# Wisconsin engineer. Volume 118, Number 3 May 2014

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

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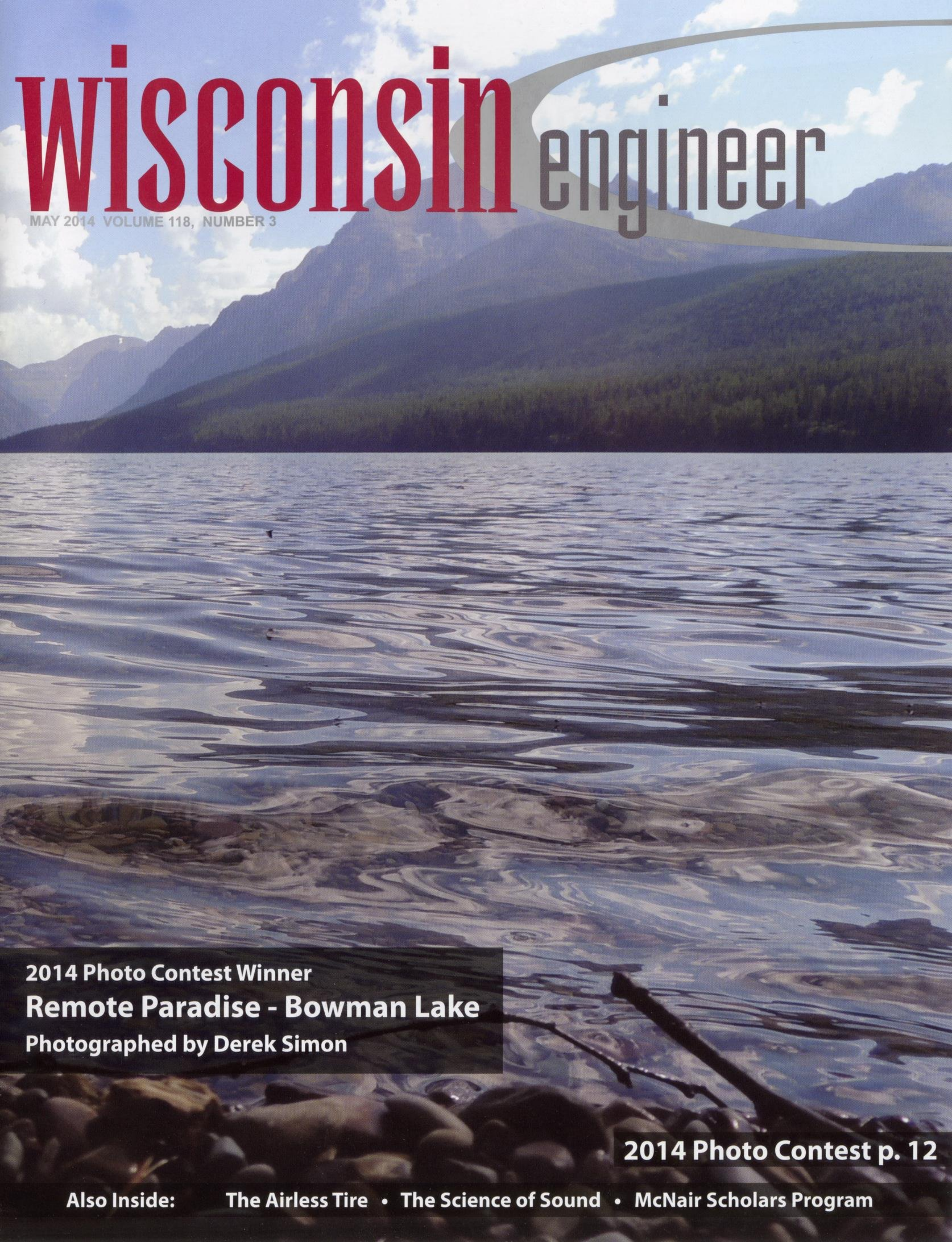
# wisconsin engineer

MAY 2014 VOLUME 118, NUMBER 3



**2014 Photo Contest Winner**

**Remote Paradise - Bowman Lake**

**Photographed by Derek Simon**

**2014 Photo Contest p. 12**

**Also Inside:** The Airless Tire • The Science of Sound • McNair Scholars Program

# Wisconsin engineer

Published by the students of the University of Wisconsin-Madison VOLUME 118, NUMBER 3 MAY 2014

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The *Wisconsin Engineer* Magazine, a member of the Associated Collegiate Press, is published by students at UW-Madison. Philosophies and opinions expressed in this magazine do not necessarily reflect those of the College of Engineering and its management. All interested students have an equal opportunity to contribute to this publication.
**Faculty Advisor:** Steven Zwickel **Publisher:** American Printing Company, Madison, WI **Web address:** http://www.wisconsinengineer.com
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The *Wisconsin Engineer* is published four times yearly in October, December, March and May by the Wisconsin Engineering Journal Association.
Subscription is $12 for one year. 

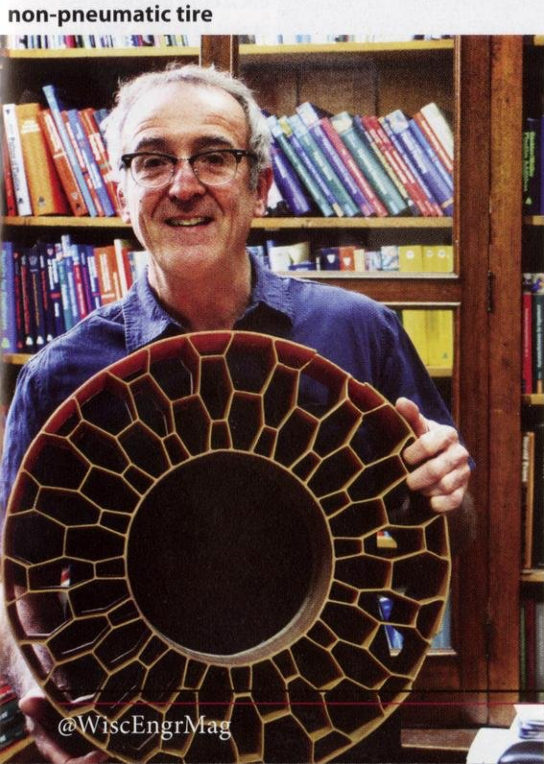
# The Airless Tire

## *A follow-up to the article "Reinventing the Wheel," which discusses the direction that non-pneumatic tires could take in the future.*

Imagine a world where vehicle tires could not be popped, and if you ran over a pothole, you would not have to go through the dangerous process of changing a tire on the side of the road. This could all be possible due to an innovative non-pneumatic tire that was developed here on the UW-Madison campus.

The magazine first covered this story in the April 2009 article 'Reinventing the Wheel.' At the time, the U.S. Department of Defense hired the Wausau-based Resilient Technologies in collaboration with the UW-Madison Polymer Engineering Center (PEC) to develop a non-pneumatic (airless) tire to be used on heavy-duty military vehicles similar to the Humvee. The goal of the project was to design a tire that would be able to continue being driven on even after part of it had been blown off. This means that the vehicles' tires could be neither shot off nor could they be blown off, at least not as easily as with traditional tires.

**Professor Osswald holding a prototype for the non-pneumatic tire**



Resilient Technologies and the UW-Madison PEC spent the next two years in exhaustive design and testing to develop the current product: an injection molded non-pneumatic tire with a honeycomb-like support structure. This design is currently being utilized by the U.S. Military.

Similar to anti-lock brakes, which were initially developed for the military, this technology has recently become commercialized. The Polaris Sportsman WV850 H.O. ATV has recently hit the market, becoming the first commercial product to have these non-pneumatic tires. This product even made Popular Science's "The 10 Best Things from February 2014" list. Both of the vehicles on which the non-pneumatic tires are being used are specifically off-road vehicles, not commercial vehicles.

This is because, despite their many advantages, non-pneumatic tires are still not widely utilized, which begs the question, "Why?" According to Osswald, there are still some design improvements that would need to happen in order to make commercial mass production viable. "There is one step still…which is building the sidewall," Osswald states. He explains that this is an important and semi-difficult step towards making the tire a universally useful product. While the sidewall is not needed on the vehicles on which the tire is currently being used, it would be important to develop a design that included a sidewall before it could be used on regular vehicles.

> **"It would be very low maintenance, and you could gear the bicycle tires to certain softness or hardness; you would have a lot more to play with than just pressurized air"**
> **–Professor Osswald**

As seen in the current design, the tire has no sidewalls, only the exposed honeycomb structure. Without the sidewalls, the tires would not operate well on a commercial scale. This is because the sidewalls prevent debris from getting stuck in the honeycomb support structure and unbalancing the tire itself. This would be an especially important feature in areas, such as Wisconsin, that get snow during the winter. Without the sidewalls, the snow and salt from the roads would get caught in the tire itself.

However, designing a sidewall is not so simple. "[The tire] has to be closed, and if that's the case, you are going to have a much harder time conducting the heat out from the inner structure," Osswald predicts. This could lead to problems with the tire overheating and could potentially lead to cooling systems being placed in the non-pneumatic tires.

To balance this design challenge, there are advantages to airless tires besides their inability to burst. These additional advantages to using non-pneumatic tires could include: better gas mileage, easier manufacturing and higher variation of materials that could be used to give different ride qualities.

Even though there are challenges to creating a fully marketable product, Osswald feels it is something he would like to see come to pass. He feels that the commercial market for non-pneumatic tires is heading towards specialized vehicles, like bicycles, ATVs, larger trucks and, possibly later on, regular cars. "It would be very low maintenance, and you could gear the bicycle tires to certain softness or hardness… you would have a lot more to play with than just pressurized air," Osswald says. In specializing the material for each application, there could be different tires used for racing bikes and mountain bikes, optimizing the performance of both. It could also mean that sports cars and trucks could have different tire materials that could also enhance not only the ride quality based on the requirements of each vehicle, but also vehicle performance. Non-pneumatic tires allow for more options when it comes to performance, as there are more material options than merely "air."

While non-pneumatic tires may not be in mass production today, it is possible that they may solve many of the problems with current standard issue vehicle tires. As presented in the "Reinventing the Wheel" article, the non-pneumatic tire has many real-world applications already, and all it would take is some additional development to make them ready for the standard market. In the future, this could lead to improved ride quality and better safety. Airless tires include the best of all worlds. WE

Written by: Heather Ruhl
Photography by: Samuel Fritz
Design by: Lukas Lindquist

# Jumping Back in Time

## After more than two decades, graduation returns to historic Camp Randall Stadium.

Over the course of its 96 year history, Camp Randall Stadium has been the site of a variety of lasting memories for generations of Badgers. Thousands of students and alumni flock to the stadium each fall to enjoy Badger Football as well as the now famous "Jump Around" tradition. On May 17th, more memories are sure to be made when the Class of 2014 celebrates the first commencement at Camp Randall Stadium in more than 20 years. As an iconic landmark on the UW-Madison campus, Camp Randall Stadium is the ideal place for the senior class to gather together to commemorate the culmination of years of hard work and dedication.

Part of the excitement surrounding the return of commencement to Camp Randall Stadium can be attributed to the rarity of such an event. Commencement was first held outdoors at Camp Randall Stadium in 1925 with "mechanical amplifiers," a primitive version of speakers that would go unrecognized by practically any guest at this year's graduation ceremony. Graduation festivities were then held annually at Camp Randall Stadium from about 1960 to 1990. Since that time, commencement ceremonies have routinely been held at the Kohl Center over the course of a Saturday and Sunday during which four ceremonies have been organized by school and college.

Despite the recent trend of holding graduation ceremonies at the Kohl Center, there has always been a sense of intrigue regarding a possible return to Camp Randall Stadium. The idea had been discussed for over three years, but it failed to come to fruition until Chancellor Rebecca Blank openly advocated for the idea. Joe Meeker, President of the Class of 2014 at UW-Madison, described the initial process saying, "One of the first things Chancellor Blank asked the student government in our initial meeting was why commencement was not held at Camp Randall. To be honest no one really had an answer, it was just always at the Kohl Center."

After receiving a vote of confidence from Chancellor Blank, the idea of commencement at Camp Randall Stadium was examined more closely. Weeks of discussions took place regarding the possibility of moving commencement back to Camp Randall Stadium. Following extensive deliberations including students, student leaders and administrative officials, the decision was finalized. This May, nearly 6,000 graduates and 40,000 guests will descend upon Camp Randall Stadium to mark the culmination of their educational careers at UW-Madison.

The event should prove to be a powerful symbol of unity for the entire senior class; especially when considering that the students are together as a full class only one other time - freshman convocation. "Sitting alongside your entire graduating class will be a really powerful experience. Regardless of your major, school or college, commencement is an opportunity to think about the time we've shared with all our fellow Badgers," says Meeker.


**Administration is hoping for blue skies like this during commencement this May, where the ceremony will proceed rain or shine in Camp Randall's outdoor seating.**

The approximately 75 minute ceremony will offer the graduating class a final chance to gather as one, providing closure to their journey here at UW-Madison. Lori Berquam, vice provost for student life and dean of students went on to describe the unique opportunity offered by the graduation ceremony in a press release from university officials.

"One thing I've heard from students is that this is a culminating event for their class and a bookend to the Chancellor's Convocation for New Students," says Berquam. "This is an opportunity to feel that affinity, that pride, and see the impact of their class all together in one place."

Not only will the move foster a spirit of unity among the graduating class, but it will also aid UW-Madison in obtaining higher-profile speakers. Previous speakers were usually charged with the responsibility of speaking at the four different ceremonies held in the Kohl Center. One inclusive ceremony will help put an end to the repetitive nature of such a task and pave the way for inspirational speakers that might not have been able to make such a time commitment.

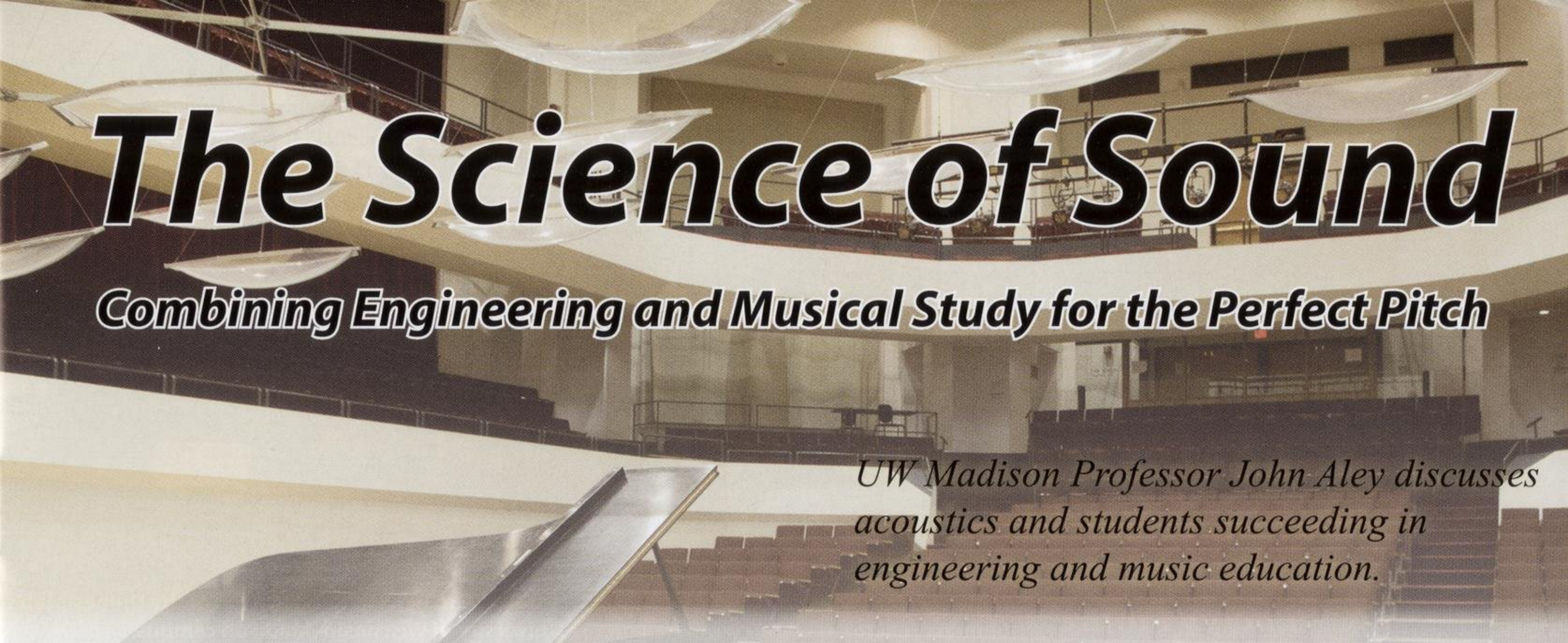
Aside from the change of venue, the ceremony itself will also undergo a substantial change as students will no longer walk across the stage and have their names called individually. Instead, students will be recognized by college in the stadium. Students will have the experience of hearing their names read and being awarded diplomas at smaller ceremonies put on by individual departments and colleges.

Before the separate ceremonies hosted by each college, the massive family parties and the conclusion of their careers at UW-Madison, the Class of 2014 will gather for one final time to celebrate their accomplishments throughout college. "Before everyone takes that next step in their lives, its great that we have the opportunity as a graduating class to gather together and reflect on our time at UW-Madison," says Meeker. "What better place is there to do that than Camp Randall? Its already home to so many of our memories. Now we are just adding graduation to that list." WE

Written by: Matt Latuszek

Photography by: Matt Henricks

Design by: Tanae Swenson



# The Science of Sound

## Combining Engineering and Musical Study for the Perfect Pitch

*UW Madison Professor John Aley discusses acoustics and students succeeding in engineering and music education.*

On the UW-Madison campus, it's a fifteen-minute walk between the College of Engineering and the School of Music facilities, housed in the Mosse Humanities building. While the two schools are not typically associated in the minds of students or the public, there exists a strong, important connection between the two disciplines – acoustical engineering.

Acoustical engineering, engineering principles applied to sounds and vibration, represents a field in which an appreciation for the art of a well-composed concerto can be combined with the rigid scientific structure of the engineering profession. Acoustical engineering is a wide and diverse field, with applications in the medical sciences, consumer electronics and even architecture, leading to creations such as ultrasounds, headphones and concert and performance halls.

John Aley, professor of trumpet at the School of Music since 1981, acknowledges the importance of this integration of disciplines. "Acoustics is an engineering science," Aley says. "It's fantastic how all this information comes into play to make a great [music] hall. I've played in halls like Carnegie Hall, and when you're in a hall that sounds great, you can sound great, and that's really fun." Performance halls need to be tuned to precise standards, ensuring that the desired sound of the performance is provided to the entire hall, and any unwanted noise is diminished. Halls will often feature soft or plush walls, absorbing sound waves that would otherwise bounce off a hard surface and create sonic interference. UW-Madison is currently planning to erect such a music hall on campus, adjacent to the Chazen Art Museum.

Aley says he is excited for the addition of the new School of Music performance center. Currently in its fundraising stage, the 57,000 square foot building is designed to house two performance halls, with a combined capacity of over a thousand people. "It's reasonably said that when a new hall is made, it will be really good acoustically speaking, because the science is there," Aley says. Almost any new effort to build a performance hall will be sure to include expertise from an acoustical engineer, ensuring that each performance for years onward will sound excellent. The difference between playing in a well-tuned hall versus one that is less well equipped is like "night and day," according to Aley.

**"It's reasonably said that when a new hall is made, it will be really good acoustically speaking, because the science is there." - Professor John Aley**

A number of students and graduates of the School of Music and College of Engineering have moved on to acoustical engineering fields, Aley says. He mentions that students in music that also find interest in electronics, such as electrical engineering, often find work for companies like Bosch that produce speaker and microphone technology. Historically, these students have had great success in blending their different educations into a career they are proud of.

Aley offers sage advice to those who wish to pursue a career in engineering and in music: "A student will not excel unless they are disciplined to practice," Aley says. "The biggest characteristic is discipline. You have two gods that have pretty exacting standards and time commitments, and you have to be really skilled in time management." The coursework may not be easy, but Aley believes that the commitment is worth it.

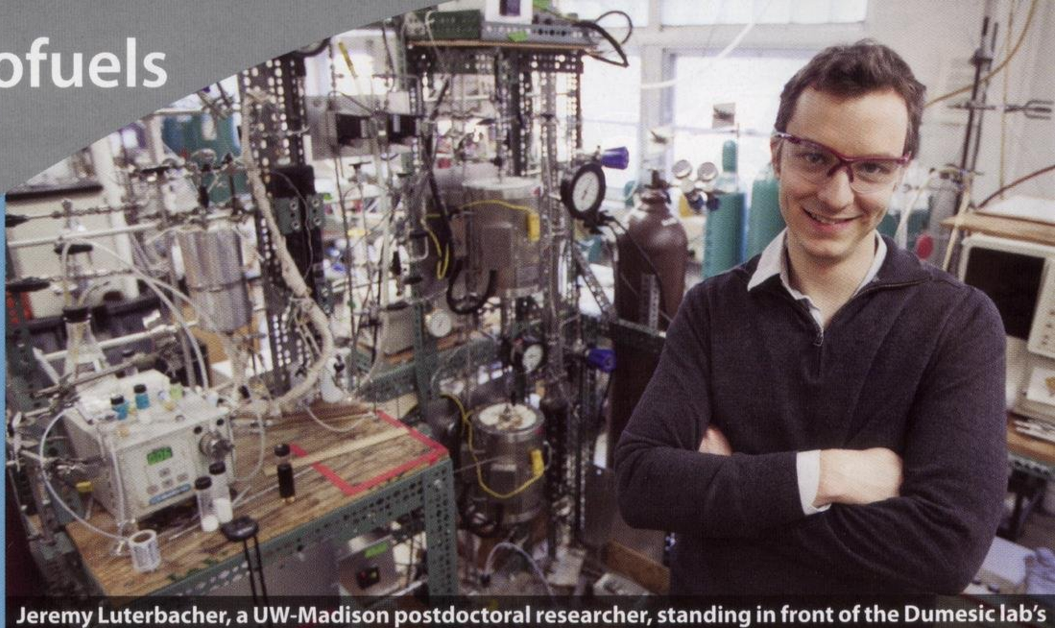
"Find a balance." Aley continues, "There are so many choices to be made. Music informs the engineering, and engineering has to be very structured. Music, within technique, is structured as well, but there is also the opportunity for creative output that enters in what you do when you play. When you have that balance, you are doing work that is focused, which continues to make you a better person." That balance between music and engineering is precisely what acoustical engineering thrives on. Students that can harness their appreciation for musical performance and their skills in engineering will not have difficulty thriving later in life, both on the UW-Madison campus and around the world. It is acoustical engineering that makes the College of Engineering and School of Music seem not so far apart after all. WE

Written by: Rick Zuern

Photography by : Parwat Regmi

Design by: Lukas Lindquist

# Revolutionary Biofuels Research at UW-Madison



Jeremy Luterbacher, a UW-Madison postdoctoral researcher, standing in front of the Dumesic lab's biomass reactor at Engineering Hall on the University of Wisconsin–Madison campus.

## *How Biofuel Research at UW-Madison Could Move Us to a Cleaner Energy Future*

On most days, we rarely take the time to pause and realize the incredibly extensive and important research that takes place here at the UW-Madison. With leading experts in fields spanning from psychology to nanomaterials and hundreds of millions of dollars put into basic research, our professors, faculty and students are consistently making important discoveries and innovations.

James Dumesic, professor of chemical and biological engineering, and Jeremy Luterbacher, who received his postdoctoral degree at the UW-Madison, along with their team of fellow researchers, are discovering a revolutionary method for catalyzing a reaction that humans have been inducing for centuries.

Luterbacher and Professor Dumesic have discovered a cheaper, more environmentally friendly way of catalyzing the deconstruction of polymers of sugars in plants. These deconstructed polymers can then be used for synthesizing biofuel.

Our current economy depends heavily on carbon sources, particularly petroleum, which is used in plastics, clothing, gasoline and countless other products. According to Luterbacher, the problem is that "we need to use carbon products," but "there are only so many carbon sources." Besides petroleum, there are $CO_2$ and plants. Because so much of the weight of plants is sugars, Luterbacher and Professor Dumesic are trying to go after the sugars as a fuel source.

In the past, this process has been much easier said than done due to the requirement for highly concentrated acids and enzymes that have made the process expensive and environmentally burdensome. This is where Luterbacher and Professor Dumesic's research comes in. "What's neat here is that we found that with GVL, a molecule that we can produce from the plant itself as a solvent, we are able to promote this deconstruction with very little acid," said. So what's the significance of this discovery?

UW-Madison researchers James Dumesic and Jeremy Luterbacher examine a vial containing the light colored concentrated sugar solution.

> **"We need to use carbon products, but there are only so many carbon sources."**
> **- Jeremey Luterbacher**

The importance lies in the fact that their process of deconstructing the sugars with a chemical found in plants and with little acid could prove to be roughly 10 percent cheaper and significantly more environmentally friendly than current processes.

However, Luterbacher says that what he is excited about is not the number, but rather that in their attempt to replace a large fraction of the petroleum market, which has been going on for 50 years, they have discovered a new entry point into the market that is economically comparable to current processes. As a result, their process could open up a "whole range of uses" and could lead to further research and applications in other fields.

According to Luterbacher, it's important to add another way because it increases the likelihood of being able to produce and get to where you're trying to go.

There are still many challenges facing the team of researchers. Having just accomplished the lab step, the first in a four-step process, they are ready to move on to the pre-pilot plant step. They will increase production levels to see if any red lights appear to suggest that their process might not work on a larger scale. Following that, they will move into a full pilot plant and then, if everything goes well, to a full plant.

The research being done by Luterbacher and Professor Dumesic is revolutionary and could become an integral component of the biofuel energy equation in the near future. Providing alternative sources of energy is becoming increasingly important, and Luterbacher and Professor Dumesic are helping move us to a cleaner, more diverse energy market. WE

Written by: Brett Adkins

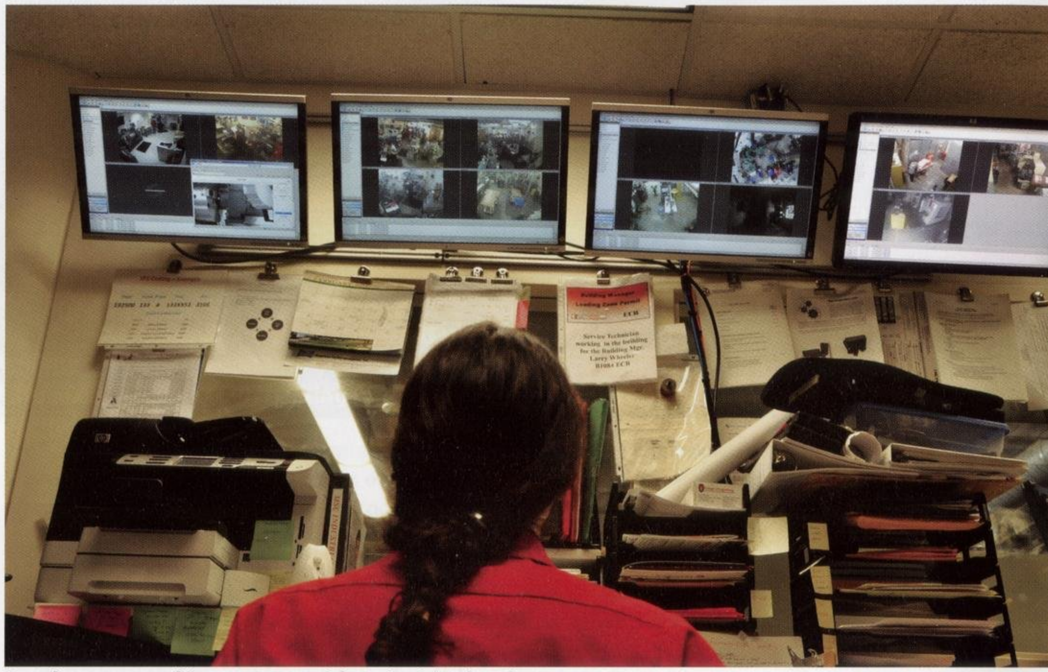
Photography by: Matthew Wisniewski / Wisconsin Energy Institute

Design by: Tom McAdams

**The flow-through reaction setup progressively dissolves biomass producing fractions that are rich in (from left to right) lignin monomers, hemicellulose and cellulose-derived sugars.**

# CoE's Student Shop: Providing the best machines for students eager to learn

***The reasons behind the changes seen in the basement of the Engineering Centers Building.***



Employees watching camera videos inside the shop.

If you have recently visited the Engineering Centers Building, it would be hard to miss the impressive effort that has been put into upgrading and expanding the Student Shop. No longer having enough room in the main student shop, B1086 has spilled out into the Discovery Area.

Looking over the edge of the main floor of ECB, you can see any number of mills, lathes and other machines occupying most of the space in the Discovery Area. With such an obvious change, many wonder why this is happening and, perhaps even more important, where the money is coming from. The answer: the student body.

Starting in 2008, students admitted into programs within the College of Engineering have been paying differential tuition. In response to this change, Polygon, the student government body of engineering, took a survey to find what students most wanted to see changed in the College of Engineering. The answer was a way to expand and upgrade the Student Shop.

Mechanical Engineer student Mason Mok working on his project in the shop.

Larry Wheeler, the CoE shops manager and head of the shop expansion, reveals that almost as soon as the differential tuition kicked in, the shop got right to work. The purchasing of new machines began in late 2008 and the beginning of 2009.

**"I don't see an end in sight; the only thing that would stop us is space."**
**- Larry Wheeler**

"There are many machines that have been replaced," Wheeler says when asked about the new equipment. "We were still dealing with machines that dated back to 1948." He goes on to say that over the last five years, nearly a million dollars has been spent on the new, state-of-the-art equipment and staff increases. Both of which were necessary to fill the increasing demand that the student shop has seen.

When he first implemented the permit licensing process, Wheeler says they only gave out 200 shop permits. Since then, the shop has been growing about 30 percent annually, permitting 1300 students just last year. To deal with this increased demand of permits, not only have more machines been purchased, but an entire room near the shop has been dedicated to providing students with the hands-on practice and education not just needed to get permitted to use the shop equipment, but also necessary in industry.

Two other rooms have been repurposed to serve as space solely for welding. Another room, which has been dubbed the micro-fab room, is used for small parts manufacturing and prototyping. The equipment in this room consists of a small-scale mill, a lathe, and four 3-D printers. To add to the utilization of this room, it has been coupled with a space dedicated to giving students their shop passes and will soon be outfitted with cameras and monitors to enhance the teaching opportunities of the room.

When asked what was coming next, Larry expresses his concerns on the room available in ECB: "I don't see an end in sight; the only thing that would stop us is space."

Following an interview was a tour of the improvements that have been the result of this project. Larry's closing statement about the shop emphasized the worth of the updated student shop: "If people are interested in getting a hands-on education, this is the place to do it, and it would benefit any engineer." All are welcome to see these improvements, and engineering students are encouraged to participate in the permit process and attend the many seminars that occur each week. WE

Written by: Nathan Vogel
Photography by: Catie Qi
Design by: Jing Li

*Shedding light on whether pursuing multiple degrees is worth the effort.*

# Doubling Down

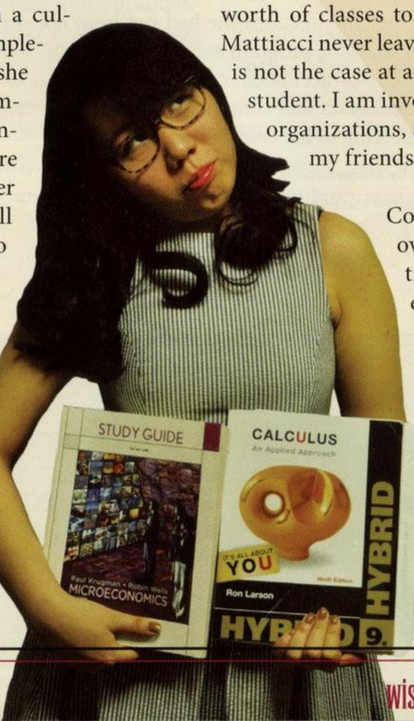
Majoring in more than one subject is on the rise at UW-Madison. More than ever, students are double and even triple majoring. In 2008, almost a third of undergraduates were pursuing multiple majors. While earning multiple degrees can create opportunities and open doors after graduation and beyond, it also costs precious time and resources. Depending on the overlap of the majors, many university leaders aren't convinced that the benefits outweigh the cost.

As most students know, picking up a second or third degree can be a daunting task. More degrees mean more classes, more classes mean more work, and more work means less time for everything else. This is why the decision to pursue multiple majors should not be made lightly, and students are looking for answers to help them with this important question.

A knowledgeable voice on the subject is Elaine Klein, Assistant Dean of the School of Letters & Sciences. When asked whether she has an opinion on the benefits of multiple majors, Klein is hesitant to make a blanket statement one way or the other. Instead, she chooses to focus on the combination of majors that a student chooses. "What seems to be more important from my point of view is what the combination of programs will do to enhance a student's learning in a particular area," Klein says. Not completely opposed to any certain combination of majors, Klein certainly has those that she looks highly upon. "What I like to see is when the biology major realizes that to understand biology well, it would be helpful to know more about anthropology, and they then also achieve an anthropology degree with a cultural focus. That is a very complementary type of program," she says. Degrees such as these combine multiple aspects of learning. Balancing majors that are complementary to one another but are also notably diverse will be a key topic for students who are considering going after another major.

With an eye on the future, many students who choose to major in multiple subjects believe it will make themselves a more lucrative job candidate and able to nail the career of their dreams, but employers tend to not put as much faith into multiple degrees as people think, especially if they overlap. Reiterating this opinion, Klein gives her perspective on the subject. "If you say to an employer 'I double majored in two closely related subjects, degree X and degree Y', a smart employer will say that those are two ways of saying almost the same thing, and I don't think that's very impressive." As far as double or triple majoring being a futile endeavor, Klein says that's not the case, as majors that are different but complement each other at the same time can be beneficial in a job search. "If a student really has done that very broad array of majors, that's impressive. Then it's up to the student to be able to articulate to the employer why their multiple degrees give them the skills they need to do this job." This statement highlights that although having multiple degrees may be beneficial, students also need to be able to market themselves effectively. That extra degree may get them a foot in the door, but good communication with the employer will ultimately be what gets them that dream job.

**"If a student really has done a very broad array of majors, that's impressive."**
**- Assistant Dean Elaine Klein, L&S**




A source very close to this subject is UW-Madison undergraduate Peter Mattiacci. Mattiacci is majoring in three subjects with a significant amount of overlap: actuarial science, risk management and insurance and finance, investment and banking. While still a freshman and early in his college career, he is extremely satisfied with his choice to triple major. With three majors' worth of classes to deal with, some may think Mattiacci never leaves the library, but he says that is not the case at all: "I am a very well-rounded student. I am involved with multiple clubs and organizations, and I like to play sports with my friends."

Coming into UW-Madison with over 60 college credits, Mattiacci will be able to achieve degrees in all of his selected majors and still graduate in four years. "Initially I didn't plan on triple majoring. I just was going to do actuarial science, but with all the time and room in my schedule, I talked with my advisor and she recommended picking up more majors," he says. As a rebuttal to those who say he should have just graduated early with a single major, Mattiacci doesn't bat an eye. "Yes, there is some overlap between them, but there are certain components for each major that will be beneficial for my career in the insurance industry. I will have a good knowledge of all sides of the industry with all of my majors. I want businesses to know I am educated in all areas of the field," he says.

With every student's unique goals, academic experience and abilities, the decision to double or triple major is case specific. Aspects such as the amount of time a student wants to spend at UW-Madison, the number of college credits he or she has brought in from high school, and goals and interests all factor into whether or not pursuing multiple degrees is right for the student. Undoubtedly, with almost a third of the student body pursuing multiple majors, it's important that educated decisions are made. When asked what advice she would give to students who are interested in pursuing another degree, Klein says, "The first major should be the one you're passionate about. Then I would say, what other types of knowledge would complement that first major, so that you're doing something interesting and distinctive and probably fulfilling some sort of a need." WE

## extra

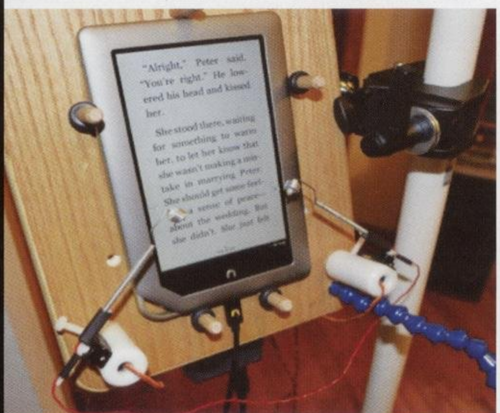
A recent survey of the magazine's staff regarding double majoring showed that only 2 out of 32 staff members are majoring in two subjects, a much smaller sample amount then the almost one third of undergraduates pursuing multiple degrees. Of the thirty students who are not double majoring, 19 say they have seriously considered it at one point during their academic career and 11 said they have never considered it, showing that a large amount are interested but never actually follow through. The two students who are double majoring have degree combinations of civil engineering and environmental studies and computer engineering and computer science. Each student's set of degrees contains considerable overlap, although both students responded as being satisfied with their choice to double major. When asked what the biggest benefit of their two majors will be, both students' recorded very similar responses, with one stating, "Having multiple facets professionally makes you far more marketable."


Written by: Nathan Friar
Photography by: Catie Qi
Design by: James DeBano

# E-Reader Interface Improves Quality of Life

## UW Hospitals' Dr. Luzzio aids the community in accessibility one device at a time.

In today's day and age, with many touchscreen devices, activities like the browsing the internet and completing work projects come to mind. Many users are fully reliant on tablets and mobile devices, faithfully placing their entire lives in hands of this amazing technology. What many do not think about is the limitations of such devices in terms of accessibility to users with different types of disabilities. Most mobile devices are not accessible to about 200,000 people in the United States who have a form of debilitating spinal injury. Thanks to a UW-Madison program, the trend of limited accessibly is now becoming less prominent in our community.



**Close up of the mechanical spring arms with tiny rollers that "touch" the screen.**

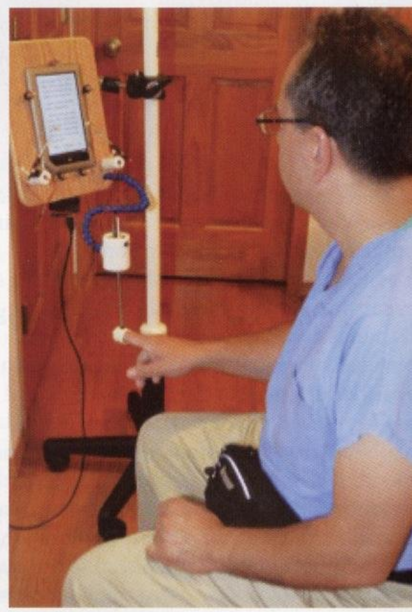
A woman was referred to Dr. Christopher Luzzio, an associate professor in the Department of Neurology at UW-Madison who is also a mechanical engineer and machinist, in hopes of gaining assistance in making her first steps towards independence. The problem was that the woman in need liked to read, but being quadriplegic due to multiple sclerosis has made it impossible to perform simple tasks, such as turning a page of the book without assistance. Dr. Luzzio decided that the easiest way to allow the client to read on her own was to create a user interface for an e-reader. He decided to take on the challenge of creating such a device.

Due to the client only being able to move only one finger, Dr. Luzzio created a device that turns the pages of an e-reader using a slight movement of one's finger. In order to prepare the customer for the use of the device, an assistant places the client's finger in a plastic loop. That loop, in turn, attaches to a pendulum with a sensor at the top. When the sensor detects any subtle movement to either the right or left, a microcontroller activates two small arms that touch e-reader's screen in order to flip the pages. Dr. Luzzio had to hand-make as well as recycle some old parts to make this device.

The most difficult part of this project was to insure the screen would be responsive to the stimulation generated by the device's arms. To overcome this obstacle, Dr. Luzzio created spring-loaded arms with aluminum rollers at the ends. Since an e-reader's screen is sensitive to touch, it is necessary to apply conduction gel to the rollers. This use of gel may be avoided today with the use of newer e-readers that have advancing wireless capability, however the existing machine was not equipped for that technology according to Dr. Luzzio. Additionally, he postulated, the movement of the mechanical arms serves as a visual extension of the clients finger, possibly facilitating its continued movement.

Creation of the user interface for an e-reader did not stop once the desired functionality was achieved. Dr. Luzzio went beyond the design to make sure the device was user-friendly, as well as aesthetically pleasing. After its completion, Dr. Luzzio often visited the client to make small adjustments to the device, mostly fine-tuning software and adding dials that allowed the patient's husband to control the speed and sensitivity of the device. The finished product is a device that has allowed the client to read without the help of her husband. "Now she can read independently; she was never able to do that before," Dr. Luzzio says. Dr. Luzzio talks about his work as, "I see myself as doing a service to the public."

This project was created as a part of the UW-Center for Rehabilitation Engineering and Assistive Technology (UW-CREATe). UW-CREATe is a great opportunity for many UW-Madison interdepartments to collaborate in order to give back to the local community. Furthermore, Dr. Luzzio working alongside Professor Heidi Ploeg (and for many years previously with his mentor Professor Frank Fronczak), is also helping with a UW-Madison mechanical engineering senior design class that is creating a solution to assist disabled members of the community. It is the students' task as a part of their class to design, build and give the machine to the client.



**Dr. Luzzio testing the machine.**

UW-CREATe projects are a great opportunity for the College of Engineering's graduate and undergraduate students to give back to the public, as the project for improving the e-reader's user interface was of no cost to the client. It has given her the freedom she had not been able to feel for years. Dr. Luzzio hopes that "the program as a whole will grow beyond UW-Madison's campus." This project taken on by UW-CREATe, as well as many others such as wheelchairs and orthotic devices, are the connection of the College of Engineering to the community. WE

Written by: Margarita Labik

Photography courtesy of Dr. Luzzio

Design By: Annie Shutt

**UW-CREATe was founded by retired UW-Madison professors in hopes of improving the quality of life and meeting the needs of individuals in the community. That goal is accomplished through education, design and mentoring of students. Some of the projects taken on by UW-CREATe are accomplished without student involvement. Currently UW-CREATe receives no outside funding for its projects and staff. UW-CREATe is constantly evolving in order to expand the program to the community. As a part of this effort, the design center is hoping to integrate a public web interface in the near future.**

# Hult Prize

*A group of UW-Madison engineers accept a challenge to reduce non-communicable diseases in urban slums.*


**UW - Madison engineers competing for the Hult Prize.**

**"It's about making health a part of a daily mindset instead of an emergency solution." - Bimpe Olaniyan**

Imagine you are entering a global healthcare competition against ten thousand other teams, all competing for a million dollar seed and worldwide recognition. The winners will be interacting with millions of people and becoming key players in the everlasting struggle to improve global health. The guidelines for your fame and success are as follows: reduce chronic non-communicable diseases, such as cancer, diabetes and heart disease, in urban slums. Good luck.

Four brave UW-Madison engineers, Bimpe Olaniyan, Cedric Kovacs-Johnson, Eric Ronning, and Jon Seaton, have decided to embrace this challenge. At the time of writing, in February, they have made it to regionals. This has placed them among merely three hundred of the previous ten thousands teams, but soon they will be competing for nationals. Olaniyan and Ronning are seniors in mechanical engineering, Kovacs-Johnson is a senior in chemical engineering, and Seaton is a graduate medical physics student who was also an undergraduate in engineering. Although their class schedules are hectic, they still manage to find time to partake in school-wide competitions, such as Innovation Days and the Schubert Writing competition, which frequently result in great success. This involvement and ambition has given each of them a very broad skill set, which they plan to utilize in this project, in addition to the abilities they have developed through their engineering experiences.

With their vast background involvement, these students now look to apply themselves in trying to attain the Hult Prize. The global competition places a strong emphasis on developing sustainable business ideas in order to attack this healthcare issue. This attracts many businesspeople and makes their team of engineers an outlier. However, Kovacs-Johnson goes on to explain that "what really made us unique was the first day we said we're not going to talk solutions. First, we're going to wrap our head around the problem and look at the situation as a system." Not only are they engineers in a crowd of business professionals, but they are also some of the youngest participates competing for the Hult Prize. Olaniyan justifies the program's support for younger minds by saying, "When you're younger, you're more reckless in terms of trying to do something you think is easy." One of the great things about this competition is that it not only fuels the crazy ideas of a younger generation, but it also tries to show that there is a business in helping people, so long as it is done properly and sustainably.

Given minimal information and a lot of enthusiasm, how does one approach the distressing questions and uncertainties associated with NCDs (non-communicable diseases)? This team of engineers has managed to combine social interactions with efficiency in order to view the urban slums systematically. What goes into the system, and what comes out of the system? Not surprisingly, the issues associated with NCDs extend far beyond the daily habits of smoking, consuming alcohol and unhealthy diets. Factors such as doctor training, cost of drugs, available resources, and existing infrastructures are all part of the issue. "The underlying problems with many slums are actually social issues," Ronning elaborates. "If we can provide a care that they can be accepting of, that could be extremely powerful."

While they have crafted a genius solution to reduce NCDs, they want to test it out firsthand prior to revealing their proposal. The group plans to take a trip to Brazil in March to test their potential solution and attain an even stronger understanding of how they can optimize the system. While searching for answers, they have been astounded by the extensiveness of the UW-Madison social network. The willingness of UW alumni to provide their time and resources has been inspiring to the team because "every Badger is looking to spend that time with someone generations apart," according to Olaniyan.

Although the team is initially focusing on Brazil, they have projected that their efforts will affect approximately twenty-five million people by 2019, assuming their methods are successful. If they advance to nationals, they will be spending the summer in an accelerated program in the Clinton Global Initiative Business Incubator. Once there, they will have the opportunity to work with many influential figures and further develop their solution. Regardless of whether they advance to nationals or not, they are very eager to see if their proposal can save lives in the real world. As Ronning eloquently puts it, "An artist wants nothing more than to have their work be seen. A writer wants nothing more than their work to be read. An engineer wants nothing more than to have their work be implemented." WE

Written by: Brian Paulus

Photography by: Jenny Demeules

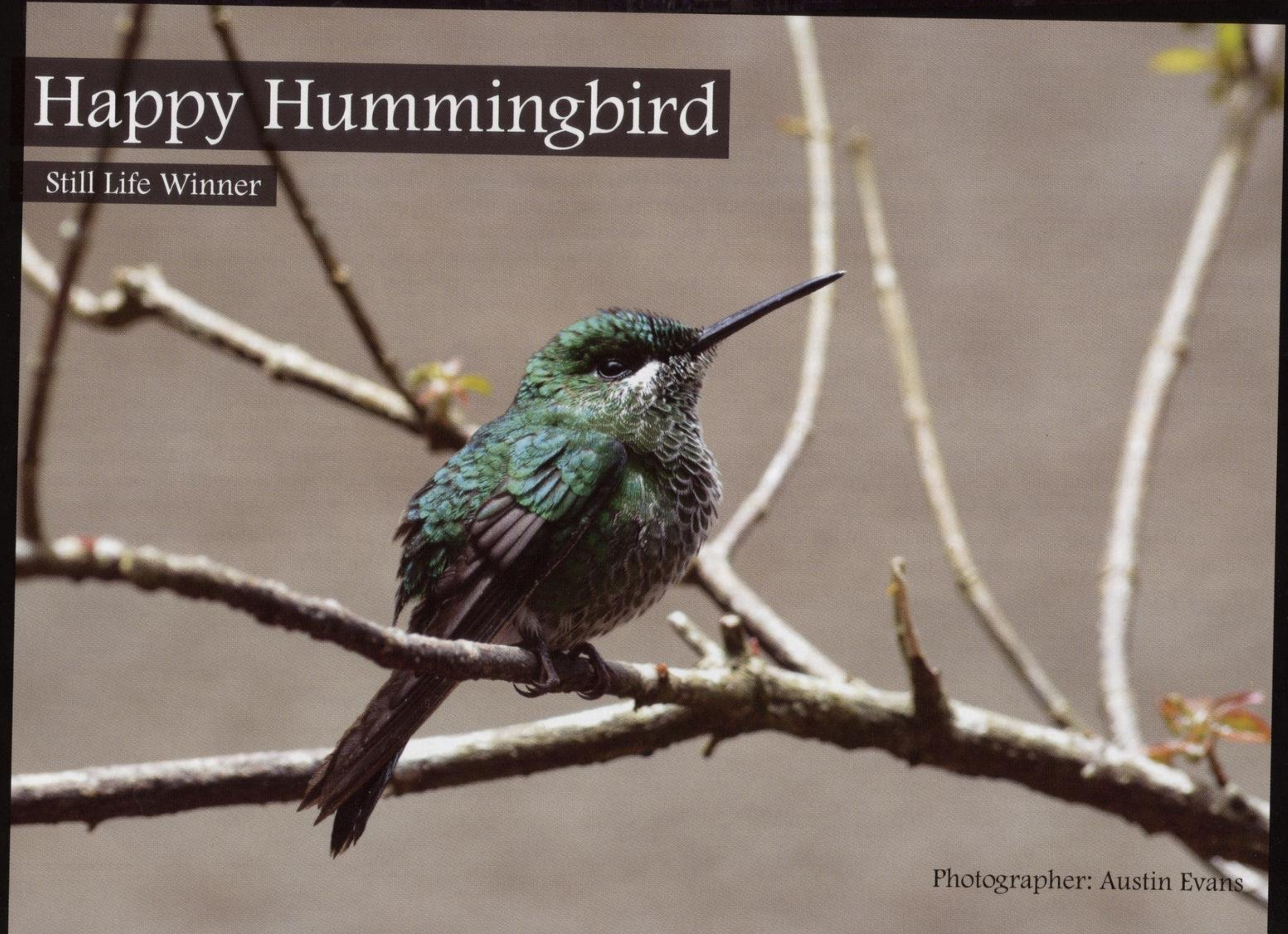
Design by: Jason Wan

# 2014 Photo Contest

## Istanbul at Sunset

Landscape Winner

Photographer: Hannah Frank



## Happy Hummingbird

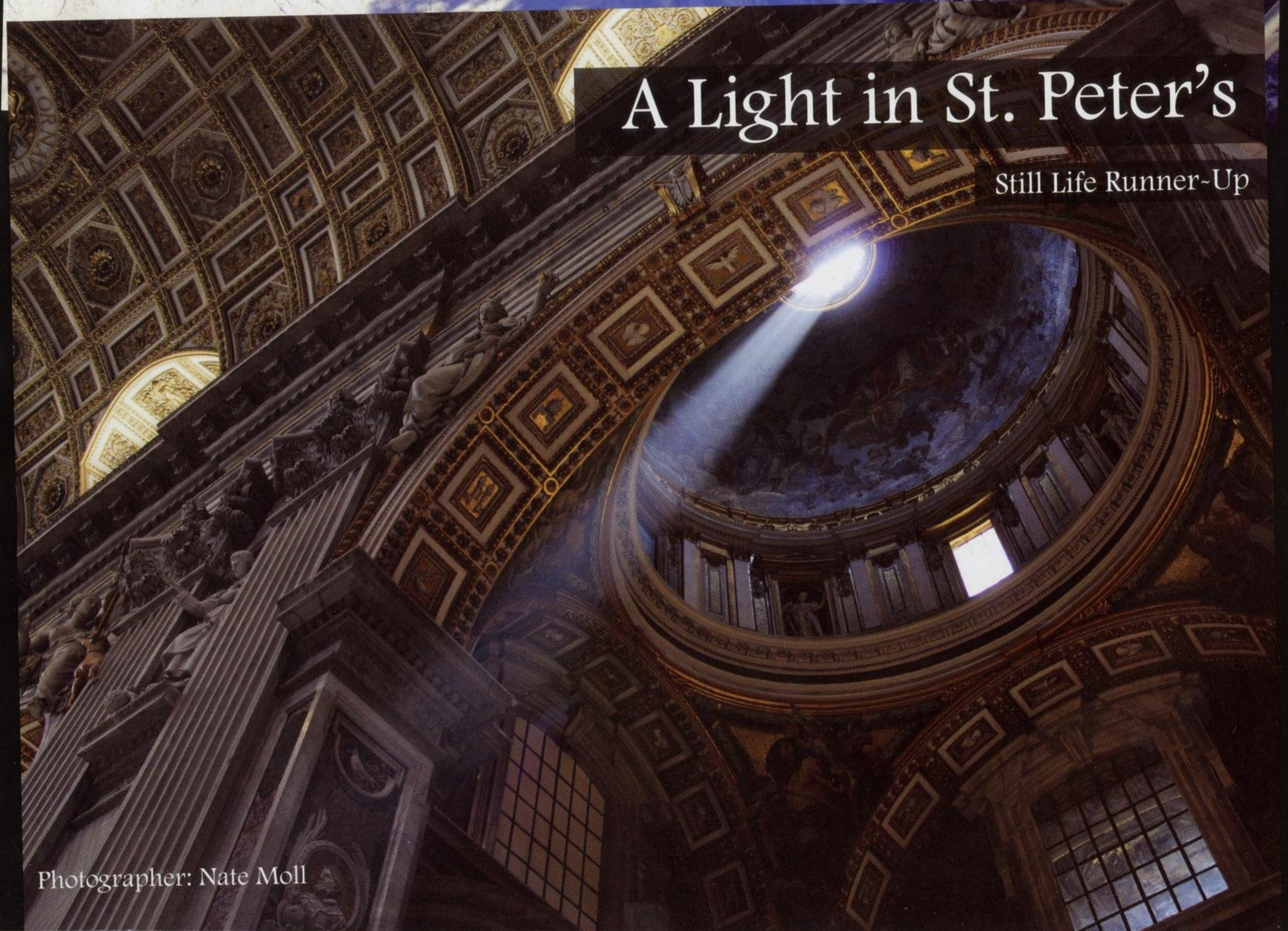
Still Life Winner

Photographer: Austin Evans

## Lift to the Sky

Landscape Runner-Up

Photographer: Jared Paul



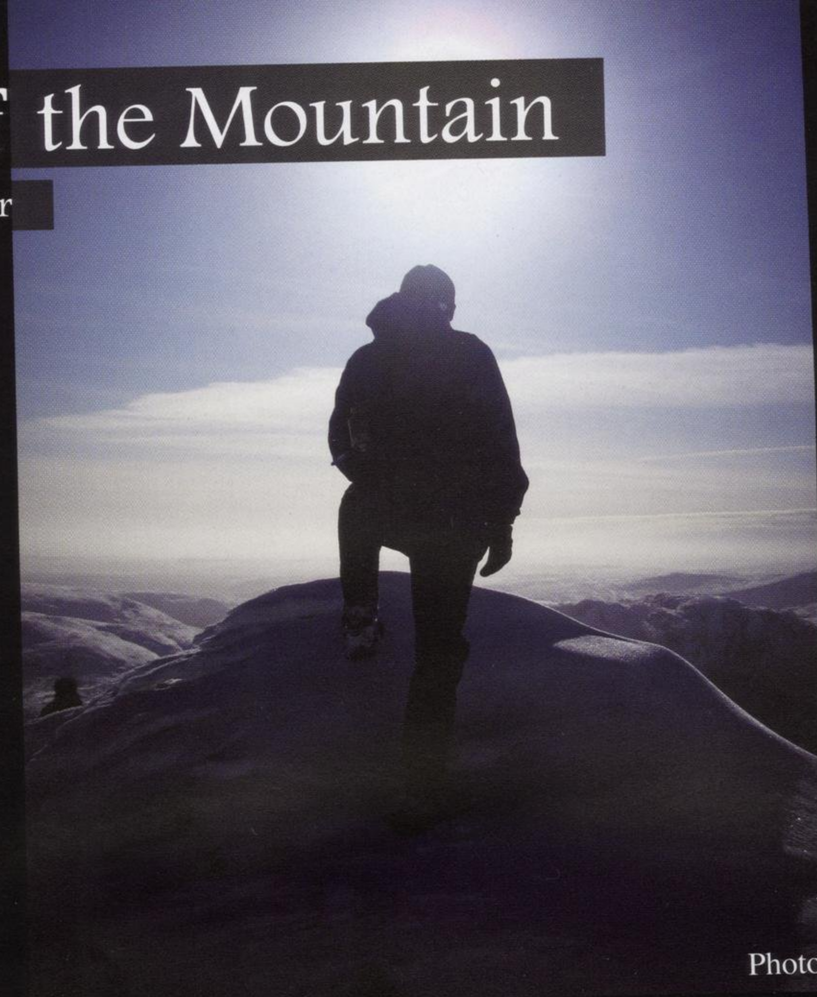
## A Light in St. Peter's

Still Life Runner-Up

Photographer: Nate Moll

# Top of the Mountain

Portrait Winner



Photographer: Charles Donaldson

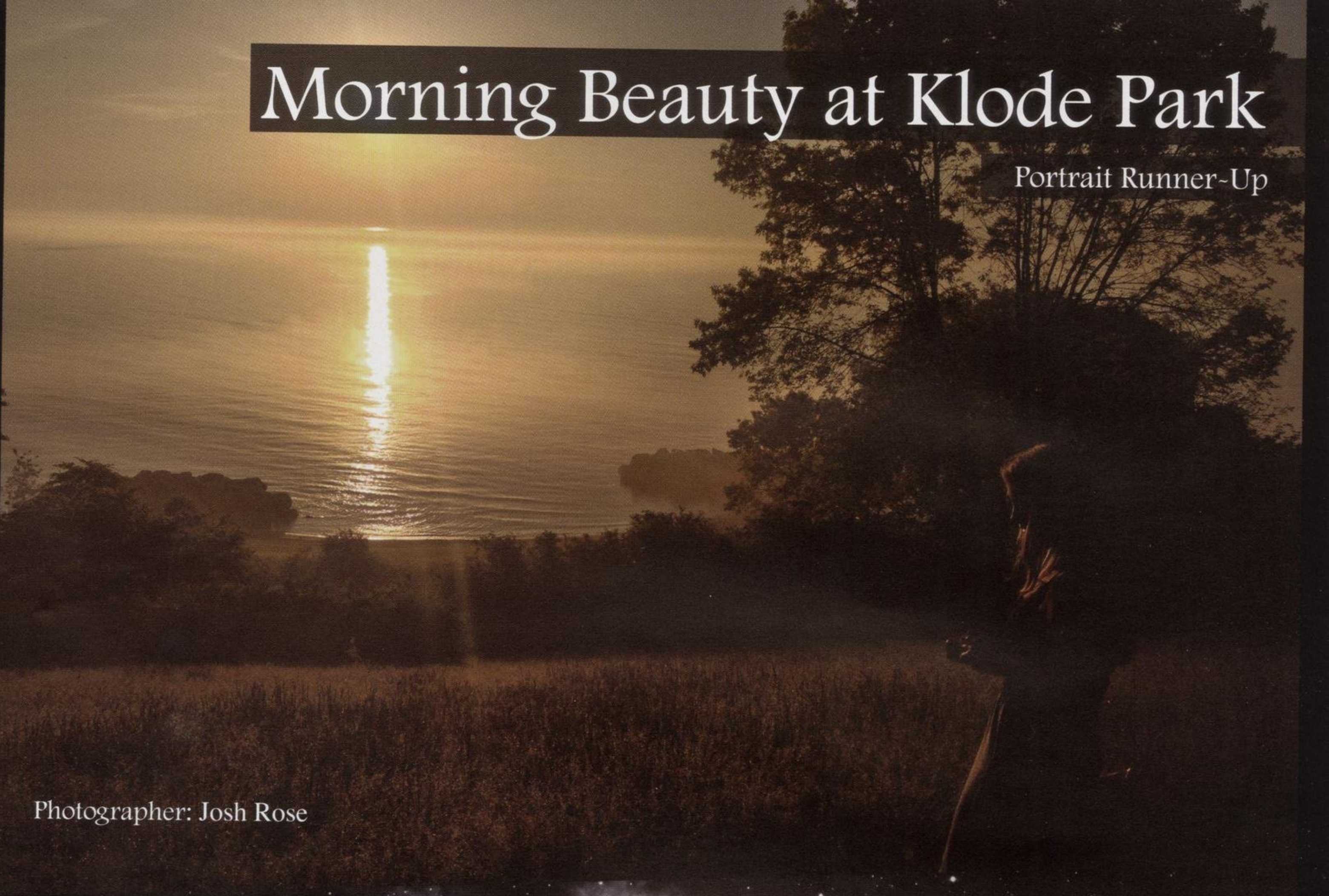
# Wisconsin's Polar Express

Miscellaneous Winner


Photographer: Austin Evans

# Morning Beauty at Klode Park

Portrait Runner-Up

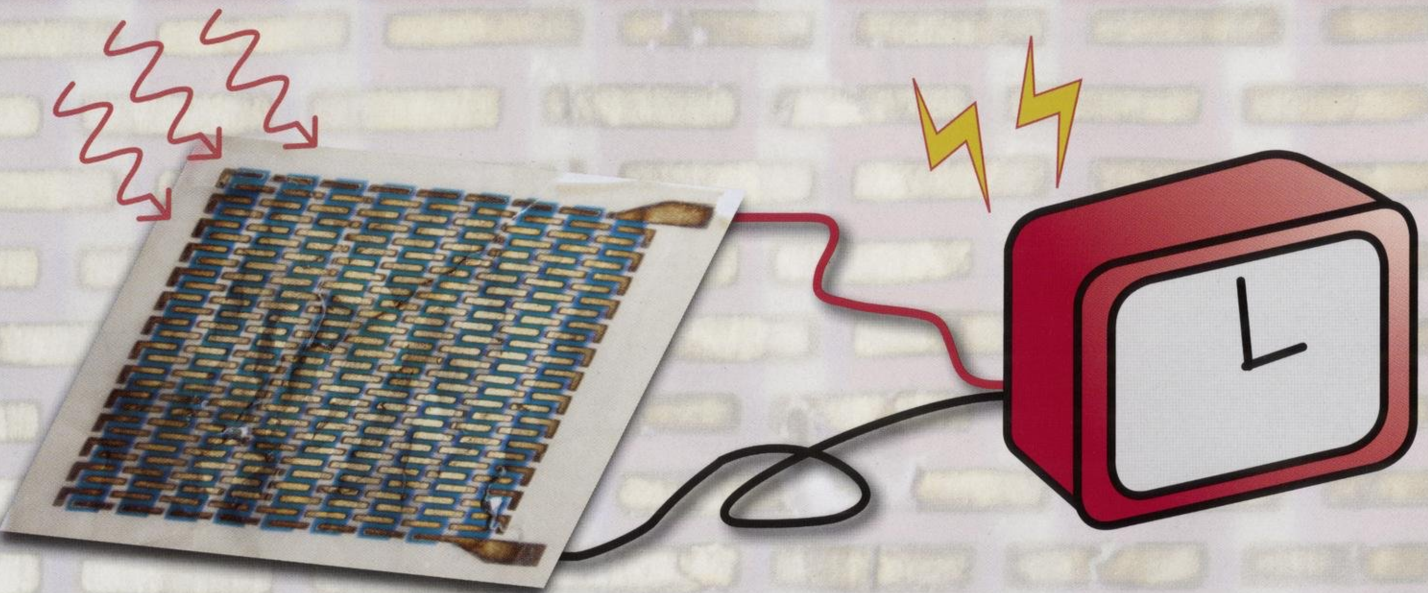


Photographer: Josh Rose

# NGC 2264 Rosette Nebula

Miscellaneous Runner-Up

Photographer: Yizhou Zhang



# From Paint to Solar Power

***Researchers at UW-Madison are creating an organic, disposable solar cell of the future.***

"Imagine having a notebook full of paper with solar cells on it. You use a paper a day to charge a clock, charge a cell phone, then you just throw it away." This is the future that Trisha Andrew, assistant professor at UW-Madison, envisions. She and her colleagues in the Andrew Lab are working to develop a new and improved solar cell. This research earned Andrew a spot on the Forbes magazine "30 under 30 in Energy" list for 2012.

Andrew notes that "today, most solar cells that you buy are heavy, they're ungainly, they're cumbersome, and you need to have special contractors and technicians in order to incorporate them into various applications." The primary material used in these cells is silicon, a naturally abundant element, and the wiring is made of silver, which is fairly rare and expensive. A mid-range solar cell has an average power conversion efficiency of 12 to 15 percent. Implementing a solar panel is quite expensive, with costs ranging from tens to hundreds of thousands of dollars. The need for a change in this technology is evident. Andrew's team is taking a whole new approach to solar cells, deviating completely from the current technology.

The new solar cell that Andrew's team is working on is completely different; it is small, affordable and disposable. The primary material that they are using might surprise you: organic dye.

> **"Dyes traditionally used for commercial purposes like car paint have some qualities that are ideal for making a solar cell."**
> **- Trisha Andrew**

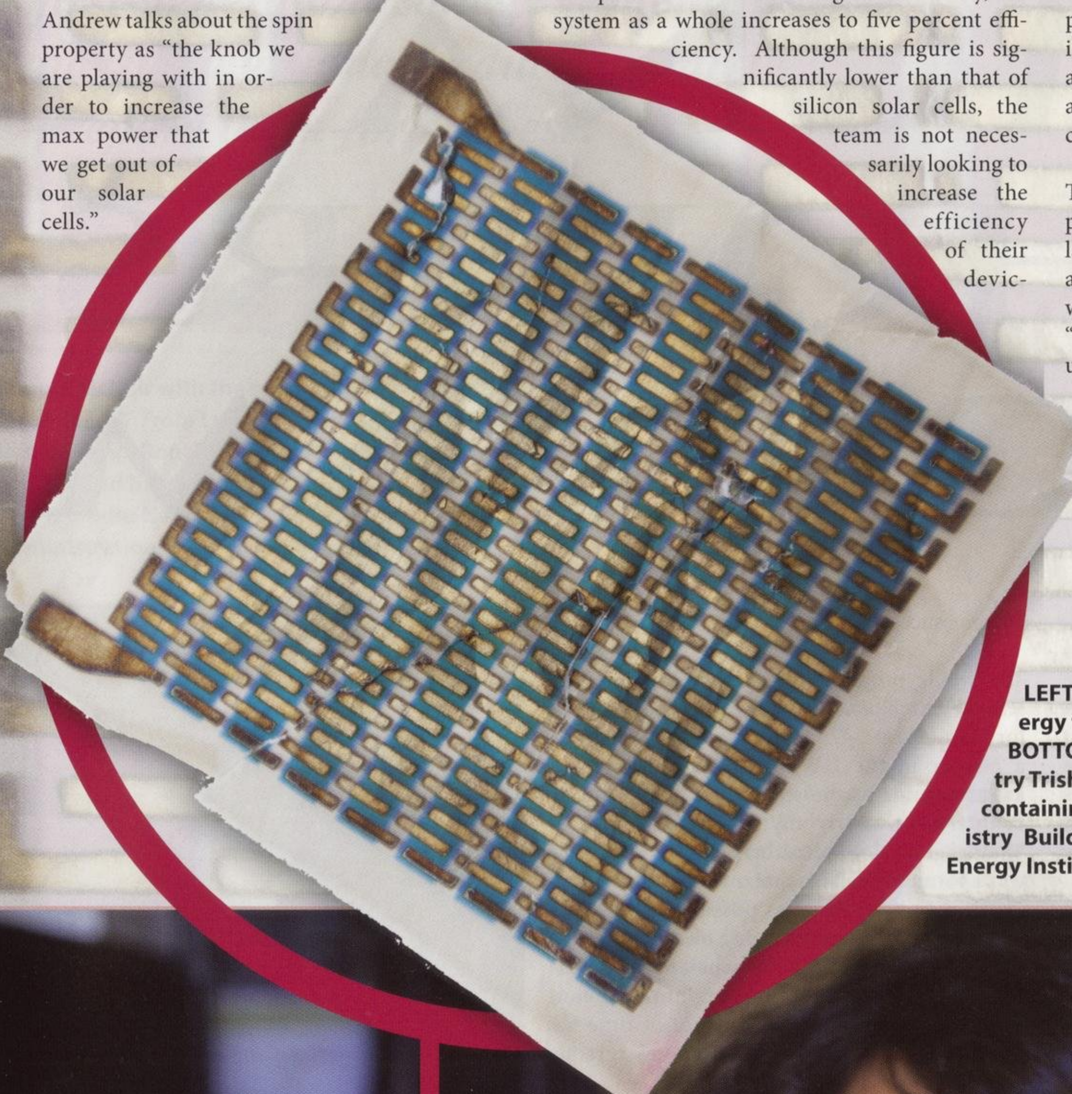
The dyes that they are using to make their solar cells are scientifically known as chromophores. They have traditionally been used for commercial purposes like car paint and have some qualities that are ideal for making a solar cell. "To make a solar cell, you want two things: to absorb light and to convert it to electricity. Ideally, you want a material that does both. Dyes are colored because they absorb light incredibly well, so the goal is to make them conduct electricity," Andrew says. Due to the high light absorbency of the dye, the amount of material needed is minimal. The average thickness of the material needed for Andrew's solar cell is four times less than silicon solar cells, measuring 50 nanometers. For a point of reference, the thickness of a human hair is 90,000 nanometers. Since there is only a minimal amount of material needed, the cells are very economical but still effective.

Another advantage to using organic dyes over other synthetic materials is that, through a very simple process, they can be deposited on a variety of surfaces. "Just about any arbitrary substrate works. You can put the solar cells on saran wrap, paper, glass slides and many more surfaces," Andrew says. Each of the substrates requires a slightly different method for printing. For example, printing on paper is accomplished through chemical vapor deposition, while polymers are spin coated.

The challenge in using these organic, nontraditional materials to create solar cells lies in how to regulate the conversion to electricity. To do this, Andrew's team is manipulating several fundamental properties of electrons. Electrons are charged particles that also have a spin. The spin exists in two states, which Andrew explains to be "equivalent to having a spinning top with the axis either pointing up or pointing down." By manipulating this spin property, they can control the life span of a particle called an axiton.

This process allows them to either productively combine charges to produce a current or make them interfere and cancel out. Andrew talks about the spin property as "the knob we are playing with in order to increase the max power that we get out of our solar cells."

Currently, each individual solar cell made from organic dye has a power conversion efficiency of two percent but when arranged in an array, the system as a whole increases to five percent efficiency. Although this figure is significantly lower than that of silicon solar cells, the team is not necessarily looking to increase the efficiency of their devices. They are more concerned with the maximum power point, or how much wattage they can get out of one cell. Each individual cell takes up approximately a millimeter squared. On a four-inch by four-inch piece of paper, you can make a "matrix of roughly 128 devices and can generate enough current density to power a little LED clock from radio shack," according to Andrew.



These cells made of ink and aluminum and printed on letter paper could very well be the solar power of the future. One day, you might be able to keep your cell phone from dying simply with a sheet of notebook paper. As Andrew says, "Ultimately, it's something ubiquitous that you use, dispose of, and pay very little money for. The goal of this is to try and open up various avenues with which you can start incorporating solar power." WE

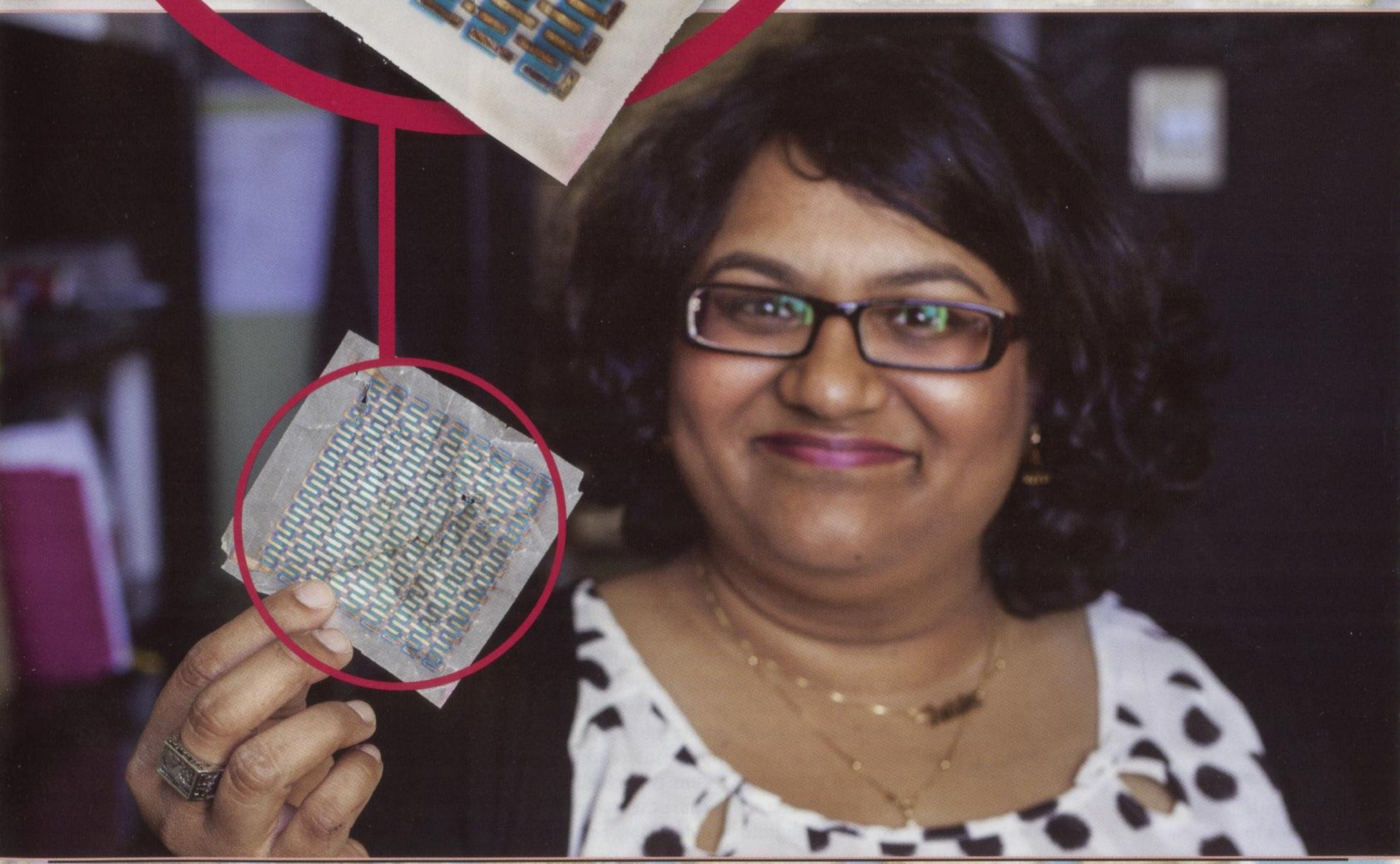
Written by: Mikaela O'Keefe

Photography courtesy of Matt Wisniewski of WEI

Design by: Michael Khor

**LEFT: This organic solar cell can produce enough energy to power a small alarm clock.**

**BOTTOM: UW-Madison Assistant Professor of Chemistry Trisha Andrew holds a piece of ordinary tracing paper containing an organic solar cell, in the UW-Madison Chemistry Building. Photos by Matthew Wisniewski/Wisconsin Energy Institute**



# McNair Scholars Program

***A program that aims to encourage first-generation college students to pursue a graduate education and prepare them for success.***

## Graduate School

Dr. Ronald E. McNair, the second African American in space whose life was so tragically ended while onboard the unforgettable flight of the Challenger in 1986, was much more than an astronaut. He established an unmatched passion for education early in life—graduating high school as valedictorian—and never slowing down. He went on to receive his bachelor's degree and eventually a Ph.D in physics from the Massachusetts Institute of Technology, publishing several groundbreaking studies along the way. McNair was widely regarded as a predominant figure in his field by the time he became affiliated with the space program.

The loss of such an inspirational individual sparked Congress to initiate a federally funded program honoring the man who dedicated much of his life to the institution of education: the McNair Scholars Program. This program aims to encourage ambitious, low-income, first-generation minority college students to pursue a master's degree or even a Ph.D, helping to bridge this transition into an even more intense echelon of higher learning. Each year at UW-Madison, the McNair program does an exceptional job in preparing 25 highly qualified students for the kind of work they will encounter in graduate school, as well as provide them with the skills to become successful later in life.


The whole program revolves around a long-term research component that is a requirement for participants. Undergraduate students find a mentor in the UW-Madison's faculty, who act as a guide as the students explore an area of interest in nearly any field of their choice. The program's coordinator, Quentin Bell, who was a former McNair scholar himself, says they "want it to be as close as possible to graduate level research without it being overburdening." This philosophy allows the scholars to experience the entire process from beginning to end, yet still leave an adequate amount of time for them to excel in their quest for an undergraduate degree.

Maya Holtzman, the program's associate director, describes this program as a "demystification of graduate education," as it exposes the students to the type of work they are sure to encounter in their future studies. Holtzman goes on to explain how the idea of graduate school is often daunting given the backgrounds of most McNair scholars, but by introducing them to the research process early on, "it helps them to see what lies beyond an undergraduate degree." This ultimately allows them to become much more comfortable in an academic environment.

In addition to the research they conduct, McNair scholars are required to present their findings at a national conference. This is an extraordinary opportunity for the participants, as their work has the potential to receive national recognition. For example, there have been instances in which McNair students from UW-Madison have won awards for their research from the American Association for the Advancement of Science (AAAS). These conferences serve as invaluable experiences for the scholars as they finally get a chance to share their work with the world and, in doing so, develop a certain confidence that their work can actually make a difference.

**Ronald McNair with the rest of the Space Shuttle Mission 41B. From Left to Right: Robert Stewart, Vance Brand, Ronald McNair, Robert "Hoot" Gibson, and Bruce McCandless.**
**Photo Credit: National Air and Space Administration (NASA ID: s83-40555)**

Alumni often reflect upon their experiences as a McNair scholar with overwhelming enthusiasm. Many of them write back and cite how helpful the program was to their graduate studies, while others stay in touch on a purely personal level in order to retain the relationships they developed. The program checks in annually with all alumni for ten years after their graduation to see how things are going, and, unsurprisingly, the program boasts an impressive success rate. About 90 percent of McNair Scholars go on to graduate school, and of those who do, there is a very high percentage that obtain at least a master's, if not a Ph.D. Many of them go on to become professors, and due to their success and affiliation with the McNair Scholar's program, they end up becoming mentors for new McNair scholars themselves. This cycle of mentees becoming mentors speaks volumes to the immense impact that the McNair program has upon its participants.

**"It is really nice that they are taking this additional time to prepare the next generation of graduate students"**
**- Maya Holtzman**

The students, however, are not the only beneficiaries of this program; the mentors express just as much fervor for their roles in the program. Many faculty members are eager to take on a new McNair student after they experience the rewarding sensation of watching as their guidance manifests into an inspirational student who is capable of producing high-quality research. Their dedication is especially noteworthy given the fact that they do not receive anything in return for their service. "It is really nice that they are taking this additional time to prepare the next generation of graduate students," Holtzman says. The pride they take in helping an individual reach their potential, and often the relationship that develops over the course of their interaction, is more than enough to keep them coming back.

The McNair Scholar's program, while relatively small in nature, has the power to create a massive impact on the lives of very deserving individuals. Persuading first-generation college students to even consider graduate school is a feat on its own, but actually guiding them through the process and adequately preparing them for success is especially significant. The program is always encouraging qualified students to apply and hopes to continue its reputation of success into the future. WE


Written by: Stephan Schwartz
Photography by: Nathaniel Corey
Design by: Margaret Butzen


Eligibility guidelines and the application itself (which is accepted year round) can be found online at http://grad.wisc.edu/mcnair/prospective.

# The Makerspace: Crafting a Future for Kenya

*In a small village in Kenya, a UW-Madison faculty associate is developing a "Makerspace" where women and girls can learn to make products that will improve their standard of living.*

Laptops no heavier than notebooks and cell phones no bigger than the palm of your hand. Gleaming sports cars with leather seats and sleek Boeing jets that travel faster than the speed of sound.Luxurious homes abounding with the comforts of air conditioning, electricity and clean running water.

Across America, engineers are expending countless hours and resources crafting these technologies to perfection. Meanwhile, thousands of miles away in the small village of Gatunga, Kenya, even the most basic forms of these technologies are almost unheard of. While Americans are accessing more information, more rapidly, and on more compact devices, Gatunga villagers are spending the majority of their precious income on the most basic education for their children. While Americans are traveling faster and in more style and comfort, Kenyans are walking for hours on end just to find clean water. While Americans are building their homes bigger and grander than ever before, Kenyans are building huts out of mud and sticks. Although conditions are less than ideal for the people of Gatunga, Lesley Sager sees a world of possibilities for a brighter future in the village – possibilities that could easily be transformed into reality if the skills and resources of the developing world could be shared with Kenya.

A UW-Madison faculty associate in the interior design department, Sager has been working in the field for about fifteen years, running her own residential design practice, as well as teaching undergraduate interior design classes. Recently, though, her focus has been directed farther afield, to the people of Gatunga. Currently, her top priority is to develop a village center called a "Makerspace," a hub of resources for women and girls to learn skills and create products that will improve their standard of living and provide a stable source of income.

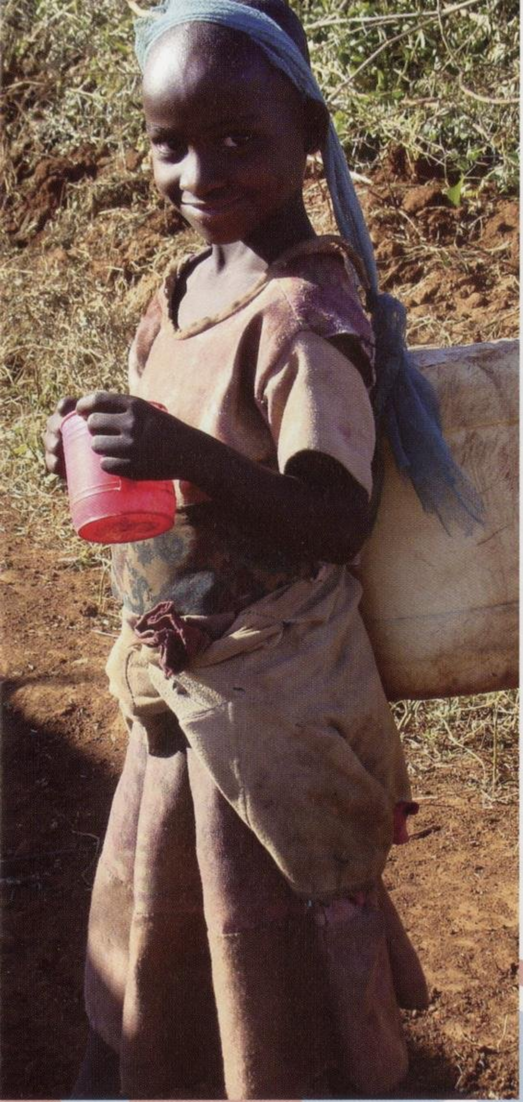
The need for this project was brought to Sager's attention through the work of a student who built a disaster relief shelter in response to a prompt for one of Sager's design courses. The completed, full-scale shelter was displayed at the Modern Museum of Contemporary Art here in Madison. "Somebody saw it and thought it was a perfect example of something that could be used in areas such as Kenya, where a lot of homes were being destroyed by monsoons due to a lack of building materials," Sager says. "Their houses were built out of mud and sticks, and when it rained, it rained hard, and the houses would literally disintegrate away." Hopeful that the design could be put to use, Sager traveled to Kenya in the winter of 2013, intending to investigate the need for portable disaster relief shelters and the materials available for building them.

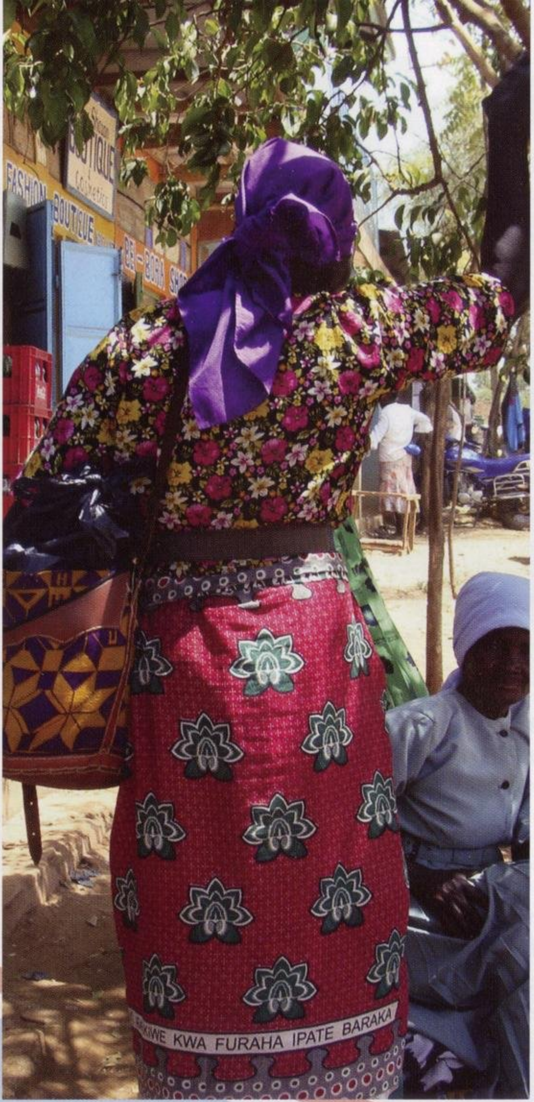
**Lesley Sager is working closely with the village leaders of Gutanga to convert this unfinished building into a Makerspace.**

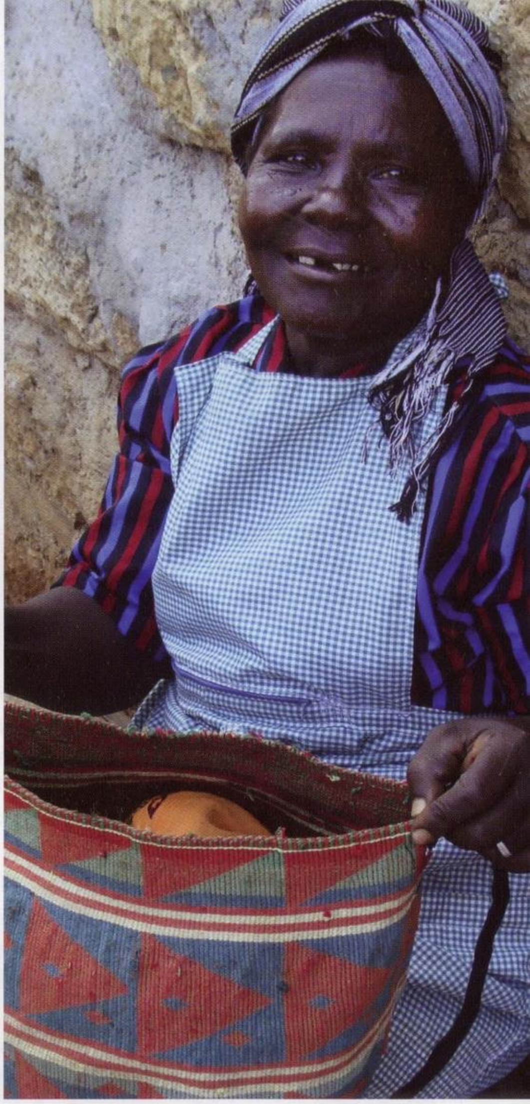
However, when she realized that it was not feasible to produce the disaster shelters in Kenya due to materials costs, Sager's work morphed into something completely different. She began working with a woman in Gatunga who had started a women's welfare program that promoted health and sex education for young girls. Her interest in the learning environment for women was piqued when she made a troubling observation. "While I was there, one of the things that I noticed was that education was very important, but the making of things was virtually nonexistent," Sager says. "The women weren't making or perpetuating anything from their traditional culture." With this observation, Sager began to form an idea: perhaps women and girls could develop these skills if they were given a "Makerspace" where they could come together to learn the crafts of their culture. "My first thought was that we could do workshops with sewing machines, we could teach them how to dye fabric and weave traditional kiondo bags, we could make clay beads," Sager says. Bursting with ideas for the new Makerspace, Sager left Kenya, planning to continue her work there the following winter.

When Sager returned to Kenya in the winter of 2014, it was with a broader perspective than before. "I went back with a graduate student," she says, "and when we got there, we took a couple of steps back." Looking at the bigger picture, Sager and her student realized that while the women did have an interest in traditional crafts, they had many higher priorities. They didn't have time to think about weaving or making jewelry when the simple chore of obtaining water demanded a four-hour trek. Most women in Tharaka made a living by selling crops, but even farming was not a stable source of income due to limited water access and an arid climate. To make matters worse, the tools available for use in the fields were primitive at best. Sager quickly came to the realization that these daily struggles were the issues that needed to be addressed first.

As Sager incorporated these needs into her master plan, the original Makerspace concept began to evolve into something bigger. Through her research and conversations with the women of Gatunga, she identified skills which, given access to training and resources, the villagers could use to improve their basic livelihoods. "Now the Makerspace, which we will be calling the Tharaka Women's Makers Studio, will be a space where women can come together and not only learn to make beads and kiondos, but also learn to make things like bee houses, so they can start bee keeping," Sager says. "At the Makerspace, they will have the equipment available to them to build their own bee houses and learn how to harvest the honey for consumption and product production."





**Left: Many women and children travel for hours on foot every day to get water. Middle: A woman carrying her handmade bag, a traditional craft in Kenya. Right: Handmade bags are one product that Sager hopes to teach the women how to sell to provide a source of income**

Other ideas Sager has generated include teaching the women basket weaving, sewing and using more efficient cooking technologies. She also hopes to provide structure for a "Merry-Go-Round" fund, a community pool of money and resources that can be invested in livestock or farm tools for use by all of the villagers who contributed to the fund.

Sager's project has drawn an enthusiastic response from the villagers, and their eagerness is now propelling the project even further. "The women and girls in Gatunga and from the neighboring villages are very excited about the possibility of a space where they can come and learn new skills as well as develop ones that they already know," Sager says. "The village chief, Nicholas Nyaga, has designated an existing building and six acres of land towards the project."

With the support of the villagers behind her and one grant already under her belt, Sager is ready to launch her Makerspace into the development phase. In order to bring the project to fruition, though, she needs to tap into the university's greatest resource: its students. She is currently devising a curriculum for a three-semester course set to begin in the fall of 2014 that will be centered on the Makerspace project. Students taking the class will work to develop Sager's existing ideas for the Makerspace, as well as research new ones. The course will be based on the concept of "design thinking," a thought process that Sager says is essential in many interior design projects. "Design thinking is basically a process that begins with the concept of empathy, meaning you think about the user first, and define what the problem is based off of their point of view," Sager describes. "From there you begin to come up with ideas of how to resolve the problem. Then you start to prototype, and once you make a product, you test it to see how it's working. And it can be a cyclical process that keeps going back to the user." Focusing on sustainability, availability of resources and time and cost efficiency, students will develop products for the Makerspace over the course the fall semester. If all goes according to Sager's plan, they will take these products to Gatunga for testing during the winter interim and then reevaluate and refine the designs in the spring semester.

Although the class will fall under the umbrella of the interior design program in the School of Human Ecology, Sager does not want to exclude students in other colleges and majors. In fact, due to the close resemblance of her design thinking process to the re-iterative design process taught in many introductory engineering classes, she is hoping to recruit engineering students and faculty to participate in and direct the course. "One of the best ways that you can get a design thinking course to work is to have multiple instructors from different disciplines, because that's what design thinking is all about. It's about people with specialties, and then they all think along this same design thinking plane," Sager explains. "It's all about collaboration, about bringing different disciplines together and finding the overlaps. That's how you come up with unusual and brilliant ideas."

This project, helmed by the powerful force of determination and compassion that is Lesley Sager, holds infinite promise for the women in Gatunga. By bringing together the talents of a diverse group of students and faculty, Sager is pioneering a better future for the people of rural Kenya – and demonstrating what a potent catalyst for change collaboration and diversity can be. WE

Written by: Alyssa Hantzsch
Photography by: Lesley Sager
Design by: Ryan Krull

# Wisconsin Firms Make a Case in the 2013 R&D 100

*Wisconsin holds its own in the international engineering game.*

While many Wisconsin residents don coats to protect themselves from cold weather, two Wisconsin engineering firms developed material coatings to protect against high temperatures. Material Interface and NCD Technologies have been awarded a 2013 R&D 100 Award for their innovative product development.

The R&D 100 Awards, known in the industrial world as the "Oscars of Innovation," are granted to the 100 most unique and technologically significant products developed worldwide. Winners are chosen by an independent judging panel, in conjunction with the editors of R&D Magazine.

The first award winner from Wisconsin is Material Interface of Sussex, WI. Material Interface developed Minimox ®, a nanoparticle alloy coating that minimizes oxidation in high-temperature environments. The appeal of Minimox® hinges on its simple application; Material Interface bills Minimox® as an "alloy treatment in a bottle," referring to its ease of use. It can be applied using a spray bottle, a brush or by dipping components directly in the liquid.

The inspiration for Minimox® came from Dr. Susan Kerber, founder of Material Interface. She has over 20 years of experience as a materials analyst and consultant and has seen plenty of high-temperature material failures due to high-temperature oxidation and corrosion. She noticed that a significant number of those failures could have been avoided had there been a method of applying alloy protection after a part is constructed and in use. Most methods of alloy protection must be implemented during production, an impossibility for a setup that has alr¬eady been constructed. Minimox®, however, can be applied to an existing system because it alters the surface chemistry of an alloy. Application at any time allows effective protection to be applied in a simple, inexpensive manner after production, even years down the line.

Dr. Kerber says that the product's novelty has been both a blessing and a curse. The high degree of customization that materials science can offer. "Materials science and engineering is a very rewarding field, in general, because materials can be custom built, atom by atom, to accomplish specific goals and achieve specific material properties. Development of a new product that does not have any parallel in the marketplace is very rewarding," Dr. Kerber says. But the originality of the product has also been its marketing downfall. Because Minimox® uses a new application process, it has been difficult to advertise in a context that clients will easily understand. Dr. Kerber says Minimox® is revolutionizing the industrial coating process, but long-held industrial habits have proven difficult to break for Material Interface.

The main end goal of Minimox®, according to Dr. Kerber, is to "improve many types of manufactured goods that operate at high temperatures – automotive systems, heat treating components and furnaces, and gas and oil processing equipment. These systems can be made to last longer and run more efficiently while costing less to build and operate."

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> **- Dr. Susan Kerber**

NCD Technologies of Madison also struck gold with a material coating. NCD collaborated with Argonne National Laboratory to develop a new tool-coating process using an augmented diamond compound. The previous standard solution depended on acid-etching, which weakens the tool steel, leading to long-term tool degradation and shorter material life. The coating process, called Nanocrystalline Diamond Pretreatment (NDP), is applied to minute industrial manufacturing machines. Since the tooling parts in question are so minuscule, the margin of error is small, and improving the process increases efficiency and output at all levels of the manufacturing process. The coating decreases the coefficient of friction between the tool and the parts being created. The tool's sharpness and accuracy are sustained for a longer period of time, minimizing the frequency of manufacturing part replacement and assembly line downtime.

Patrick Heaney, a member of the design team, says that the inspiration for NDP came from several years of working with small tooling parts. He encountered the common complaint that tools of such small size are uncoatable, leading to drastic production waste and lost time. "We figured there had to be a better solution that wasn't currently available," Heaney says. He and his colleagues at NCD saw the clear need for a coating process that can be easily applied to small-scale equipment and went to work. Heaney says that the general idea for NDP was brought to life fairly quickly, but the majority of the work was in perfecting the formula. The tweaking, Heaney says, was both the most frustrating and rewarding step in the design process. Accommodating the wide variety of environmental variables in tool shops, such as temperature, machine speed, machine quality and tool material, was the most difficult aspect of the design process.

Similarly to Material Interface, Heaney says that the toughest challenge that NCD has faced has been advertising the coating process as something that is both valuable and easily applicable. Heaney says that "the people that are using [small tools]…they're not really willing to slow down production to try a new coating, even if it has a promise of reducing costs or improving productivity, because it's such a challenge." Most firms are already strapped for funds and don't have spare money to spend on research and development. Another obstacle NCD has faced is the resistance of tool manufacturers and tool distributors. Heaney explains their hesitance: "If you think about their business, they don't want to improve tool life, because they'll sell fewer tools. Even though they're going to lose some short-term tool sales, this [NDP] is the way to immerse themselves in the industry."

NCD has attempted to make up for the distributors' opposition by appealing to companies that make their own tools in-house. That has been a much easier sell because using the coating process saves those companies money in both the manufacturing process and total tool output; tools with a longer life need to be replaced less often, decreasing the number of tools that need to be made.

Material Interface and NCD Technologies both hinge on long-term economic savings as a key selling point. Their innovative methods have garnered the attention of the international engineering community with their R&D 100 Awards, showing that the state that gave us the vacuum cleaner and clothes dryer is still determined to stay on the global engineering map. WE

Written by: Andy Kerber
Design by: Jason Wan

# A New Standard for Stem Cell Production

***A new neural stem cell development process will lead the way to a surge of progress in research and industry.***

While most students here at UW-Madison are swamped with exams and homework, stem cell researchers across campus have been letting out resounding cheers of success. Back in 2012, the stem cell research labs in the Wisconsin Institutes for Discovery were just beginning to take off. These four labs, making up the Bionanocomposite Tissue Engineering Scaffolds (BIONATES) department, were chock full of multi-disciplinary expertise, passion and ambition. As it turns out, their aspirations were not too far off. In fact, the department has taken one massive leap forward.

In order to avoid ethical pitfalls, it has become common practice to use human-induced pluripotent (iPS) cells. These are adult cells that are made to mimic naturally pluripotent cells. The BIONATES labs have been working diligently to find a better way to produce iPS stem cells and push them to become neural cells. The previous method used mouse embryonic fibroblasts (MEFs) to culture the cells, but this process required certain expertise, and the results are not always consistent. The benefits of an easy-to-use, highly repeatable method were obvious.

**Student studies cells on campus**

The significance of forward progress with stem cells is due mainly to the vast variety of potential uses. The key to the utility of embryonic stem cells is that they are pluripotent; they are blank slates that can become any type of cell in the body. This could lead to the development of treatments for many of the diseases and problems that plague us; however, the cells are not easy to produce and control.

The Ashton lab is led by Randolph Ashton, assistant professor of biomedical engineering, and was one of the four BIONATES labs involved. Ashton's lab in particular led the effort for the development of a new procedure. Ashton and Ethan Lippmann, a postdoctoral fellow working in the Ashton lab, co-authored a paper on the use of a new chemical process with an altered culture medium. The process is exactly what stem cell researchers have wished for, providing an easy, fast and consistent way to produce iPS stem cells and force them to become neural cells with 100% certainty. "You can buy everything you need off the shelf, so if people want to do this in their own labs, they don't have to learn some crazy new expertise. They can read the protocol, they can buy everything, and they can do it," Lippmann says. This means that both researchers and people working in industry will be able to produce the cells with equal success.

Stem cells are notorious for both their ethical issues and difficulty of production. The creation of IPS cells has addressed the ethical concerns, and this process, which lessens the difficulty, means that there are few excuses holding back stem cell applications in medicine.

Most stem cell researchers at UW-Madison have already begun using this process. Lippmann is now looking for ways to further direct these neural stem cells to different phenotypes. Each different phenotype has a different purpose, and by utilizing certain inputs, useful cells can be developed for desired applications.

The rest of the researchers at UW-Madison are still transitioning, some reluctant to leave old methods behind. "I think we'll start to see a push on this campus for people to adopt this methodology," Lippmann says. The hope is that, in time, the cultural stigma around stem cells in the rest of the nation will decrease, and this method will become standard for research. Stem cell science will only see increases in productivity, and with the current momentum of the BIONATES labs, who knows what they will discover next? UW-Madison students may feel stuck in never-ending studies, but stem cell research is moving full-speed ahead. WE

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