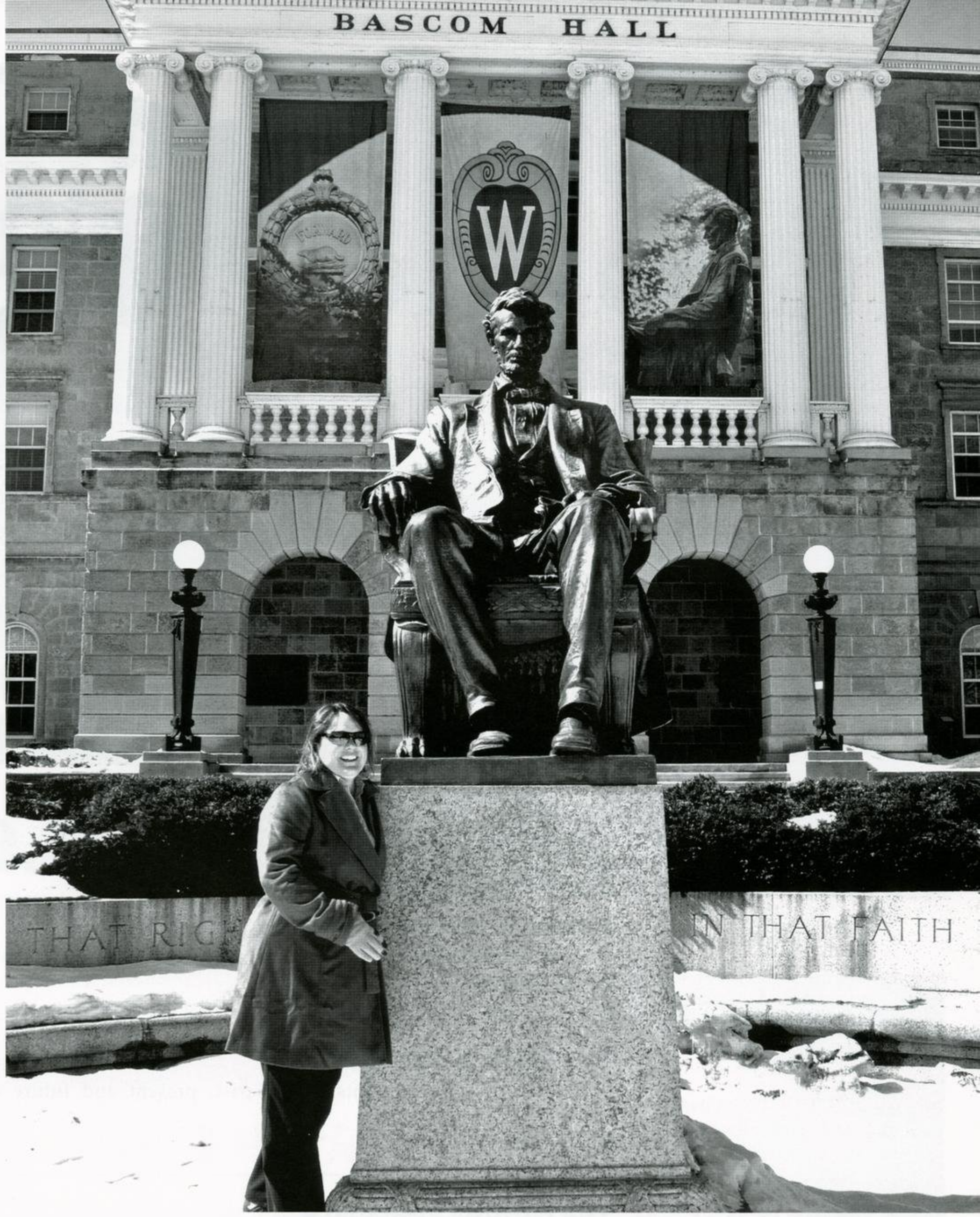
**Pictured above from left: John Vincent, George Brown, Jim Thompson and Chris Bangle**

Switching gears from space vehicles to street vehicles, UW-Madison alumni have covered ground within the automobile industry as well. According to the New York Times, this UW-Madison industrial design grad of the 1970s is, "arguably the most influential auto designer of his generation." Christopher Bangle was the Chief of Design at BMW until 2009. During his time at BMW, Bangle was responsible for the BMW, MINI, and Rolls-Royce motorcars. When Motor Trend asked him about the ever-changing auto industry and the roles engineers play he responded, "Man, we've got to go so much further. We need engineers to be prepared to go up front and lead!"

Leading is exactly what one of the distinguished alumni award recipients of 2012, Patrick Hanrahan has done. As a nuclear engineering undergraduate student at UW-Madison in the late 1970s, Hanrahan achieved perfect grades and went on to earn a Ph.D. in biophysics. He was one of the first employees at Pixar and developed the RenderMan software, which was used to create movies like Toy Story. In recognition for his work, Hanrahan and several of his colleagues received two Oscars for Technical Achievement and Scientific and Engineering Achievement. Currently, Hanrahan is a professor at Stanford University. When asked what the key to his success was, he claimed it was the foundation he laid at UW-Madison. "I loved the environment at Wisconsin. I really liked the engineering, but I had broad interests. I would not be where I am today had I not seized the opportunity that was offered," Hanrahan says.

From honors program member to football team captain, Keith Nosbusch is another distinguished alumnus. Not only did he earn an electrical and computer engineering degree in 1974, but he was also the captain of the football team in 1972. After graduation, the Milwaukee native started as an applications engineer for Rockwell Automation and is now the president of the company. Another alumnus at the top of the ranks is James Thompson, Executive Vice President of Engineering at Qualcomm. After graduating with his third degree from UW in electrical and computer engineering, Thompson joined the small start-up company, Qualcomm, which began to work towards implementing what would turn into the most common protocol for cell phone calls in the world. Today, Qualcomm is the largest fabless semiconductor supplier in the world.

Despite success in his career, Thompson said that his time at UW wasn't all "smooth academic sailing." Thompson stated, "In my first semester taking ECE courses I struggled a bit and had doubts about whether I had what it took to be successful in that major. In my first round of ECE midterm exams I got a few poor grades. This really rocked my confidence. I went to see an academic advisor expecting he would say I wasn't ECE material, but instead he told me these were weed-out courses, the grading was tough and there was no reason I shouldn't be able to overcome my slow start. I would say the next most important decision I made at the UW was just to persevere."




**One of the many past UW-Madison graduates, Sue Olson, visits the Lincoln Statue for good luck.**

Upon entering the College of Engineering, Thompson said that his sophomore year was when he started to have trouble. He reminisced about the time stating, "In one of my classes the professor handed the exam back to us and said to the class '...so you got your exam back and you got a bad grade. Don't try to rationalize it! You can be a three-legged dog in Engineering or a four-legged cat in Letters and Science. It's your choice!' I remember that moment like it was yesterday. In another class the professor told us to '...look right and look left. One of those guys will be gone!' Wow! I wondered if I was one of those guys that '...will be gone'." Thompson not only persevered, he went on to be the Executive Vice President of Engineering at Qualcomm, making many impacts on the world. Along with persevering, Thompson attributes his success to the fundamentals he learned at UW-Madison, "the broad education I received at Wisconsin is instrumental in allowing me to keep up with the changes and branch into areas outside my expertise."

Let Thompson's words be evidence that a well-rounded education from UW-Madison and the perseverance to make it through the College of Engineering is a worthwhile achievement. The College of Engineering has come a long way since 1873 with a graduating class of three. Today, UW-Madison enrolls approximately four thousand undergraduate students and fifteen hundred graduate students in the College of Engineering. In 2013, thousands of Badgers are expected to don their cap and gown and enter the "real world" of engineering. However, with a lineage of Oscar winners, Nobel Prize recipients, CEOs, astronauts, innovators, leaders and groundbreakers, the future UW-Madison graduates are bound to change the world. Good Luck to the graduates of 2013 and On Wisconsin!

Written by: Ashley Bredemus

Photography by: Chris Ross

Design by: Lukas Lindquist

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# Web Exclusive Content

*General*

## Zero Gravity Team
The UW-Madison chapter of the AIAA's Zero Gravity team has been selected to do testing for NASA
By Alexander Jones
Photos by Matt Malecha

## Oil Production
A look into the future of oil production
By Patrick O'Donnell
Photos by Nathan Hartung

## Future of Education
Change is coming to UW-Madison in the form of educational advancements
By Eric Trunk

## The Science Behind Wood
Technological advancements in the past, present and future of the Forest Products Laboratory
By Zach White

## The Future Cyberspace
The SWAMP research center works to eliminate vulnerabilities in national cyber-infrastructure
By Lizzie Puck
Photos by Wenyao Ma

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