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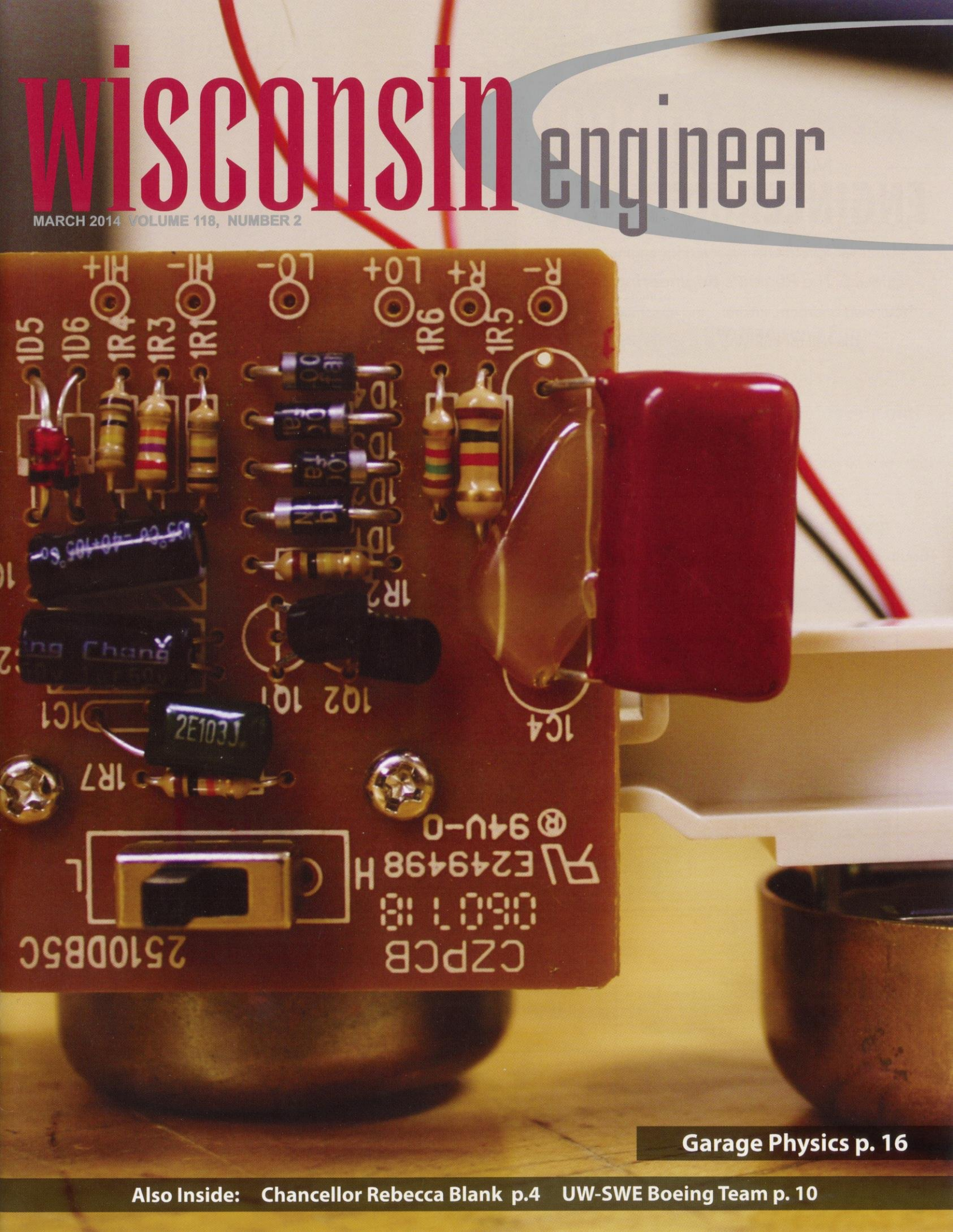

wisconsin engineer

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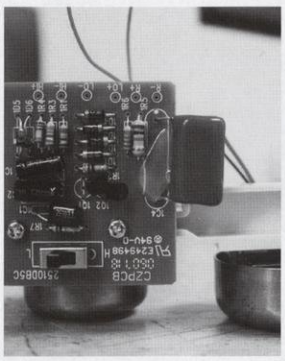
General



Cover photo by Olivia Fritz

Photo Essay

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A New Look At the Common Cold

A fresh look at the common cold virus and why it is so hard to combat.

Walking around campus during the winter months, it is hard to turn a corner without hearing a cacophony of sneezing, coughing and nose blowing. The symptoms vary from person to person, but ask anyone, and chances are they will pull some tissues out of their pocket and say that the common cold season is in full swing. "It just seems like everyone is sick. You have got to be extra careful and make sure you are not catching what the person next to you has," remarks freshman student Elliot Bender. What is even worse, medicine prescribed to patients often does not provide any relief.

Holly Basta examines a common cold sample in the lab.

Most people know that types of viruses called human rhinoviruses often cause the common cold; up until a few years ago, scientists thought there were two types, HRV-A and HRV-B. At the doctor's office, caregivers usually prescribe antiviral medication based entirely off models of these two types. Sometimes these drugs work, but just as often they do not. This ineffectiveness was usually blamed on patient variability. It was only in 2007 that a third type of human rhinovirus began to be detected in labs, eventually classified as HRV-C. Thought to be responsible for about half of all common colds and large amounts of asthma cases, it is very prevalent in the world today.

Traditionally, scientists detect rhinoviruses by taking a genetic sample, usually mucus, from a human patient and culturing its cells. HRV-C does not grow on these cultures, making it almost impossible to detect. Scientists and researchers learned of its existence by using advanced genetic sequencing technologies.

"HRV-C is very hard to grow. It can only be done in a few labs in the country, including UW-Madison"
- Holly Basta

Researchers at UW-Madison took this newfound discovery and pushed it a step further. Holly Basta, a research assistant under the direction of biochemistry professor Ann Palmenberg, used data from the lab, along with computational methods, to create a highly accurate model of HRV-C. An extremely significant development, this model clearly highlights the differences HRV-C exhibits from other strains of the virus. Actually growing pieces of HRV-C was the initial challenge. "HRV-C is very hard to grow. It only can be done in a few labs in the country, including UW-Madison," explains Basta.

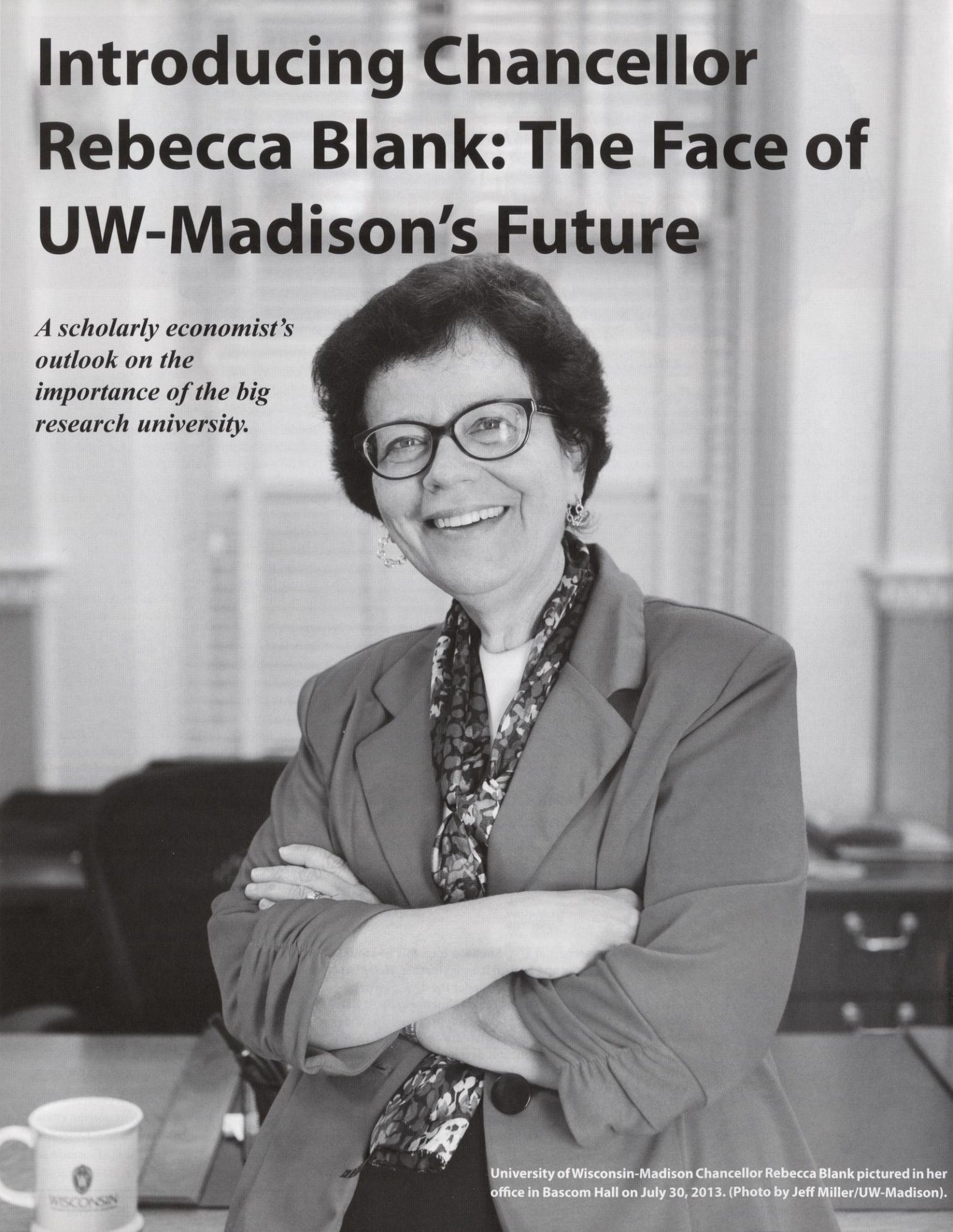
Described by Popular Science as a model more closely representing "a big boogery blob," Basta's model is a color-coded representation of the capsid, or shell of the virus. The receptor region of the capsid where antiviral drugs would bind is distinguishably different from models of both HRV-A and B, making current drugs useless against this strain. Basta provides the exact reasoning why prescribed antiviral drugs are ineffective against HRV-C, saying, "As far as drug-binding goes, the model predicts that the pore that leads into the drug-binding pocket is highly restricted or even closed in the C-species, which would prevent antiviral drugs from entering the capsid. This model helps to answer researchers' lingering questions and explain why antiviral drugs work on some patients and not others. It explains anomalies in clinical drug trials." The outlook is looking more positive every day though. Using this model, drug companies can now start to develop new drugs specifically targeted towards HRV-C. Before it was even published, biotech companies were already requesting copies of the model. Basta's team itself is collaborating with a drug company out of Australia.

As exciting as these new developments are, do not expect a complete cure for the common cold soon. "It is not going to be beneficial today," Basta says. Time is needed before any human drugs will be available for use. "Once you design the drug, you have to test it, and then take it to clinical trials. If it has any side effects at all, it is not going to market. Not even something as simple as dry mouth. The challenge is having absolutely no side effects." This means that the sniffling and sneezing on campus should not be expected to become a thing of the past anytime soon. Even though another cold season has come and gone, trash bins filled with tissues and lecture halls filled with the sounds of stifled coughs are going to be a common sight on campus for the foreseeable future. WE

Written by: Nathan Friar
Photography by: Ashley Klein
Design by: Margaret Butzen

Introducing Chancellor Rebecca Blank: The Face of UW-Madison's Future

A scholarly economist's outlook on the importance of the big research university.



University of Wisconsin-Madison Chancellor Rebecca Blank pictured in her office in Bascom Hall on July 30, 2013. (Photo by Jeff Miller/UW-Madison).

Although oftentimes it is unseen or overlooked, there is something unique going on in Madison, Wisconsin. Nestled on a beautiful isthmus and committed to ecological conservation, Madison is the capital of a state whose motto, "Forward," encapsulates movement toward a better future. Politicians work to govern the state; entrepreneurs work to form new businesses; professors work to research and teach; and students work to learn to succeed in the future. The entity that houses the professors and students, UW-Madison, is living up to Wisconsin's motto by taking a step forward with its new chancellor, Chancellor Rebecca Blank. An economist and scholar, Chancellor Blank recognizes the crucial and distinct role that UW-Madison plays in the future of Wisconsin and the world.

Chancellor Blank's job prior to UW-Madison was serving as the Acting Secretary for the U.S. Department of Commerce. Before that, her career was dedicated to academia. "I love the big public research universities – I grew up around these sorts of places," says Chancellor Blank. She grew up in Minnesota, received her undergraduate degree at the University of Minnesota and then spent most of the last 20 years of her life at Northwestern University and the University of Michigan as a teacher, researcher, and, at Michigan, the Dean of the Public Policy School. After spending time at schools in the Midwest, Chancellor Blank knew UW-Madison very well and easily adapted to her new home. "I'm very familiar with the Big 10, and Wisconsin is one of the top public universities, so the chance to provide leadership here, to me is really just a wonderful opportunity," says Chancellor Blank.

While it may seem odd to have left academia to be the Acting Secretary of the Department of Commerce, only to return to the university life as the Chancellor of UW-Madison, Blank sees a similarity between the two positions. "What I'm doing here doesn't feel that much different than what I was doing over at the Department of Commerce," says Chancellor Blank. "The connection between the Department of Commerce and the university deals a lot with the idea of American competitiveness and thinking about what is going to matter in the long run." Chancellor Blank expresses that two important factors playing into that competitiveness are creating a highly skilled work force, especially with respect to technical skills such as those of engineers, and staying on the front edge of innovation and invention. "There's only one real institution that does that, and that's the big research university."

Taking a step back and looking at the role of the big research university in society, these institutions create the future through research and education. The functionality of these universities should be cohesive with the rest of the societal functions, namely the economy and the government. Chancellor Blank believes strongly in this relationship. "Stepping up our involvement with state economic development, making sure that we are stimulating the growth of new businesses and that we are partnering with existing businesses, all of that is key to saying what I think is absolutely true, that the big research university here in this state, the University of Wisconsin-Madison, is central to the economy of this state, and we need to be in partnership together," says Chancellor Blank. There is a continuous cycle in which the university educates students and develops technology through research to create a new work force, businesses provide work for graduates and incorporate the technology, and the state makes laws to govern and implement the new developments to ensure society's success and maintain its organization.

The question is raised of what we can do to help make the world a better place as a public university, whether it's about ideas or students.

In the past, the association between UW-Madison and the state hasn't been as unified as many would like. Mending this bond is an issue Chancellor Blank takes very seriously. "One of my primary jobs is to recreate a smooth working relationship with the state, and an important piece is to make it clear to everyone how committed the university is to being part of the economic development of the state," says Chancellor Blank. In any big institution, in particular big research universities, one of the biggest challenges is financial stability. Facing the decline of state funding, the tuition debate and even federal budget cuts, UW-Madison's financial management is always a topic of discussion and debate. Fortunately, with such a strong background in economics, Chancellor Blank is confident that it is possible to effectively maintain stability in order to keep Wisconsin on the forefront of technology and innovation is possible.

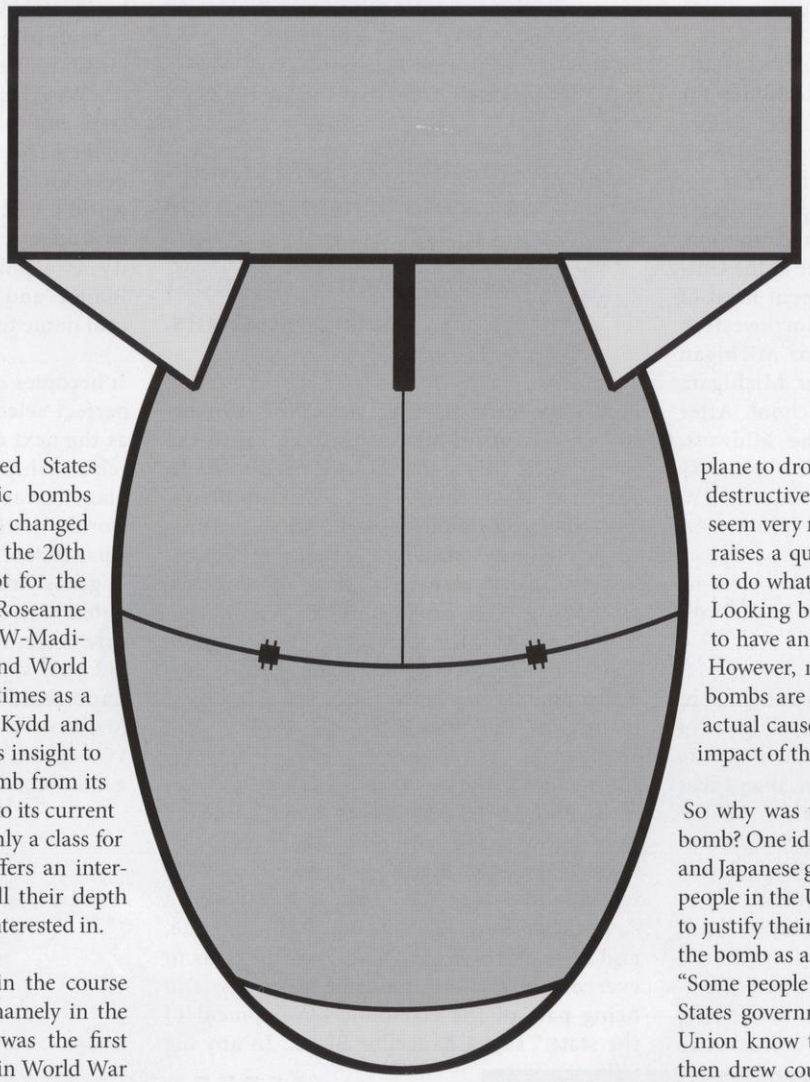
Staying ahead of the game in these fields and recognizing the relationship that UW-Madison has with the state shows how Chancellor Blank believes in the Wisconsin Idea – an idea regarding the importance of the university reaching out beyond its campus boundaries so that what happens here on campus is in service to the state. But Chancellor Blank has even a bigger idea: to not limit the Wisconsin Idea just to the borders of the state, but to think about Wisconsin in service to the nation and in service to the world. "The question of what can we do to help make the world a better place, whether it's about ideas or students, I think we have that responsibility as a public university," says Chancellor Blank, "and I love the fact that we have an actual name for it – the Wisconsin Idea."

It becomes clear that UW-Madison made the perfect selection in choosing Rebecca Blank as the next chancellor. She is committed to a relationship with the state, a stable economic plan, research and education to provide the world a better tomorrow. It is undeniable that Chancellor Blank lives the Wisconsin Idea. "I guess I really deeply believe that these big public universities are fundamental to the future of our nation, and making sure that they not only survive but they thrive is incredibly important," says Blank. As the role of UW-Madison was and is becoming defined in Wisconsin, the future of this great university is undoubtedly bright. WE

Find a Q&A session with the chancellor at: www.wisconsinengineer.com

Written by: Charlie Duff

THE DECISION THAT CHANGED THE WORLD



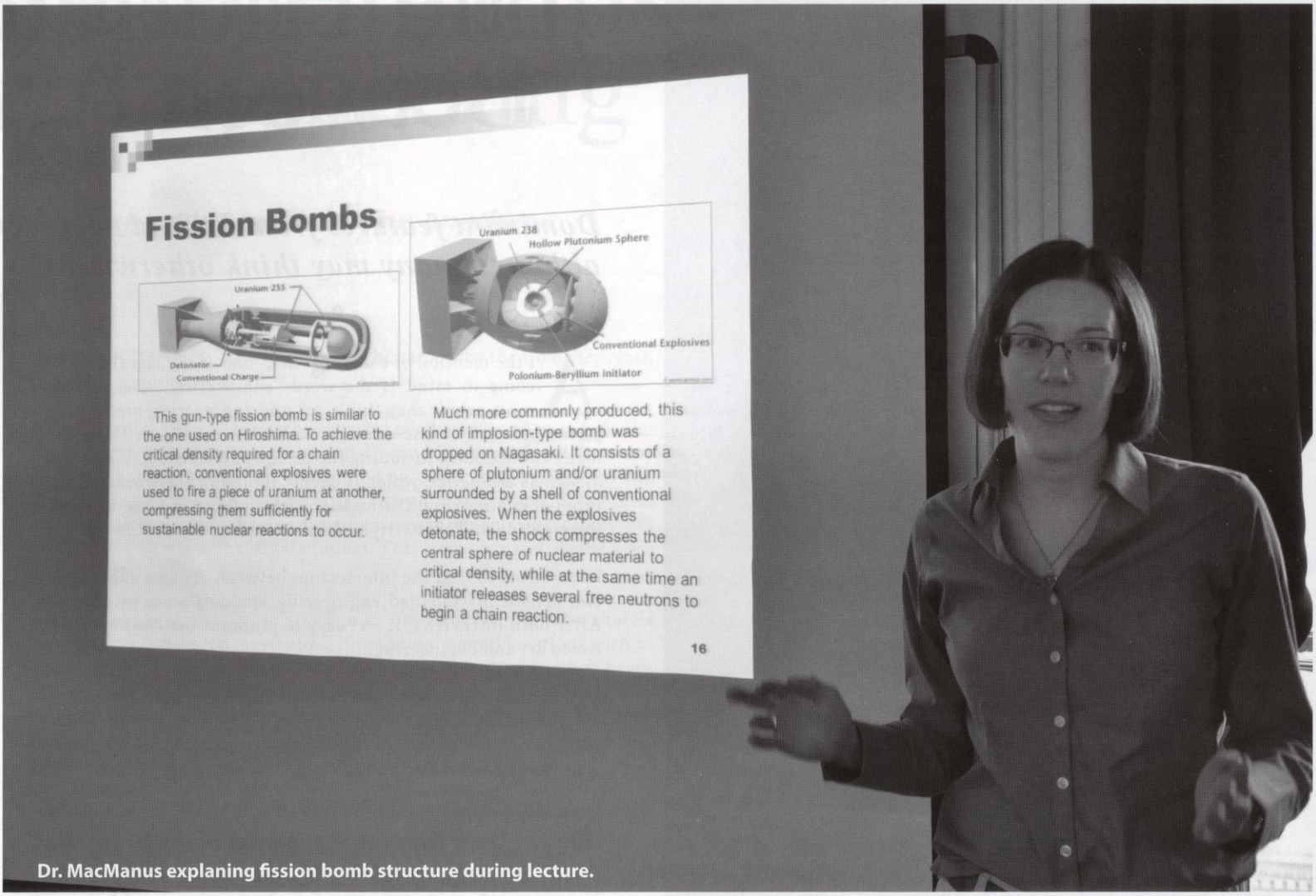
The decision of the United States government to drop atomic bombs on Nagasaki and Hiroshima changed the course of history for the rest of the 20th century and up until today, but not for the reason that people think. Roseanne McManus, a Ph.D. candidate at UW-Madison, has taught Nuclear Weapons and World Politics (PS377) seven times -- five times as a Teaching Assistant under Andrew Kydd and twice as a lecturer. This course offers insight to the political effect of the nuclear bomb from its invention and role in World War II, to its current effect on the world today. It is not only a class for Political Science majors, but also offers an interesting option for Engineers to fulfill their depth requirement in something they are interested in.

One of the critical topics covered in the course is the history of nuclear weapons, namely in the political scene. The United States was the first country to develop nuclear weapons in World War II under the Manhattan Project and performed just one test before dropping the Hiroshima and Nagasaki bombs. "Interestingly, out of the two types of bombs dropped on Japan, we only tested one," says McManus. The United States tested the "fat man" bomb which is the more complex type of the two, but used the gun type bomb before it was tested.

The interesting part about these two bombs is how they are portrayed in history. Because of their destruction, they are commonly believed to have caused the Japanese surrender. "It is debatable whether they actually ended the war or not," says McManus. "Certainly the end of the war was proximate to the dropping. Now that scholars have dug more into the archival evidence, some people have been raising questions about whether dropping the bomb did lead to the end of the War." This is because it does not seem that the Japanese government was concerned at all in its meetings about the dropping of the bomb. Also, we had been doing fire-bombing on Japan already. "These fire-bombings were actually even slightly more destructive than the nuclear bombs," says McManus. "It was not as efficient. We had to send hundreds of planes instead of just one plane to drop the bomb, but it was at least equally destructive and the Japanese leadership didn't seem very moved by that." This lack of response raises a question: can you really get a country to do what you want by bombing their people? Looking back on history, both countries seem to have an idea that the bombs ended the war. However, nowadays among some scholars the bombs are seen as more of an excuse then the actual cause. This excuse, though, had a lasting impact of the next decades and up until today.

So why was there such a large emphasis on the bomb? One idea is the perception the United States and Japanese governments wanted to create. "Some people in the United States government had a need to justify their actions, so they wanted to promote the bomb as a cause of surrender," says McManus. "Some people say that the only reason the United States government did this was to let the Soviet Union know that we had this bomb." This focus then drew countries to pursue nuclear weaponry through the Cold War and up to current nuclear politics today, which includes some countries having nuclear weapons 1000 times more powerful than the bombs originally dropped during World War II.

The current political scene involving nuclear weapons has many more players than it used to, and this number seems to always be expanding. Two countries that have recently been making news in the area of nuclear weaponry are North Korea and Iran. The reason that these countries are making news is because they have made recent advance-



Dr. MacManus explaning fission bomb structure during lecture.

ments in the nuclear fields. "North Korea actually does have nuclear weapons," says McManus. "They are not very advanced yet, and their tests have been very small in size." They also do not yet have a missile capable of hitting the United States. "They basically got their nuclear weapons by cheating on the Non-Proliferation Treaty," says McManus. They secretly pursued nuclear weaponry even though they had agreed not to. This is concerning because North Korea has presented a threat to South Korea and Japan, both of which are American allies.

The case of Iran is a much more speculative scenario. They do not yet have nuclear weapons, but a case can be made that they are pursuing such technology. They have a civilian nuclear program, which they are allowed to have. However, some other suspicious activity has been happening. "They are enriching a lot of uranium to 20%," says McManus. This level is not needed for most things. "With uranium enrichment, there are three [relevant] levels," says McManus. "For a bomb, you need 93% enriched, for certain medical purposes you need 20% enriched, and for nuclear power you need 4% enriched. However, once you get to 20%, it is not hard to get to 93%." This enrichment of uranium to the 20% level was halted by the November agreement between the United States and Iran.

Another suspicious behavior that Iran has been engaging in is not declaring nuclear facilities until the news or other agencies report that they have them. "What has happened with two enrichment plants recently is that they have not been declared until it is basically leaked to the press by some group or intelligence agency, and so it is not clear whether or not they ever did tend to declare them," says McManus. This raises the question to the IAEA (International Atomic Energy Committee) of whether or not Iran has undeclared facilities. Because of that, Iran has been told by the IAEA to stop the enrichment of uranium, and now by a UN declaration has been required to stop enrichment. Also, when the IAEA has asked to see other suspicious facilities, they were denied, and in one instance, parts of the facility were actually destroyed. These ongoing events continue to progress and change each day, which makes it such an exciting and relevant topic.

"Some people have been raising questions about whether dropping the bomb did lead to the end of the War."
- Roseanne McManus

The development of the nuclear weapon during World War II has had a significant role in every time period since its creation, and it seems that it will affect the world for many years to come. There have been on-edge times, times of security, and everything in between throughout the international politics of nuclear weapons, and it will be interesting to see how these events will play out in the decades to come. WE

Written by: Zach White
Photography by: Catie Qi
Design by: James DeBano

The Hidden Relationships Between Art & Engineering

Dominant features from art and engineering play important parts in one another although many may think otherwise.

At the mention of the word "art," one of the last things that come to mind is the word "engineering." Despite what most people may think, art and engineering are not complete opposites of one another. Rooted within both fields exist many connections, including the design and constructive process, as well as aesthetics, which is deeply rooted in the works of many types of engineering. Ultimately, both engineering and art utilize imagination and creativity to further explore the unknown.

In an effort to find the intersection between art and engineering, two artistically talented engineering students were interviewed. After both interviews, it was easy to pinpoint the similarities between art and engineering.

UW-Madison undergraduate Taylor Passofaro was able to point out the differences between the two fields, but he also believes there exists a deep connection. Taylor is majoring in mechanical engineering and is currently taking a pottery class. He also enjoys

"I think that the part of my brain that understands physics and math is the same part of my brain that makes pots and is good at writing."
- Taylor Passofaro

writing, woodworking, singing and playing multiple instruments. Between the art and engineering classes he takes, there are vast differences, including the fact that an art class involves minimal "teaching," whereas a typical engineering class includes a lecture and a lab. Regardless of the content each subject offers, Taylor says, "I think that the part of my brain that understands physics and math is the same part of my brain that makes pots and is good at writing." This part is his intuitive mind. He utilizes his creativity and imaginative skills to perform in both subjects.

As much as engineering involves creativity, producing works of art such as pottery involves some scientific reasoning as well. While forming a pot on a wheel-head, for instance, the artist must exert the right amount of pressure on the rim of the pot to prevent it from collapsing. No matter how small the base is, as long as the rim has the correct compression, the pot will stand. This is a question of physics.

It gets more technical than this. Potters must also figure out the percentage of the pot's size that will shrink after it is fired through a standard mathematical process. By knowing how much the pot will shrink, provides them with the correct temperature to fire their wares. Taylor's pots will shrink by 12 percent by the time they reach bone-dry conditions.

Before a pot is allowed to reach bone-dry conditions, and even before it can be molded on the wheel-head, artists sometimes sketch out the shape and design of their artwork. Depending on the type of project, art can require careful research and planning as well. For example, large-scale art projects can entail precise drawings, measurements and prototypes before creating the actual final product. This strongly parallels the work of engineers.

Artists and engineers not only design in similar ways, they also share a common consideration: aesthetics. From monumental creations such as bridges, tunnels and skyscrapers to small-scale inventions such as headphones, cellphones and even shoes, engineered items everywhere display aesthetics the same way a work of art does. Kristin Roskopf has first-hand experience with this relationship. Kristin is a UW-Madison industrial engineering undergraduate working toward the Integrated Studies and Science Engineering and Society certificate focused in design. She loves making art through drawing but uses her engineering background to focus on the practical side of materials when it comes to designing.

In her design class, she was not only assigned an analysis of the visual outcomes of specific buildings but also an evaluation of the buildings' room placement and usage of entryways. The specific job she plans on entering after graduating concentrates on human factors and optimizing materials to satisfy humans. Constructing objects so they are pleasing to the eye is a large part of her designs. Although art is incorporated in generating engineering projects, Kristin says, "I always try to keep it practical." In the end, the functional factor always prevails in an engineering project.

Even so, both Taylor and Kristin continue to perform and create their own pieces of art to retain their creative ways because, as Taylor puts it, "Every great engineer should be an artist at heart somewhere because as engineers, we are the people who are asked to design the most creative ways out of the most bizarre situations." Being able to use your engineering background as well as imagination and creativity to solve a problem is a talent. "It's the most important part of who I am as an engineer," Taylor says.

If you go back far enough in time, you will find there existed little distinction between art and science. Humans experimented and explored with the resources they could find to answer questions and further civilization. The outcome of each invention and each resolved question was a work of art. As our world advanced and developed throughout history, the connection amongst artists and engineers drifted apart, but they will always find overlap in their work. WE

Written by: Susan Yang
Photography by: Abby Schaefer

Taylor Passofaro, an engineering student, embraces his artistic talent and enjoys working in the ceramics studios.

Art students are never afraid to get their hands dirty, especially in the ceramics studios here on campus.

UW-SWE Boeing Team

UW-Madison's SWE Boeing team took first place in the national Team Tech Competition.

UW-Madison's SWE Boeing team asserts itself on the national scale.

In October 2013, for the first time, UW-Madison's Society of Women Engineers (UW-SWE) team earned first place in the national Team Tech Competition. Sponsored by Boeing and founded in 1994, the competition requires SWE chapters to solve real problems posed by partners throughout industry. Each year, teams consisting of twelve SWE engineering undergraduate students from top schools around the country compete over the course of eight months. The competition culminates with a conference in Maryland that pits the best SWE chapters against one another, during which teams are judged on team cohesion, effective use of the engineering process, professional communication with industry and the quality of their final product.

Emily Ballweg, a senior studying civil and environmental engineering with a construction management emphasis, led this year's team. The team worked with Kraft Foods to develop a cheap, easy to clean and maintain, simple and adjustable system for packing meat into Lunchable trays. Outlining the challenge, Ballweg says, "[Kraft] was interested in a mechanical system that would be a cheap, easily repaired alternative to

more complex systems which can shut down an entire plant in the event of a failure."

To solve the problem, Ballweg assembled a team of SWE members from a variety of fields. She explains that she filled the team roster with only the most interested and dedicated members, regardless of age. Over the course of the competition, the team worked closely with Kraft Foods. This involved taking numerous trips to Kraft Foods headquarters and the Peacock Lunchables plant in Illinois. Through team meetings, all attended by a Kraft representative, and numerous drafts and revisions, the team steadily perfected their design. Armed with a $1,500 budget, the team conducted cost analyses and produced a 3-D model printout, as well as a proof-of-concept mock-up after finally settling on a design dubbed the Vertically Fed Slicer. The system is easily added over an existing conveyor belt and would store meat logs to be cut and plunged into trays below. The design also improves upon overly complex robotic systems and expensive human systems as required by Kraft.

Emily Ballweg proudly holds the teams award winning design solution.

This triumph added to the stunning record of UW-SWE Boeing Tech Teams, contributing to the team's fifth podium finish in six years.

Following the success of the design, Kraft Foods committed 1.5 million dollars to further test and analyze the SWE design as well as a few others, one of which will be implemented into Lunchables factories.

This triumph added to the stunning record of UW-SWE Boeing Tech Teams, contributing to the team's fifth podium finish in six years. Furthermore, by beating out California Polytechnic, which has taken first place four times and placed three more in seven years, UW-SWE established itself as a contending heavyweight in the years to come.

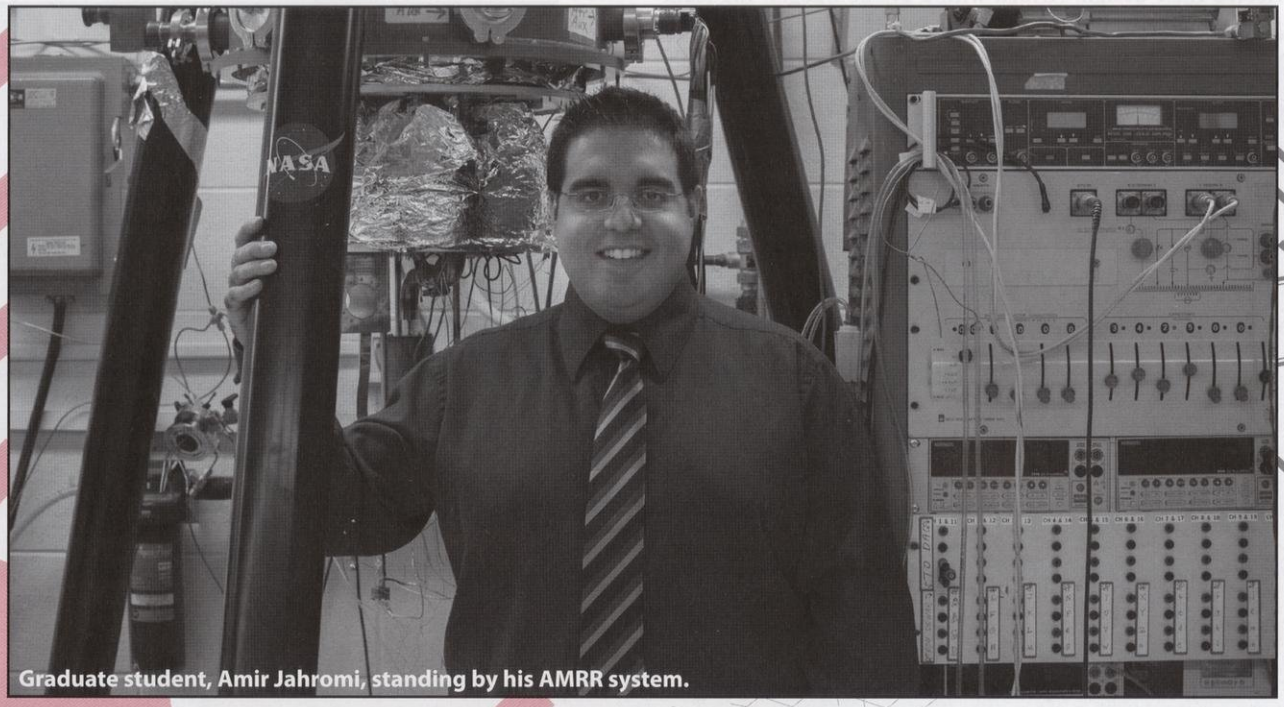
Aside from the national title however, the victory for UW-SWE Boeing also represents the dominance of UW-Madison women engineers. Engineering has historically been the battleground of titanic gender gaps, and UW-Madison is no different. While women make up 51 percent of undergraduates at UW-Madison, they are only 20 percent of those within engineering majors. SWE is a professional organization that aims to bring increased opportunities to female engineers in a field overwhelmingly dominated by men through professional development, mentorship and outreach. With any luck, SWE Boeing may entice more females to pick engineering as their major through their small, yet measurable advancement for women in engineering. WE

Written by: Samuel Fritz

Photography by: Katie Brow

THE SCIENCE OF COOL

A UW-Madison graduate student's innovative design for a sub-Kelvin refrigeration system may bring us one step closer to understanding the origins of the universe.



Graduate student, Amir Jahromi, standing by his AMRR system.

When one thinks about the applications of refrigeration in everyday life, a cold drink on a hot summer day or a leftover chicken salad sandwich that still tastes fresh three days later is typically come to mind. While food preservation via a refrigeration system is an extremely important function that has revolutionized society since its invention in the early 1800s, it has long since faded into the background of daily life and ceased to be an exciting technology.

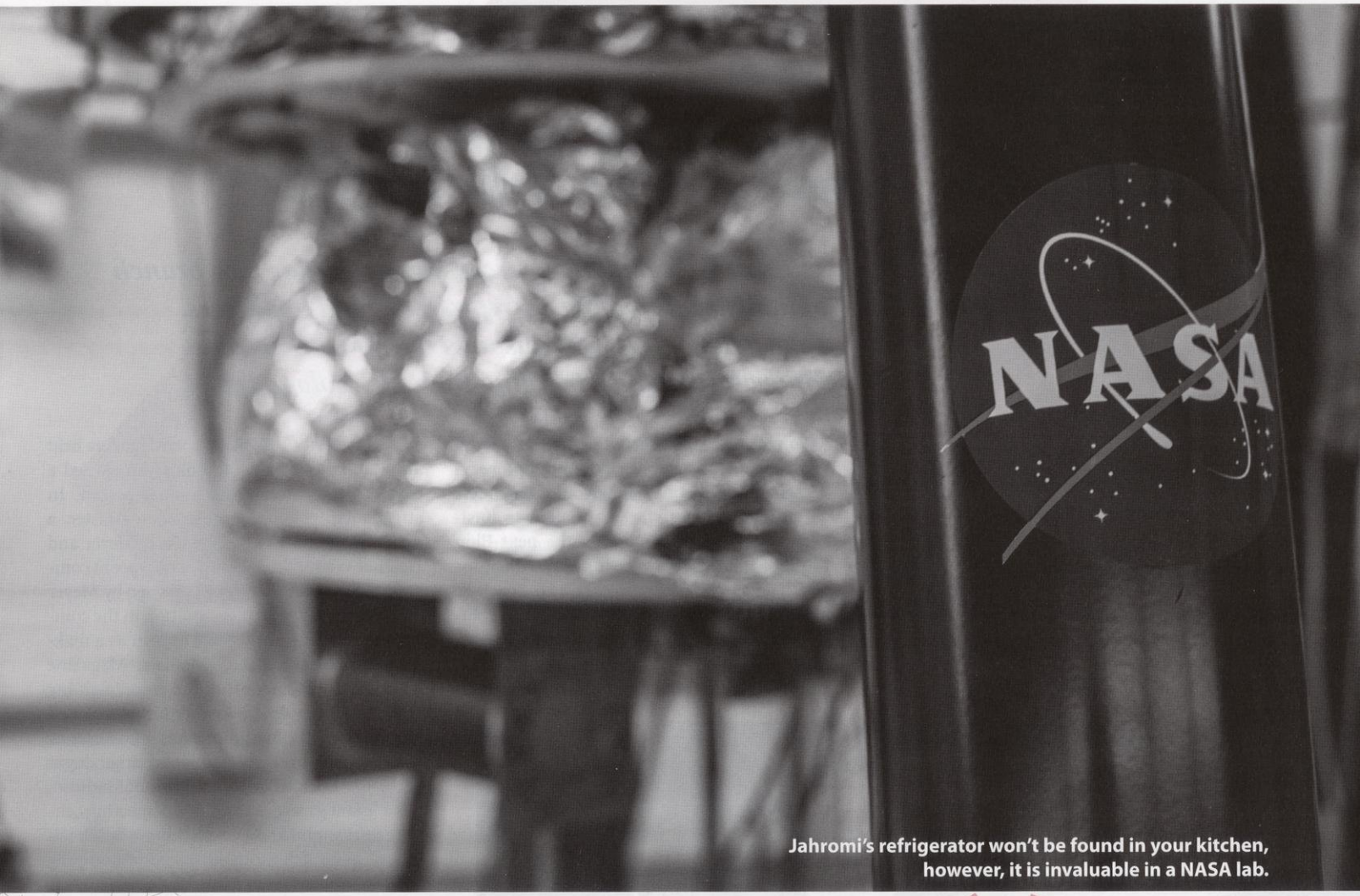
For UW-Madison graduate student Amir Jahromi, however, refrigeration is just as intriguing as it was on the day of its conception. He has taken this (literally) super cool technology to the next level. Jahromi's vision of refrigeration is not limited to that of a technology which can cool off a lukewarm glass of milk, but rather a tool that scientists can use to explore the unknown mysteries of the universe.

Jahromi is currently working on his Ph.D. in mechanical engineering with a focus on cryogenics, or low-temperature physics. He is in the midst of a research project with an extremely ambitious goal: to create an Active Magnetic Regenerative Refrigeration (AMRR) system, capable of cooling objects to less than 1 Kelvin, within extremely close range of absolute zero.

Such a cold temperature obviously has no place in a household kitchen; in a NASA lab, however, sub-Kelvin environments are invaluable. Jahromi's AMRR system can be applied in many different types of space detectors, which scientists at NASA use to measure the energy of incoming particles or photons in space. "The reason we need the low temperature background for these detectors is to lower the thermal noise substantially for a higher resolution reading," Jahromi says. "If we reduce the noise, we are better able to read the signal since it is buried in less noise." Due to his work obligation at NASA, where he spends approximately three months of each academic year, Jahromi is well aware of the significance of this kind of technology. "By knowing the energy of the particles or photons, we can get a better understanding of dark matter and the origins of our universe, figuring out what happened from the Big Bang and so forth," he adds.

With this objective in mind, Jahromi is developing a system much more complex than the average household refrigerator; however, despite the disparity in both temperature and intricacy between AMRR and normal refrigeration, the two systems are analogous and operate in similar ways. The refrigerator in a kitchen functions by cycling a refrigerant fluid from the cold side of the system – inside the refrigerator – to the hot side of the system, or the external environment. The circulating fluid absorbs heat from the inside of the refrigerator, lowering the internal temperature, and expels the heat on the other side of the system, into the air of the surrounding environment. "This reject temperature is the temperature of the ambient conditions - for conventional refrigeration systems, at room temperature," Jahromi explains. "The reject temperature of my cooling system, which I need to build for my PhD, is a nominal temperature of 1 Kelvin. So 1 Kelvin will be my hot side." With a hot side of 1 Kelvin, the goal for the cold side of the refrigeration system is 0.7 to 0.8 Kelvin. To put that into perspective, that is about 60°F lower than the temperature of the surface of Pluto, and 331°F lower than the coldest recorded temperature on Earth!

To achieve this super low temperature, Jahromi is building upon one of his own previous designs – a 1 Kelvin cooling system, which he completed for his Master's Degree in mechanical engineering at UW-Madison in 2011. With this system, he already has the hot side of his new system taken care of, and now only needs to



Jahromi's refrigerator won't be found in your kitchen, however, it is invaluable in a NASA lab.

tackle the cold side. Jahromi believes that this is possible with the use of the Superfluid Magnetic Pump (SMP) technology that he is currently developing. These SMPs will be employed in the final design of the AMRR to circulate liquid helium through the system. Two back-to-back SMPs each consist of a metal canister containing 1 mm diameter spheres of Gadolinium Gallium Garnet (GGG), a synthetic compound, with the space between the spheres filled with a mixture of liquid helium-3 and superfluid helium-4. The canister is surrounded by a superconducting magnet. "The way the pump operates, it applies a magnetic field on the constituents of the canister. As I apply a magnetic field on the constituents of the canister, the temperature of the GGG particles goes up. As the temperature of the GGG particles goes up, it has to reject its heat to the surrounding helium, because the surrounding helium is cooler," Jahromi says.

When the helium absorbs this heat, some of the superfluid helium-4 is converted into normal liquid helium-4. This creates a chemical potential imbalance between the two back-to-back pumps, since one now contains more superfluid and less normal helium than the other pump. To achieve equilibrium between the pumps, superfluid flows out of one pump and into the other through the superleak port between them, which consequently pushes some of the helium out the other side of the 2-pump system. When the magnetic fields of the two pumps are fluctuated 180 degrees out of phase with one another, a reciprocating flow of helium can be created continuously throughout the system.

Once Jahromi completes development of the SMP technology, he will be able to use these pumps in the context of a cooling system. Using SMPs in series with heat exchangers and regenerators, he will hopefully be able to achieve the sub-1 Kelvin temperature he has been working towards for the past four and a half years. He is expecting to be able to demonstrate the entire system to complete his PhD by December of 2015. "My responsibility here is to just do a proof of concept, a validation of this system, because no one else has ever done this," Jahromi says. After he completes his part of the project, he will graduate and pass off the project to another student, who will be able to bring the technology to the implementation stage. "Provided that it will work," laughs Jahromi. "I am optimistic, but we will see."

From that point, Jahromi is not sure if he will be further involved in the project. "I will be done with my PhD, on a personal basis, and then I will be able to move on with my job at NASA to work there permanently. I might be involved later on, because I am the best bridge between NASA and this technology here at UW-Madison. It is something I worked on, something that I can do a pitch on at NASA, and say, maybe we can use this technology for future detectors," Jahromi says.

Next time you grab a snack from your refrigerator, take a moment to appreciate the unexpected applications of a seemingly commonplace technology; while refrigeration is hard at work keeping food fresh, it is also being used to penetrate the dark void of space. For that, thank Amir Jahromi, who has proven that refrigeration is far cooler than ever thought possible. WE

Written by: Alyssa Hantzsch

Photography by: Nate Hartung

Design by: Jason Wan

The Startup

The startup company is becoming a popular new branch of industry for young entrepreneurs and engineers. Take a look at how Madison is recognizing its own innovators in this emerging high technology sector.

In recent years, it seems as though startup companies have been popping up everywhere in Silicon Valley; young engineers with creative ideas starting their own businesses in hopes of becoming the next Elon Musk of this generation. Musk is credited for starting Paypal, Tesla Motors and Space-X, and is known for his innovative and revolutionary outlook. With that kind of reputation, it is only natural that the movers and shakers of the engineering world are looking to Musk and other start-up stars of the Silicon Valley as role models. However, the start-up craze is not concentrated in California anymore. It has moved its way across the country to the local capital, Madison, WI. This year, Madison Magazine has made it a point to recognize this creativity by introducing the "M-List," a debut of the top 53 entrepreneurs and technologists who have recently started their own innovative and exciting high-technology companies in Madison.

In November of 2013, Madison Magazine held an event in honor of the folks who earned a coveted spot on the first annual M-List. In attendance was the number one M-Lister, a dynamic duo power couple, Chris Meyer and Heather Wentler of Sector67, a non-profit company that was started three years ago by Meyer and has rapidly gained recognition in the community. The business is best known as a makerspace or hackerspace. Madison Magazine describes the essence of Sector67 by explaining that people can dream up anything there and can "tinker with toys, jumpstart a business or hang out with hackers—it is just another day at Sector67." Located on the east side of Madison, it is a "giant garage, a community meeting center, an art studio and a co-working space. It is a school, a woodshop, an advanced prototyping

53 entrepreneurs were honored on the M-List and joined together for a night of recognition at the Majestic Theater in Madison.

If you are in engineering, you are in hot demand at this point. Everybody wants that talent and everyone, Silicon Valley included, thinks they don't have enough engineering talent.

center, a business incubator, a library and a 'social club for nerds,' as one member puts it." Quickly becoming a breeding ground for creativity and innovation, there's no question as to why Sector67 is at the top of the M-List.

The list of top entrepreneurs does not stop there. It ranks 52 other companies and people with the same magnitude of accomplishments as Sector67, making Madison an emerging community in the realm of technology. The keynote speaker of the M-List event, Hugh Forrest, echoes a common thread throughout each M-Lister success story. Forrest is the director of South By Southwest Interactive, a company that brings together innovators, entrepreneurs and movers and shakers to host events that address current issues in the technology sector and provide networking opportunities. In his speech to the M-Listers, Forrest's main point has to do with creativity, and he urges people to "find ways to encourage mass creativity. Yes, South By Southwest Interactive is a technology event, but ultimately we are a creativity event that happens to use the language of technology." Forrest and the M-Listers seem to all agree that creativity is the basis for a successful start up.

In his speech, Forrest lists off the seven life lessons that South by Southwest lives by, which more or less sound like the top pieces of advice for people trying to launch a business. Although each of the seven lessons seem daunting and/or obvious, such as number seven, try to make the world a better place, the M-List recipients clap and cheer after each point in support; they can attest to those lessons being pertinent to their success.

Forrest's advice does not come without experience. Through his work at South by Southwest, he has hosted keynote speakers who are the product of those lessons. For example, Forrest recalls memories of their most recent guests. He says, "Our keynote speaker last March was Elon Musk. His quote last year was, 'I want to die on Mars, but not on impact.' So that was pretty cool. We have also been fortunate enough to have former Vice President Al Gore speak at South by Southwest interactive the last two years. Peter Thiel, harsh critic of our education system, has also spoken at the event. He has a program called the Thiel Fellowship, where he pays college students under 20 years old $100,000 to drop out of college in hopes that they will become the next Facebook." With that being said, Forrest has had the opportunity to showcase other start-up success stories and highlight innovation such as the M-Listers of Madison, WI.

After the event, the magazine was able to hear what advice to engineering students Forrest could provide. At first, Forrest responds by joking that we should all "quit and become liberal arts majors," but, in all seriousness, he says, "If you are in engineering, you are in hot demand at this point. Everybody wants that talent and everyone, Silicon Valley included, thinks they do not have enough engineering talent. So my advice is to put in as much work as you can now and you will reap the benefits significantly once you get out." When asked his opinion on the potential to join the emerging start-up world, Forrest states, "What is remarkable about the start-up world now is it can happen so many places. The barriers to entry are so much smaller now than they ever were before. We would love to see more engineers come to South by Southwest. You are at the top of the market and can name your price and name your city."

With that type of encouragement, the future looks bright for young engineers hoping to start their own business, and, with the support of M-Listers like Sector67, Madison is a great environment to facilitate that growth. Every year, Madison Magazine will be debuting a new M-List. Perhaps some fresh Badger graduates will be on the list next year. WE

Written by: Ashley Bredemus

Photography by: Catie Qi

The M-List recognizes the top entrepeneurs and technologists.

WELCOME TO... GARAGE PHYSICS

Where anything you imagine...

The first powered flight on December 17 of 1903 initiated an aviation industry. Orville and Wilbur Wright's invention grew out of experimentation in their bicycle shop. Neither received a high school diploma. They were handy. They had imagination. They studied what they needed to know. They had a place to test their ideas. They had perseverance. And they had each other.

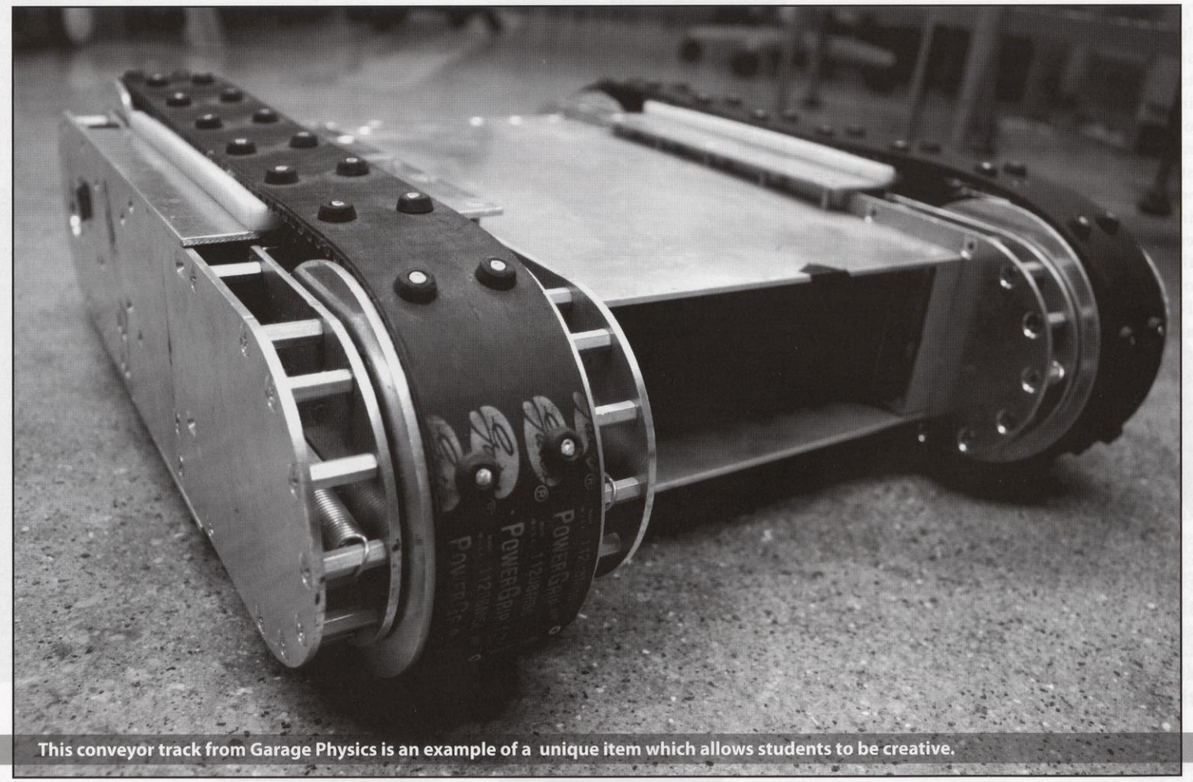
It can be difficult to find a workshop on campus where a few students can be creative, explore their own innovative ideas, think outside the box, meet like-minded students outside their major and perhaps even launch a new industry. That's where Garage Physics comes in.

Garage Physics is student oriented open laboratory space. Started in February of 2013, already over twenty students are participating and about 12 projects are currently active. Sponsored by the Physics department, Garage it is not just about physics research. Students of variety of majors and ages are working together interdisciplinary projects that may surprise you.

Professor of Physics, Duncan Carlsmith created Garage Physics with the help of Brett Unks, Laboratory Instructional Manager of Physics Department. Professor Carlsmith thinks this kind of open work space is enabling, and that challenging students to pursue their own idea and put them into practice is an important component of a 21st century university educational system.

"Technology and information are increasingly accessible. Control processor electronics, 3D printers, laser cutters, and open source mechanical and electrical design tools and software development tools have made design and prototyping available even to the grade school student. Hands-on work (trying/making) constitute a form of learning complementary to the traditional classroom and laboratory experience," Carlsmith says. "Building a robot and a cellphone app to control it are child's play today. Garage Physics is intended to provide 'Fabrication Lab' known as fablab type of space for students to take advantage of and to push technology, to be inventive and challenge themselves, especially at the boundaries of disciplines."

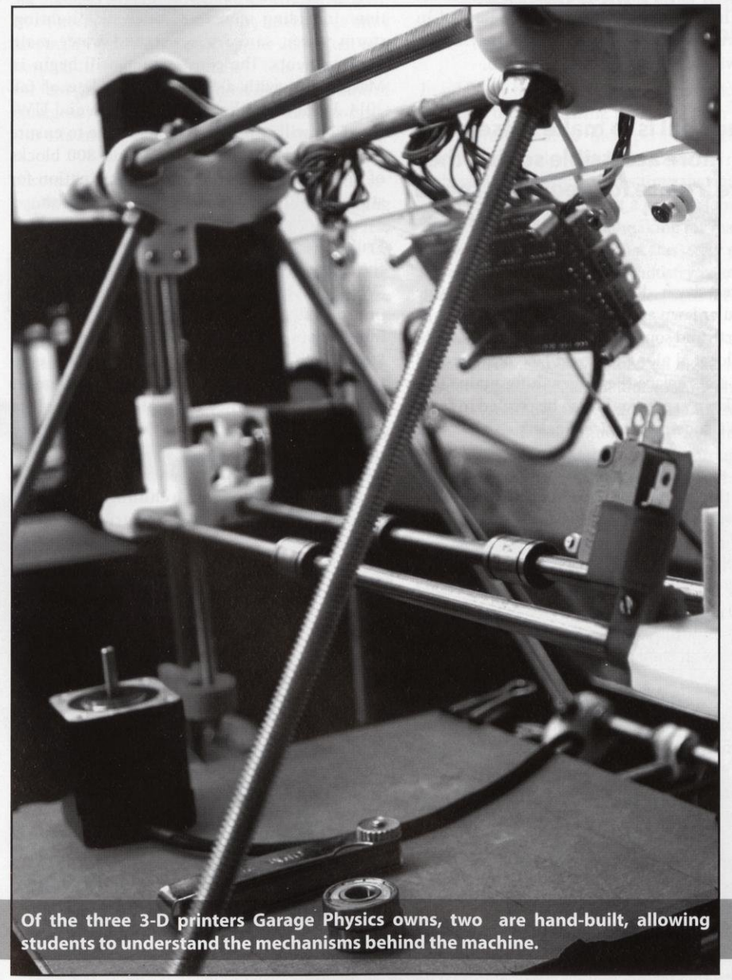
University open laboratories for R&D are not new. Fablabs and innovation centers may be found at many universities worldwide, and the makerspace movement testifies to the popularity of explorations with consumer grade technology. The engineering department at UW-Madison supports several different project-oriented programs including Microgravity team, Hybrid Motor team and the Wisconsin Space Grant [Rocket] Competition. What makes Garage Physics unique perhaps is its support for truly multidisciplinary projects spanning the campus, its focus on undergraduates, and its recognition of entrepreneurship broadly defined as essential in everyone's education.



This conveyor track from Garage Physics is an example of a unique item which allows students to be creative.

Students are welcome to join Garage Physics for non-credit work or for independent work for credit through their department or the URS program. A pilot interdisciplinary makerspace centered class on sustainability, ECE379, lead by Prof. Carlsmith, Prof. Erica Halverson in the School of Education, and Prof. Giri Ventkataramanan in Electrical Engineering, works in the Garage prototyping sustainability projects.

Arguably, one of the greatest inventions ever happened in their house garage.



Of the three 3-D printers Garage Physics owns, two are hand-built, allowing students to understand the mechanisms behind the machine.

Projects that are currently active is Garage Physics include:

3D Food Printing: Collaborating with the food science department with support from URS program, this project aim to develop personal 3D food printing technologies.

Quadcopter: This student initiated project is close to its goal of building from scratch a multipurpose quadcoper controlled by Arduino circuitry that can carry a 20 lb instrumentation payload.

Troy Project: Organized by Professor Carlsmith, this project is developing cosmic ray muon tomography for application to archaeology, connected to the UW Molecular Archaeology Group.

Bubble Stability: Pursued by two physics students, this project studies stable bubble inflow structures and expects to publish a paper about their findings.

Living Pantry: Part of the ECE 379 class, this project is prototyping a self-sufficient LED-lit hydroponic indoor greenhouse for food production.

Grey Water Toilet: Another ECE 379 project, the goal of this project is a prototype toilet supplied by grey water from a shower or bath.

The Garage Physics is currently looking for students to participate in active or suggested projects and would welcome new ideas. Garage Physics is located in Sterling Hall.

For more information about Garage Physics, visit **https://wiki.physics.wisc.edu/garage**.

Written by: Hanwook Chung
Photography by: Olivia Fritz
Design by: Jason Wan

The Fifth Season

How the renovation of Library Mall has become a part of life for former and current Badgers alike.

For years, current and former UW-Madison students have dealt with unforgiving weather conditions, ranging from 40 mph winds in the dead of winter to triple digit temperatures. As most people from Wisconsin might say, it comes with the territory. There is, however, one season that tends to be overlooked by unsuspecting visitors. Like a reoccurring nightmare, construction on the UW-Madison campus has been a seemingly year-round event for as long as most students can remember.

Whether it is the sight of a new high-rise apartment or renovations to an aging university building, fences guarding bulldozers and piles of debris are a common reality. Although the frequent improvements showcase UW-Madison's commitment to providing its students and faculty with the best amenities possible, the consistent rattling and banging of equipment can wear on even the most patient supporters. One famous source of such frustration is the construction at Library Mall.

For the past ten years, the area between the UW Memorial Library and Wisconsin Historical Society has been a hub for construction workers. In fact, students that arrived in 2008 never had the chance to see Library Mall without some sort of construction. The major cause of this inconvenience is ongoing utility repairs.

Construction crews have been hard at work over the past few years to take care of ongoing problems with utilities in the area. "We have been doing a lot of utility upgrades in the area, actually all the way down East Campus Mall from Dayton Street to Langdon Street over the past few years," says Gary Brown, UW Director of Campus Planning and Landscape Architecture.

These improvements will ensure that common problems related to utility failures are only a minor inconvenience. "We now have a walkable utility tunnel this entire length, including under State Street and Library Mall to Langdon Street, that can be serviced in the tunnel, rather than having to dig up all the utilities and repair them when they have a problem," Brown says.

Despite these improvements, the future of Library Mall remains very much in the balance. Three different design options are being explored with regards to its redevelopment. The "oval design" would create a large oval sidewalk system with a lawn in the middle, similar to what exists today. The iconic Hagenah fountain, located in the heart of Library Mall for years, may be replaced with a more interactive fountain.

The goal is to make these areas more accessible so that they are a place for people to spend time and relax.

The "great lawn design" would create a large rectangular lawn area with larger sidewalks running north and south. A new water feature would also be located along the west face of Memorial Library and replace the Hagenah fountain. Two smaller lawn areas would also be created in front of the Wisconsin Historical Society.

Finally, a "historical design" would essentially rebuild the existing configuration with expanded sidewalks to handle the pedestrian and bicycle traffic that flows through Library Mall. The Hagenah fountain would be refurbished, while the existing Class of 1923 Clock Tower would be relocated. This preservationist option would return everything to the status quo of a decade ago, before all the construction in Library Mall began to take place.

In addition to the continuation of the Library Mall construction, the city of Madison, in partnership with UW-Madison, is preparing for construction on the adjacent 700 and 800 blocks of the State Street Mall.

Commonly mistaken as being part of Library Mall, these two blocks serve as the continuation of State Street by running past Memorial Library, the Wisconsin Historical Society and the Mosse Humanities Building. "Even though the university is responsible for Library Mall, and the city is in charge of the 700 and 800 blocks, it is crucial that we work together in order to ensure the entire area functions well," says Bill Fruhling, AICP Principle Planner for the City of Madison.

The blocks will undergo complete reconstruction including concrete sidewalk, lighting, storm sewer, sanitary sewer and water main improvements. The construction will begin in March 2014 with a tentative end date of fall 2014. Until then, the city of Madison and UW-Madison will continue to collaborate to ensure that Library Mall and the 700 and 800 blocks of State Street are once again a destination for students, alumni, and residents of Madison.

Fruhling describes the partnership between the university and the city of Madison, saying, "We are working closely with the university to improve these two blocks, since they fall at the intersection of two iconic Madison corridors, State Street and East Campus Mall." He continues, "The goal is to make these areas more accessible so that they are a place for people to spend time and relax."

As seasons pass and new generations of Badgers continue to trudge through chilling snowstorms and unbearable heat waves, construction on the UW-Madison campus will continue to serve as a constant reminder of the university's commitment to providing all students with world-class facilities. Although frustration may set in following months of seemingly endless construction projects at Library Mall, like long winter nights, it too will pass in favor brighter days. Brown describes the end results from years of construction at Library Mall: "Library Mall will continue to be a major outdoor gathering area for not only the university, but the Madison community at-large." WE

Written by: Matt Latuszek

Design by: Cara Sandlass

Air Ambulance: Simulations for a Safer Flight

UW-Madison researchers are developing more practical training methods for medics and pilots working in aeromedical flights.

A Serbian officer lies on the battlefield of the Great War, far from any medical facility and dying from a gunshot wound. Suddenly, he hears a loud roar above his head and is lifted aboard a French Air Service plane and taken to a hospital in a matter of minutes. This event marks the first aeromedical evacuation flight, a method of emergency medical transportation that has saved this officer's life and many others to date.

Also called MedEvacs, these aircraft have the capability to transport patients with life-threatening conditions to nearby hospitals in significantly less time than land ambulances. However, one of the challenges the medics and pilots working in these helicopters often face is the inability to synergize from lack of collaborative training.

Chris Johnson, a UW-Madison post-doctoral research fellow, is investigating the current forms of aeromedical evacuation training with the goal of creating a new and more practical training simulation. "The training currently exists in silos [individually], because pilots get trained one way and medics get trained in an emergency room setting. Right now, the first time trainees experience a mission together is on a real mission," Johnson says. The current system of training uses a simulation for pilots and biologically correct mannequins for medics, but skills such as communication, cooperation and group decision-making are left out.

"Right now, the first time trainees experience a mission together is on a real mission."
- Chris Johnson

In addition to issues with communication, pilots may face hazards during flight like poor weather, which greatly affects their performance. Medics may have difficulty with lack of medical resources or have a constraint such as time that may influence the way they can treat a patient. Johnson has researched pilots' decision-making for many years and was intrigued to find that the safety record in the aeromedical evacuation industry is low due to pilots' inability to make snap decisions for both the health and safety of the patient.

Johnson's research in aeromedical flights has led to the development of a simulation that integrates both types of training, aeronautical and medical, into one. "Our goal is to improve safety in aeromedical evacuation, and we intend to do that through developing a more robust simulation that integrates both the aviation side as well as the medical side of the business. We want to combine these two training schemes to create a scenario where we are training technical skills together, as well as non-technical skills," Johnson says. The simulation will allow both pilots and medics to experience a more realistic mission and teach them to make appropriate decisions in that environment.

The main goal of the research is to establish a simulation in an encapsulated area representing a helicopter cabin so that trainees can physically experience working in a cramped space. However, the current simulation in progress is fully virtual, using a serious game to create life-like situations that the medics and pilots may experience during a real aeromedical evacuation mission. The virtual game contains many scenarios that trainees may deal with so that they can improve their decision-making. "We want to give them exposure in a virtual environment to prepare them for what to expect, the pressures and emotional constraints, and teach them how to organize the resources they have aboard an aircraft to maximize the patient safety," Johnson says.

Hopefully, the result of this research will increase the safety record of aeromedical flights. With stronger and more practical training, more pilots and medics working in MedEvacs will save time, resources and lives. WE

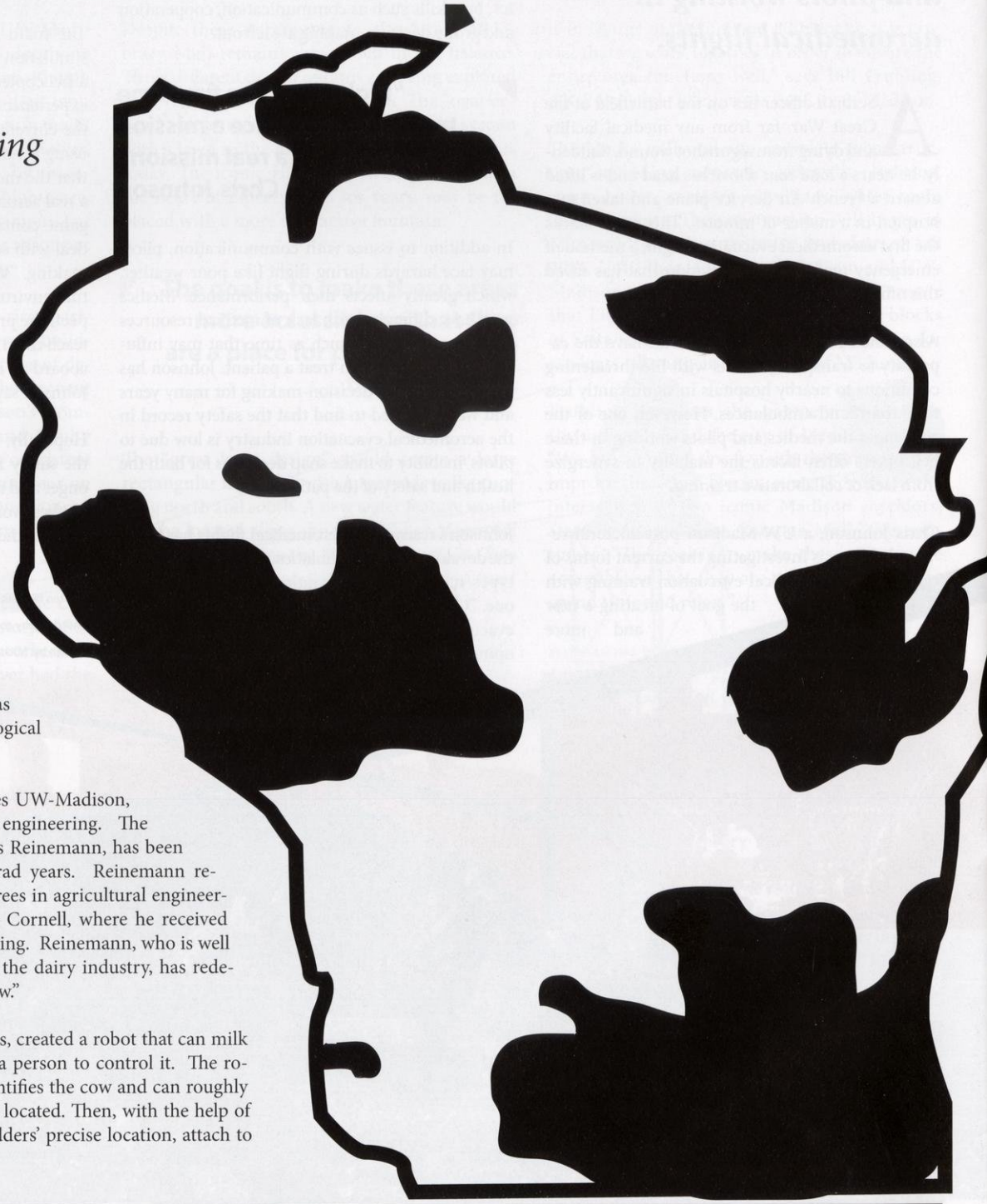
Written by: Kelsey Bright

Photography courtesy of ARMY.MIL

Design by: Michael Khor

Milking the Cow: A New Perspective

UW-Madison agricultural engineering department chair, Douglas Reinemann, has redefined the milking process.



Wisconsin is often referred to as the "Dairy State," and rightfully so. Since Wisconsin's agricultural rise in the late 1800s, Wisconsin has been a leading producer in the dairy industry. For many years, the dairy industry has relied on mechanical processes to retrieve milk from cows. The mechanical techniques worked well; however, since 1980, a larger focus has shifted towards robotics and the biological side of the industry.

At the epicenter of the Dairy State lies UW-Madison, traditionally excelling in agricultural engineering. The current department chair, Dr. Douglas Reinemann, has been with UW-Madison since his undergrad years. Reinemann received his bachelor's and master's degrees in agricultural engineering at UW-Madison before attending Cornell, where he received his Ph.D., also in agricultural engineering. Reinemann, who is well known for his many contributions to the dairy industry, has redefined what it means to truly "milk a cow."

Reinemann, with his fellow researchers, created a robot that can milk up to sixty cows without the need of a person to control it. The robot uses recognition software that identifies the cow and can roughly determine where the cow's udders are located. Then, with the help of sensors, the robot can pinpoint the udders' precise location, attach to them and begin the milking process.

Once milking has begun, the robot examines the milk quality, checking the bacteria count, sematic cell count and the color of the milk. If the milk does not pass these tests (for example, if the milk has blood in it, causing a discoloration), the robot is programmed to discard the milk. The robot does not stop there; in fact, it sends a message to the farmer, telling the farmer to examine the specific cow for illnesses related to the findings. This technology saves famers both time and energy, allowing for a maximization of milk output.

Currently, these robots are more applicable on small farms because of their high price tag. Typically, these farms have at least two robots. The robots operate in a boxed-in area, located at the end of an open stable. The open stable provides a more relaxed, natural lifestyle for the cows, as they are not confined to a small pen. In order to familiarize the cows with the robot, feed is placed in the milking areas to initially entice the cows to enter the box. Over time, the cows are conditioned to associate the box with milking and will return on their own will.

Reinemann believes the industry will expand exponentially in the next ten years, as he sees robots taking over for the current mechanical mechanisms. As technology advances and the sensors improve, the robots will draw even more attention, likely from larger dairy farms. Importantly, as Reinemann states, "[The small farmer] will continue to see benefits as larger farms begin to use the boxes. The technology is size neutral. Whether you have two boxes or twenty boxes, you can only have sixty cows per box." This is encouraging news to small farmers, who have seen large gains in production since implementing these boxes. Size neutrality also encourages farmers to space the cows out across the land, making for better living conditions.

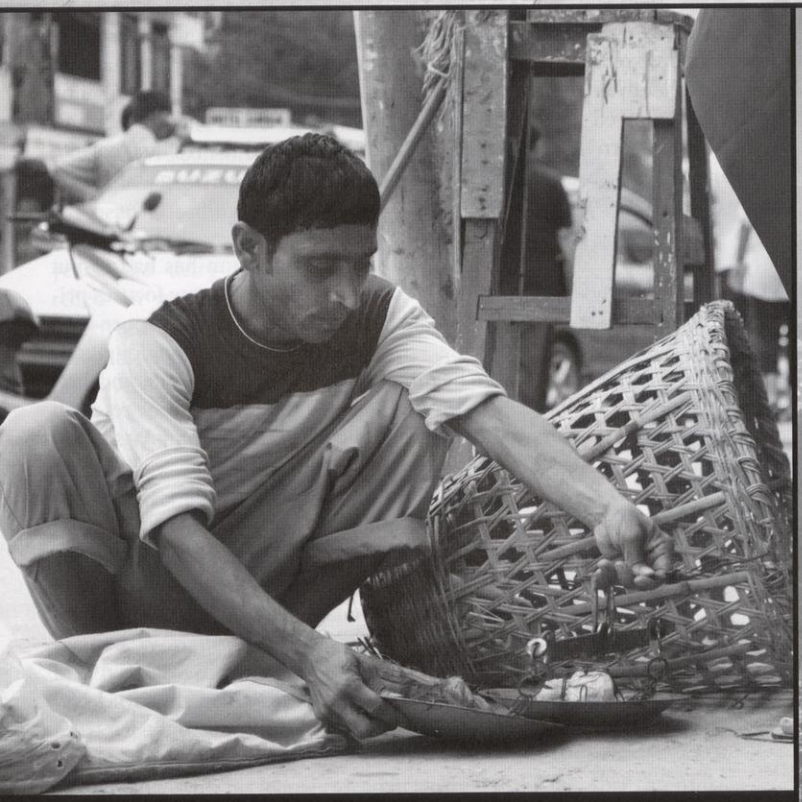
Reinemann's machine milking research is just one portion of his contribution to agricultural engineering. He has also researched stray voltage, which focuses on how much voltage a cow can withstand before becoming irritated. Based on his findings, lawmakers in many states have passed laws that restrict the amount of voltage used on cows to induce milking. Reinemann has also compared the advantages and disadvantages of using corn to produce ethanol. His research proved that the process is still efficient, and it is more lucrative to first use the corn to produce ethanol and then to feed the residual corn to cows and other animals. This process does not affect the cows and brings more money to the farmer.

Since accepting his department chair position, Reinemann has had to put most of his stray voltage and ethanol research on hold. He now focuses primarily on his milking machine research and teaching several upper-level courses in agricultural engineering. The ever-advancing technology constantly provides ways for researchers like Reinemann to innovate and better the existing technologies. The groundbreaking milking machine research done on campus and around the state continues to exemplify why Wisconsin is the "Dairy State." WE

Written by: Justin Alt

Wanderstruck

a photo essay



TOP: Eternal Peace Flame in Lumbini - the birthplace of Gautam Buddha.

RIGHT: Paragliding over Pokhara.

LEFT: Carrying goods and a scale in the basket from his village, a merchant sets up a shop on the sidewalk by lakeside Pokhara.

**Check out wisconsinengineer.com for more photos

Photos by: Parwat Regmi

Lucky Bucky:

Babcock Hall Dairy Store to Debut St. Paddy's Day Flavors

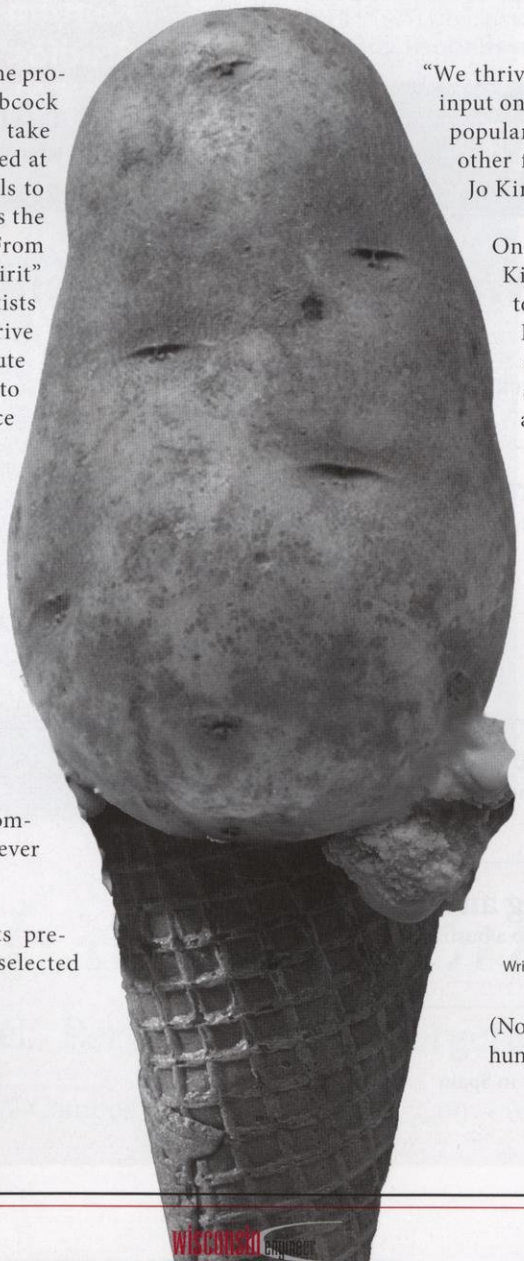
UW-Madison is known far and wide for the production of the campus's very own Babcock ice cream. Students and faculty alike take pleasure in the delicious variety of flavors offered at many locations, ranging from dorm dining halls to student unions. As most people know, March is the month of the Irish holiday, St. Patrick's Day. From leprechauns to Shamrock Shakes, the "Irish spirit" will soon be all over. This year, the food scientists at the Babcock production facility on Linden Drive have been hard at work creating their own tribute to St. Paddy's Day. Babcock Dairy is excited to present its latest creation: St. Patrick's Day ice cream flavors.

According to head of production, Jo King, "Seasonal ice cream flavors are typically a big hit. Pumpkin pie and caramel apple were especially popular this past winter ... so why not ring in St. Patrick's with its very own feature flavors?"

King's production team quickly went to work brainstorming their favorite St. Patrick's Day treats.

"This is why I love my job as a food scientist," comments food scientist Anna Grahm, "My work never fails to excite me!"

After narrowing their list, the food scientists presented potential ice cream flavors to specially selected focus groups.



"We thrive on constructive criticism. We really wanted input on whether or not certain flavor choices would be popular. The last thing we wanted was to produce another flop like last Christmas's Fantastic Fruitcake," Jo King says.

Once results were received from the focus groups, King and his team of Babcock food scientists went to work developing the most popular St. Patrick's Day flavors. Customers can look forward to seeing options like Irish Soda Bread, Cabbage and Carrots, Golden Wonder (a very traditional, potato-flavored ice cream), Corned Beef and Bailey's Irish Cream – which is projected to be very popular.

"I am especially excited for the public's reaction to Corned Beef and Cabbage and Carrots. This was our first time experimenting with these savory ice cream flavors!" remarks food scientist Bill Loney.

When can fans of Babcock ice cream expect the new "Irish-inspired" choices to hit stores and stands?

"We will be releasing everything the week of March 17th so that the new flavors can be enjoyed on the holiday itself. We are working on promotional tactics right now," King says. WE

Written by: Margo Donnell

(Note, this article is a satire meant to provide humor and comic relief to all readers.)

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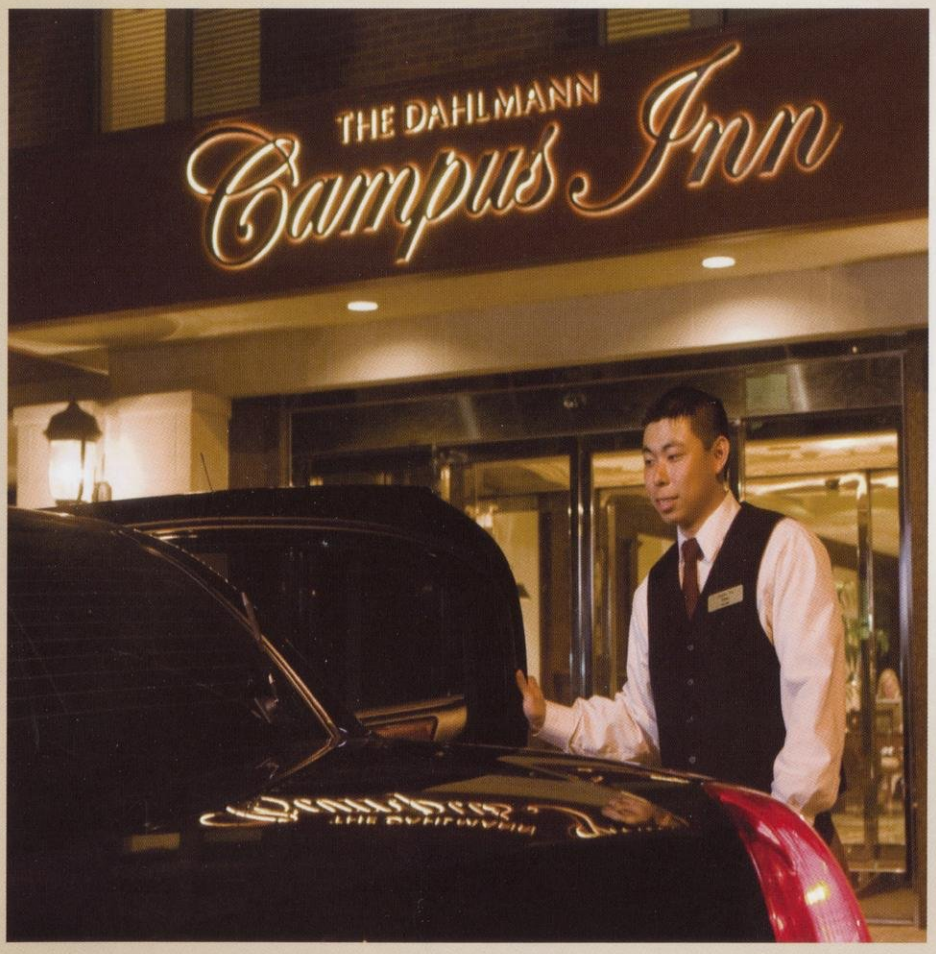

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