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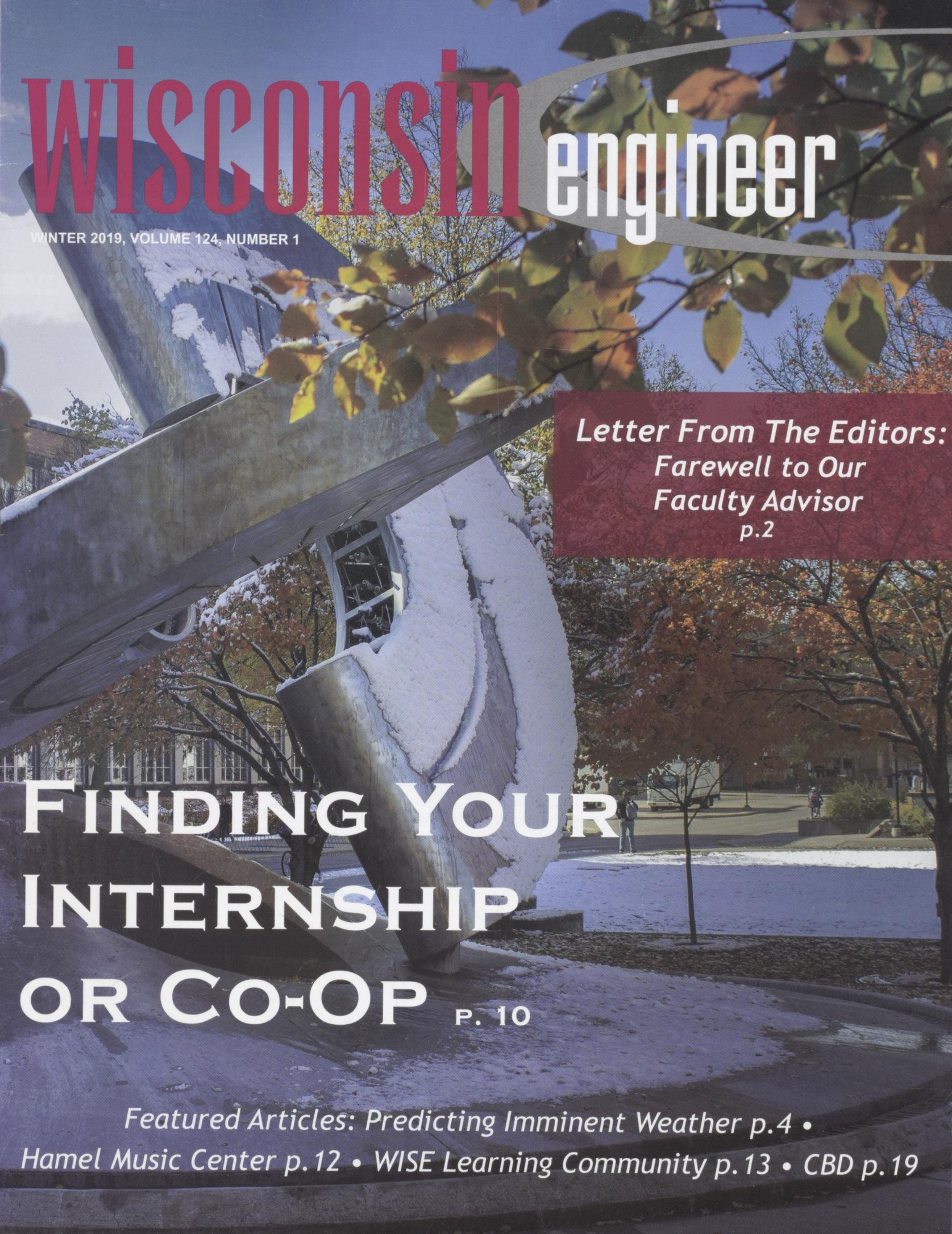

wisconsin engineer

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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.

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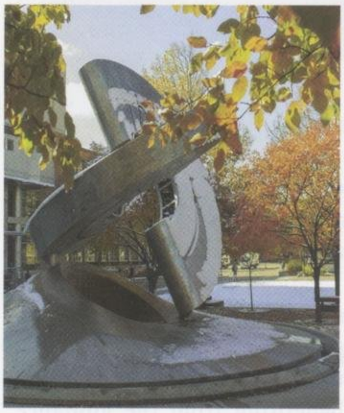
General



Cover photo by Austin Nellis

Letter From the Editors

As the end of the semester draws closer, most of us are stressed, busy, at the end of our ropes. Through all these difficulties, the finish line of winter break is almost like a carrot dangling in front of us. For months, we've been working hard and dedicating a majority of our time and effort into schoolwork. The opportunity to get to focus on anything but school for longer than an evening seems to be a dream. Then, after a full month of holidays, family, and relaxation, we will come back to campus once again, maybe with some reluctance, to hit the books and finish out the academic year strong.

For some others, this winter break will not just be a break, but the end of their career here at UW-Madison. It is common for students to graduate a semester ahead of time or, in the case of many engineering students, take a "bonus" semester. When these people leave campus after the last exams in December, the next time they return will be as alumni.

While we often consider this bridging between stages of life for students as they finish their time in college, rarely do we stop and reflect on the many faculty members who also finish their time at this university each semester. This is especially true for us at the magazine this semester, as our faculty advisor of 27 years, Professor Zwickel, enters retirement at the end of this fall semester.

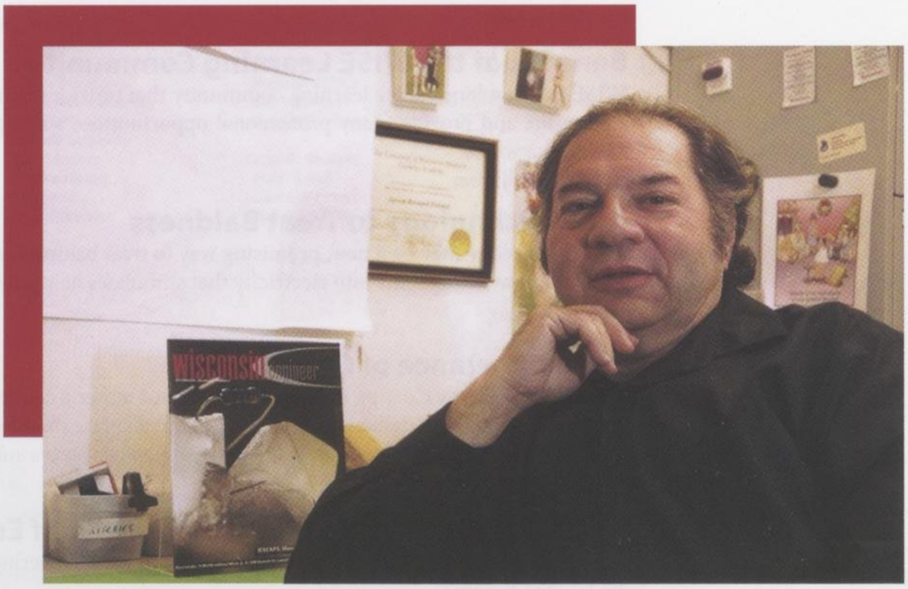
With an organization as old as this magazine (since 1896!), it naturally enters and exits many different stages of styles, content, and members. For over two decades, Professor Zwickel has overseen the student staff as we produce each issue twice a semester. He has seen the magazine transition to new styles of printing, the creation of our website, dozens of issues, and hundreds of staff members. Without fail, he is always able to offer an insight into any issues that we encounter, tips for creating better content, or a story from one of his many escapades (teaching English in China, writing two books, and climbing Pikes Peak, just to name a few).

As two new Editors-in-Chief this semester, Professor Zwickel was always available for our questions regarding the behind the scenes of the magazine that gets this product from an idea in our heads to the printed copy you have now in your hands. Having someone like him who not only is full of knowledge and experience, but also truly cares about this magazine has been a real gift to us.

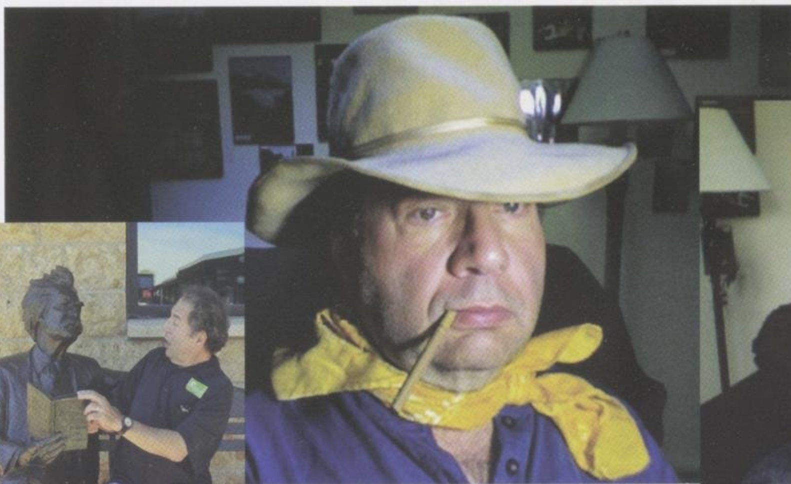
In January, Professor Zwickel will be kicking off his retirement by spending time in El Paso, Texas. He won't only be enjoying the sun while we brave out this Wisconsin Winter, but will be putting his social work expertise to good use. In light of the recent issues with treatment of children at the United States-Mexico border, Proessor Zwickel has offered his services in an attempt to better this situation. We are incredibly proud of the work he will be doing and wish him all the best.

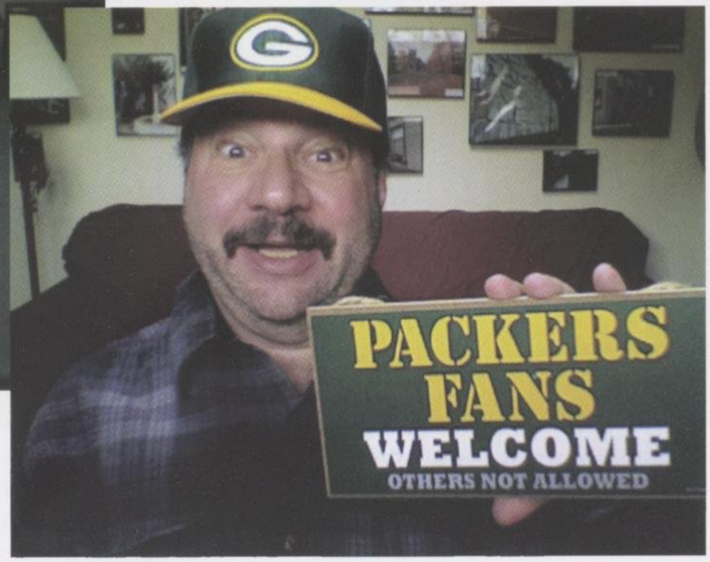
Moving forward into the spring, we take on the challenge of producing the next issues without our counted-on faculty advisor with determination to continue creating a great magazine, but also a heavy heart. When someone has dedicated as much of their time and effort into an organization the way that Professor Zwickel has, it truly leaves a long-lasting mark. For years, this magazine will still be benefiting from the guidance and commitment that he has given over the years. Thank you for everything, Professor Zwickel, and enjoy retirement!

-Katlyn & Erin



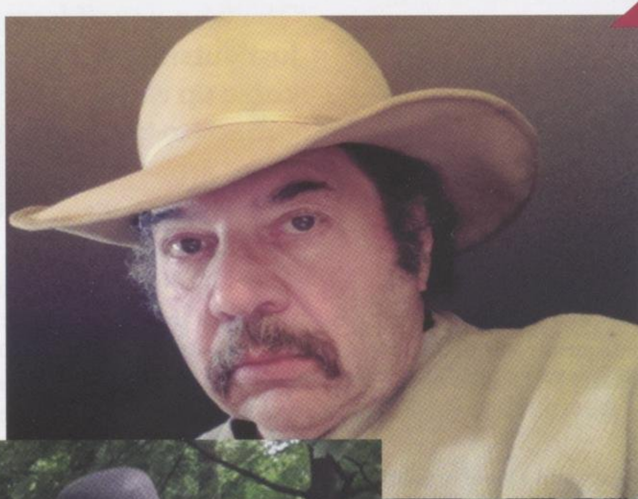
Professor Zwickel, our long-time faculty advisor.

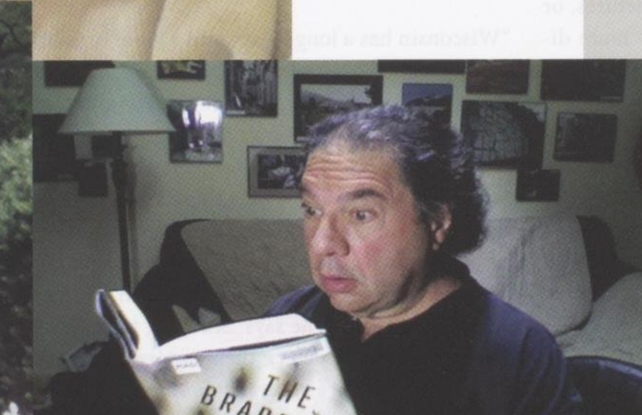


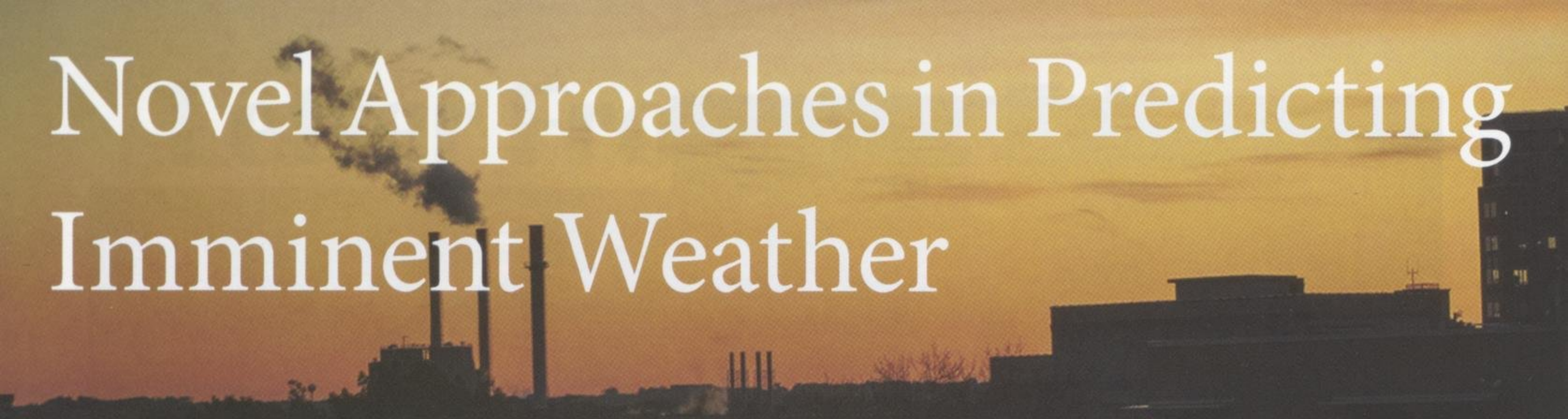


Thank you, Professor Zwickel!

27 Years as Faculty Advisor







Novel Approaches in Predicting Imminent Weather

Hurricanes are truly catastrophic natural disasters in a meteorological sense. A research scientist at UW-Madison uses computer programming and artificial intelligence in order to obtain real-time estimations of imminent weather, such as hurricanes.

A new wave arises. Computer programming and artificial intelligence are at the vanguard of science and technology. Whether it is writing algorithms that shorten pages and pages of calculations, accelerating healthcare progress, or augmenting the boundaries of communications, artificial intelligence is exponentially revolutionizing human progress. One particularly fascinating subdivision in which one can see the application of computer science and artificial intelligence is in the works of research scientist Dr. Anthony Wimmers. Dr. Wimmers has been a researcher at the Space Science and Engineering Center/Cooperative Institute for Meteorological Satellite Studies since 2003. Two years ago, Dr. Wimmers began working on utilizing artificial intelligence to gain insights about imminent weather, especially hurricanes.

In describing his projects, Dr. Wimmers says that his focus lies in meteorology -- "short term prediction" or "real-time estimation" of impending weather hazards. This apparatus of using artificial intelligence in order to monitor weather patterns is, unsurprisingly, quite new. The prior state of the art techniques involved algorithms that read off distinct properties of a hurricane such as temperature differences, size of structures, or asymmetry. They were predominantly more direct analytical techniques. The presiding method implemented a satellite to approximate the intensity of a hurricane. Furthermore, a set of rules and flowcharts known as the Dvorak techniques, initially developed in the 1960s and 70s, are widely used for these predictions. At the time, this approach was quite groundbreaking as it allowed for quantities, such as the intensity of a hurricane, to be estimated to a degree of precision.

However, these techniques are finally waning as they do not capture the more objective but complex characteristics required to truly comprehend these natural disasters. On example of such an evaluation is analyzing certain structures from images of a hurricane. Therefore, Dr. Wimmers felt as if this area of study needed innovation. In his research, Dr. Wimmers uses a device known as a geostationary satellite. Its primary job is to provide real time information on the weather and to observe patterns that connect to interesting weather. The geostationary satellite, along with artificial intelligence, is relatively advanced and provides sophisticated alternatives to the dominant old-fashioned methods.

Artificial intelligence offers a way to integrate objective and subjective components. "Artificial intelligence finds holistic patterns that connect to a desired prediction, instead of taking a traditionally reductionist approach," says Wimmers. "For example, it can detect the spiral band forming around a hurricane, which only gets part of the way toward analyzing the hurricane. Artificial intelligence quickly builds a model that tells it apart." This line of research is incredibly useful in not only comprehending the conditions that lead to a hurricane, but consequently creating real-time estimations so necessary precautions can be taken.

"Wisconsin has a long legacy and a lot of breadth in the field of satellite meteorology," says Wimmers. The Space Science and Engineering Center was founded over 50 years ago and researchers at the university have been engaged in using weather satellites from the very beginning. Dr. Wimmers' interest in studying hurricanes did not begin until he started working on his PhD. "Hurricanes are the most expensive type of natural disaster caused by weather," he says. Studying techniques and programs to detect them and understand them seemed to be a natural fit for him. Dr. Wimmers' loves the "teamwork between the different research efforts here" and the "encouragement to explore and try new approaches."

"Sometimes the best approaches are not the ones that are laid out in front of you," says Wimmers. "For example, when I started teaching myself about machine learning, I had just read things in the popular press. I thought it had a lot of potential. It wasn't something that everyone was pointing me toward. There's a payoff from looking just outside your discipline to come up with a more creative approach to the same problems that are facing the people in your field."

"There's a payoff from looking just outside your discipline to come up with a more creative approach to the same problems that are facing the people in your field."

"The reason that artificial intelligence is back in vogue is that there is an innovation in a field called 'deep learning'," he states. Deep learning is a knowledge subset of artificial intelligence in which predictive models are developed automatically by relating complicated and abstract patterns within the data. This is exactly how Dr. Wimmers is currently studying the distinctive evaluations of hurricanes. In this day and age, the implementation of technology for gathering knowledge is ubiquitous. Applying artificial intelligence could mean original and compelling results. Dr. Wimmers has expressed that he would be interested in working with students to research applications of his work to deep neural learning in the future.

Written by: Teja Balasubramanian

Photography by: Marshall Walters

Design by: Lucas Bartel

S'Not Impossible Anymore:

Capturing the Structure of RV-C

Ann C. Palmenberg, a professor in the UW-Madison Biochemistry Department and the Institute of Molecular Virology, leads a team that resolved the structure of RV-C, a rhinovirus that is associated with severe asthma in children.

For more than fifty years, the causes of the common cold have been studied at UW-Madison. Recently, the focus has shifted to asthma research. 50 years ago, samples of children's snot were placed directly into cell cultures to identify cold-causing virus agents. The common rhinoviruses grew well in the cell culture and could be identified by the holes, or "plaques" they created in the cell culture sheets. However, while this technique helped to find RV-A and RV-B, other virus species did not grow well under the same standard conditions and were missed in the initial screening studies. This includes the whole species of RV-C.

What makes RV-C different from RV-A and RV-B? RV-C requires a receptor called Cadherin-related protein 3 (CDHR3), which is a very special protein. It is displayed on the top surfaces of ciliated lung cells only when the correct gene form, or allele for CDHR3, is available. All humans have CDHR3, but only those whose genetics encode tyrosine at position 529 of the protein Y529 instead of cysteine 529 (Cys529) can properly display CDHR3 on the surface of their cells where it is accessible to the virus. Severe asthmatics have this allele (Tyr529) as part of their genetic makeup, and therefore get more severe RV-C infections, which in turn trigger their asthma symptoms.

"RV-C is not a new virus, but the ability to detect it is new," says Dr. Ann Palmenberg, a professor in the UW-Madison biochemistry department and the Institute of Molecular Virology. Working with collaborators at UW-Madison, she helped detect multiple RV-C isolates a few years ago through sequence analysis. She uses this information to determine why RV-C grows so poorly in standard tissue culture. The trick was that the RV-C has a unique protein receptor to bind to cells. CHDR3 is usually found only on the surface of native lung cells, not cultured cells. Luckily, CDHR3 cells can be provided by recombinant engineering and cultures can be made that will support RV-C growth. Before this discovery, 40% of anti-RV clinical trials failed because they were not aimed at the right virus. Now, with the new sequencing and receptor information, Palmenberg's RV-C studies can potentially be used to design the right drugs to combat diseases caused by RV-C, as well as RV-A and RV-B.

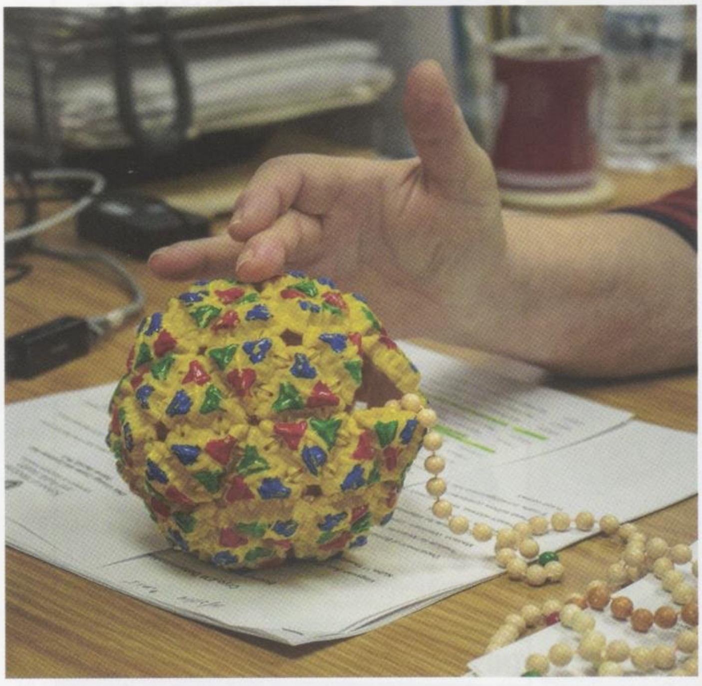
As part of those studies, her group worked with collaborators at Purdue University to map the atomic structure of RV-C with cryo-electron microscopy (cryo-EM). This is a relatively new technology that can take very high resolution 3D photographs and videos of virus particles or even individual proteins. By collecting the patterns of thousands of images, the cryo-EM can build the whole structure of RV-C. To do that, the biological sample in solution is applied to a carbon grid, then frozen in liquid ethane. Under the high-power microscope, the grids are bombarded with electrons to collect the images. Before cryo-EM techniques were available, the RV-C could not be studied at the atomic level, because alternative structure techniques used crystallography, which required a much larger sample of the virus than it was possible to grow. Crystallization is less efficient than cryo-EM, and in the past it took several years of work just to produce a single virus structure. From a single sample of Palmenberg's RV-C, her colleagues at Purdue University were able to fully resolve the complete atomic structure of RV-C15a using cryo-EM in just three day.

Palmenberg's lab also works extensively with Dr. James Gern, a professor at the UW-Madison medical school whose research interests focus on allergy and asthma. Dr. Gern specializes in studying viral and environmental factors that contribute to respiratory illnesses. The Palmenberg-Gern collaboration is trying to reconstruct a patient's childhood immunology history using samples collected by the Gern lab and identify the role of viruses, specifically rhinoviruses, in that history. To do this, they have cloned various RV virus strains, made recombinant viruses, and probed the regions of the virus' outer capsid shell. Then, based on the information found, diagnostic chips containing bits of CDHR3 proteins can be reacted with patient blood serum samples, and tested for reactivity. This research is aimed at identifying disease-causing viruses that might have affected a child throughout their lifetime. This information, in addition to the child's CDHR3 genotype, can help the child receive the correct treatment.

"Every discovery we do is aimed at being transferable in the clinics. It is amazing," says Palmenberg. Through their collaboration, Ann Palmenberg, James Gern, and her colleagues at Purdue University are expanding the frontiers of asthma research and increasing the accuracy of asthma diagnosis. RV-C research has the potential to exponentially increase the amount of information we have on treating asthma, and it's only through the application of new technical innovations such as cryo-EM structures that we can hope to potentially cure such diseases.

Written by: Gabriela Setyawan
Photography by: Jacobo Kirsch Tornell
Design by: Lujain Al Jumah

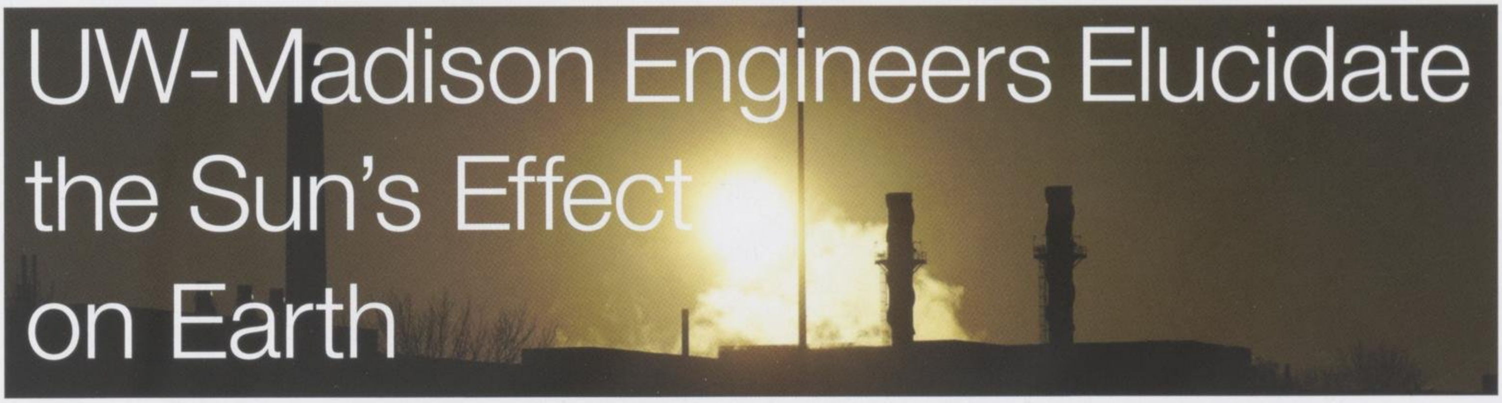
"Every discovery we do is aimed at being transferrable in the clinics. It is amazing."
- Dr. Ann Palmenberg



Model Retrovirus Type C, with simplified genomic sequence made out of beads.

Retrovirus growth testing. The white area indicates population of the virus.

UW-Madison Engineers Elucidate the Sun's Effect on Earth



The sun is a star we all benefit from, but have you ever wondered: Apart from warming our planet, what does it really do? Engineers at UW-Madison have built an artificial sun in the Wisconsin Plasma Physics Laboratory to answer exactly that question.

Nearly three meters wide in diameter, the artificial sun created by the Wisconsin Plasma Physics Laboratory holds a vacuum which pumps in helium gas, ionizes it, and turns it into a plasma state. A current is then applied and magnetic rings inside the sphere manipulate the plasma, imitating how the sun spins. By using this setup, engineers can then take measurements using devices such as hall effect sensors to measure the magnetic field.

Initially built to study a concept called the "dynamo," or how plasma motions in the sun create a magnetic field, the engineers moved on to investigate how solar wind is born and recreated a laboratory model of the Parker Spiral. The Parker Spiral describes the interaction between the sun's magnetic field and the solar winds which gives a "spiraling magnetic structure". The sun's magnetic field is generated by the electric current in the sun, resembling a field of a bar magnet, and the polarity periodically flips every 11 years. Solar winds are charged streams of particles that have escaped the sun's magnetic field. These solar winds come in two main forms: fast and slow. It may sound elementary, but their distinction moves far beyond just their speed, as their temperature and density are also key differentiating factors. Slow solar winds are between three hundred to five hundred kilometers per second, whereas fast solar winds are around seven hundred and fifty kilometers per second. Furthermore, "...fast winds are often quite steady in flow, density, temperature and elemental composition, which is indicative of where the plasma comes from in the sun," explains Ethan Peterson, a former graduate student and an initial member of the project. Fast solar winds are well studied in comparison to their counterpart, as they are simpler to understand. The varying nature of slow solar winds is much less understood, which is why researchers at UW-Madison have focused their efforts on this part of the field.

Although we are usually protected from solar winds by the Earth's magnetic field, occasional solar flares from the sun emit energy equivalent to a million nuclear bombs. This energy is carried to earth in the form of solar winds and renders Earth defenseless. The effects of the energy from solar flares are something to be feared, especially in a time where we are heavily reliant on technology and electricity in our daily life. The solar wind produced by these solar flares can disrupt navigation systems, satellites, and power line communication systems. One of the most notable examples of a solar flare affecting Earth came during 1989 in Quebec. On March 10th, 1989 a powerful solar flare was observed; traveling at a million miles per hour towards Earth. At 2:44 AM on March 13th, the storm arrived, creating strong currents all throughout the ground of North America, by 2:46 AM the Quebec power grid lost all power. The blackout lasted for 12 hours, forcing schools, offices, the metro system, and the airport to close. The whole province was forced into a shutdown. Due to the possible damage that solar winds can cause, solar winds should be more thoroughly studied.

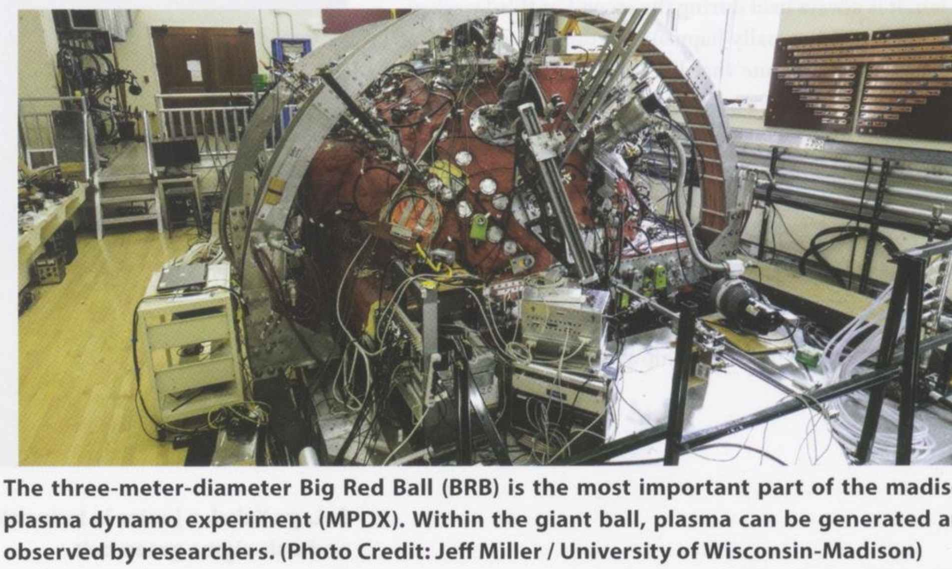
When asked about how the study of solar wind can prevent situations like these, Peterson explained that "...it all lies in being able to predict accurately how big these storms are going to be and when they arrive," and that this has been largely undertaken by NASA, whose models are "good but still have a ways to go." UW-Madison's artificial sun will be used to study the fundamental physics behind this in order to aid in building more accurate models. Building these accurate models will help to put preventative measures in place, such as secondary power sources or acknowledging necessary repairs to certain parts of the power grid.

Despite the strides that UW-Madison engineers have made, the study is far from complete. "There are many outstanding questions: We don't exactly know why [the solar winds] are so hot and we don't know all the ways it has accelerated from the sun," says Peterson. Whatever the answer to these questions may be, UW-Madison engineers and the artificial sun they created are helping to shine a light on new discoveries.

Written by: Pierson Chu

Photography by: Rung Shih

Design by: Lucas Bartel



The three-meter-diameter Big Red Ball (BRB) is the most important part of the madison plasma dynamo experiment (MPDX). Within the giant ball, plasma can be generated and observed by researchers. (Photo Credit: Jeff Miller / University of Wisconsin-Madison)

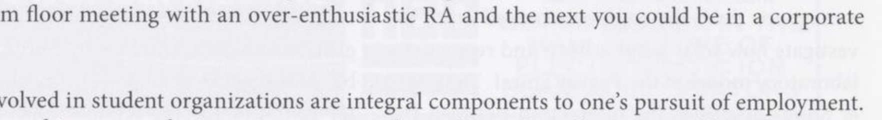
Finding Your Internship or Co-op

As a freshman, you may think your first degree-related work experience is far on the horizon. Many freshmen do not attend the career fair because they are worried that they are unqualified. Additionally, many students don't know how to create a resume, much less a cover letter. But don't worry! Almost everyone with an internship or a co-op was once a freshman in college and had to experience their first career fair or interview. If you play your cards right, one minute you're in a boring dorm floor meeting with an over-enthusiastic RA and the next you could be in a corporate development room with the CEO of a Fortune 500 company.

Most people can agree that earning good grades and getting involved in student organizations are integral components to one's pursuit of employment. But often students don't know how to successfully navigate a career fair, prepare for interviews, or start their job search at all. Here to address these areas are several students who have successfully completed internships!

"The process of getting to the career fair at UW-Madison can sometimes be dicey. For the engineering career fair, it is always held during the second or third week of school, which usually happens to coincide with warm weather. For anyone that lives a meaningful distance away from the career fair location, I would strongly consider taking a bus, biking, driving, or even having a friend drive you. Walking a long distance wearing long sleeves and pants in hot weather isn't going to be comfortable, and sweating profusely in front of recruiters probably isn't going to make them want to hire you... probably."

- Johnathon Brehm (Internship at Scot Forge Company)



"My best advice would be to get the ball rolling early on internships. Don't be afraid to get your name out there and even and internship as a sophomore. Put the work in early as far as resume, interview practice, etc. It will pay off down the road!"

- SaLeya Yukel (Internship at Baker Tilly)

SaLeya Yukel, a junior in Industrial Engineering with certificates in entrepreneurship and a six sigma green belt.

"I prepared by doing a lot of research on the company by looking at their website. I used the interview guide on the ECS website to practice interview. They asked me a combination of technical questions and interview questions. They asked me to tell them about a time that I failed and some other common interview questions. My best advice for an interview is to have answers and specific experiences ready for the common interview questions."

- Sam Hietpas (Co-op at SubZero and Wolf)

Sam Hietpas, a senior in Mechanical Engineering.

"One thing I've learned about interviews is that it is more about how well you connect with the interview team than how impressive your resume is. If you don't feel comfortable in an interview, you're doing it wrong. All of my job offers have come from interviews that felt more like conversations and less like an interrogation. Companies are looking for somebody that they would enjoy working with in the summer, not necessarily the smartest or most qualified candidate. It's easy to teach someone how to be a good engineer. It's much harder to teach someone to be a good coworker. Focus on showing companies your teamwork skills instead of boring them with the latest news from your research lab. I can guarantee they don't really care."

- Will Mockert (Internship at H Findorff and Son)

"The best way to prepare for an interview is to research potential questions relating to your field. When it comes to engineering, all professional advice suggests you provide answers that show the interviewer how your mind works and as well as your other interests outside of STEM. Being a well rounded person is the best way to stick out from the pack. Always expect and preplan answers for vague questions such as "Can you tell me a little about yourself?" These questions are designed to see if you have prepared for the interview and are an opportunity to show your interests and relate to the interviewer on a level outside of your resume."

- Zack Cooper (Internship at United Airlines)

If you read these tips and want more, there are plenty of resources on campus for career fair preparation, interview tips, and professional development. Handshake is a great way to learn more about companies and it allows you to filter search results to find positions geared toward your major. The Engineering Career Services website is another valuable resource whether you need to prepare for an interview, write a resume, or get information about the next career fair. Engineering Career Services also has a calendar of events that will help you to find your next internship or co-op. Finally, be sure to check your email for upcoming events and workshops, especially in the week before the career fair!

Writer: Alix Rosenblatt

Photography: Austin Nellis

Design: Hannah Smoot

THE INTERSECTION OF ENGINEERING AND MUSIC

The newly constructed Hamel Music Center, at the intersection of Lake and University Street, was carefully engineered and constructed to meet the performance needs of UW-Madison's musical scene and highlight the students of Mead Witter School of Music's abilities.

One of the busiest intersections in Madison is now home to the most musical building on campus. The Hamel Music Center opened its doors this fall after a two-year construction period and a tremendous fundraising effort. Behind the glass doors lie three halls, each skillfully designed to provide students and faculty with state-of-the-art performance spaces.

The Mead Witter Foundation Concert Hall and Collins Recital Hall replace the use of Mills and Morphy Halls in the Mosse Humanities Building. Previously, when recordings were taken for students to submit to graduate school or ensembles, the HVAC system was so loud it had to be turned off. "A hall really is another musical instrument -- it's part of the ensemble," says facilities director Brian Heller. Students' performances will no longer be inhibited by the restrictions of the Humanities Building. Instead, the new hall will enhance the ensemble by serving as a cohesive part of the performance.

Both the concert hall and recital hall feature motorized, retractable curtains to allow for the adjustment of sound in the room. Reverberation of sound can be changed by using one of twelve programmable settings, tailored specifically to the wants and needs of the ensemble. The programming was done by acoustician Rick Talaske of Talaske Group Inc., an acoustic and sound consulting company from Chicago. Talaske created an accurate prediction of how the space would sound even before construction began. Talaske has a computer model that accounts for the shape, materials, and angles of the space to measure the reflections from the stage and absorption of the seats. No model is perfect, though. In early September, students were encouraged to come and listen to performances so the model could be put to the test and final adjustments could be made.

In addition to the motorized curtains, the large concert hall features two reverberation chambers on each side of the stage, 30 feet in the air. These "ears," as they are called, allow for acoustic energy from sound produced on the stage to enter the room, bounce off hard surfaces, and be redirected back into the room. There are no parallel surfaces in these chambers in order to prevent standing sound waves, therefore allowing for almost all the acoustic energy to be redirected and allowing for a high reverberation time. Reverberation time describes the rate of sound decay -- the time it takes for sound to die away after the sound source ends. Higher reverberation time allows for increased control of sound in a space, making it a critical component in the overall acoustics.. For reference, the average reverberation time of Carnegie Hall in New York is 1.7 seconds, Symphony Hall in Boston is 1.8 seconds and Musikvereinsaal in Vienna is 2.05 seconds [1]. With a maximum reverberation time of around 2.3 seconds, the Mead Witter Foundation Concert Hall is right on par with some of the best performing spaces in the world.

An imperative aspect of the design of the building was ensuring that the mechanical systems were isolated to prevent the intrusion of their sound. Each music hall is surrounded by two concrete walls separated by a two-inch air gap, called an acoustic joint. This air gap isolates the space from vibrations conducted by hard surfaces in the building. In addition, mechanical systems and plumbing are led through back corridors and pipes are wrapped with added insulation. In the concert hall and recital hall, air is slowly diffused through gaps in the floor underneath the seats. This allows for the quietest flow of air possible, while maintaining heating and cooling requirements of the building.

Throughout the building, design and acoustics are intertwined in almost every way. The construction of the entire space was completely based on the acoustics; each material was evaluated for its acoustical properties. Many structures serve a dual purpose as both a design element and aiding the acoustics of the space. The circular panels in the walls of the concert hall absorb and reflect sound back into the hall, but also give the space character. The exterior of the building is pleasing to the eye while providing soundproofing in the form of 16-inch-thick double walls.

> **"This is the most complicated building JP Cullen has done ... They'll never do another building like it"**
> **-Susan Cook**

The Hamel Music Center was designed and constructed by a team of professionals and companies from around the country, while also featuring many local Wisconsin companies. A familiar face on the project was Ben Sonnentag, a 2016 UW-Madison graduate and UW Engineer. A civil engineering major, Sonnentag was the project's site engineer for contractor JP Cullen and provided valuable input as a former UW-Madison jazz band musician. "This is the most complicated building JP Cullen has done ... They'll never do another building like it," says Susan Cook, Director of Mead Witter School of Music.

The construction of Hamel Music Center has proven the importance of teamwork and interdisciplinary teams. This performance center, the product of the integration of engineering and the arts, highlights the musical abilities of our campus and provides opportunities that will resonate throughout the state of Wisconsin.

1] "21- Design of Studios and Listening Rooms." Architectural Acoustics, by Marshall Long, 2nd ed., Elsevier Academic Press, 2014, pp. 829–871.

Written by: Mary Laudon
Photography by: Julien Bravo
Graphic Design by: Lujain Al-Jumah

THE BENEFITS OF THE WISE LEARNING COMMUNITY

WISE is an undergraduate learning community that provides many assets for its students to ease the transition into college-life and find professional opportunities, while positively impacting UW-Madison and women in STEM as a whole.

UW-Madison is home to a variety of learning communities, including the BioHouse community (located in Cole Residence Hall) and the International Learning Community (located in Adams Residence Hall). One special learning community is Women in Science and Engineering, otherwise known as WISE. WISE started about 25 years ago, by a professor in the College of Agricultural and Life Sciences. Located in the Elizabeth Waters Residence Hall, WISE is home to 140 members, most of whom are freshmen. In the past several years, WISE has been in high demand among students, with over 200 applicants this year alone. Some student perks of being in WISE include a personal den for the program, peer mentors, and a variety of social activities. These include activities such as movie nights, button making, and a Halloween cookie decorating night. These perks are just a small part of the benefits the students in the program receive, however, as the major benefits are long-term and can significantly impact the lives of WISE students during and beyond college.

Professor Sue Babcock, the faculty director of WISE, emphasizes both the importance of academic benefits and of the community support provided to WISE students. Professor Babcock runs the seminar part of WISE -- a one credit class taken by most students in WISE. This class helps students network with professors and learn about different career paths, some of which they never would have been exposed to otherwise. "They started at A, they thought they were going to go to B, and they ended up about 120 degrees to B, doing something completely different than anticipated, ... and that was certainly my case," says Professor Babcock in reference to changing educational direction. Brianna Fay, a current WISE member says, "WISE has [also] allowed me to connect with professors in the STEM field which has opened up possibilities of research opportunities." In a campus where research is renowned, valuable opportunities can arise and can even lead to careers. "When I'm thinking academics, I'm thinking exposure, and building some confidence," says Professor Babcock.

Many WISE members have similar class schedules, so it is easy to find someone in the same class to study with within the community. "I have made so many new friends through WISE which not only makes for a great support system but also a strong basis for study groups," says Maya Tanna, another current member of WISE. The social aspect and the idea of community are very central to WISE. "Being in WISE has made the transition to college less daunting by bringing like-minded women together, which has made making friends a lot easier," says Stacy Ducheny, another WISE member. The WISE learning community helps ease the transition for first year students as they juggle developing skills in time management, efficient studying, living independently, and creating a strong social network.

"It's a good place to start... Even in this day and age, and especially in certain fields of engineering where they [women] constitute in some cases just 10%," says Professor Babcock. In science and engineering fields, it is especially vital that women have people to fall back on, and WISE provides that first group of women who are in similar situations.

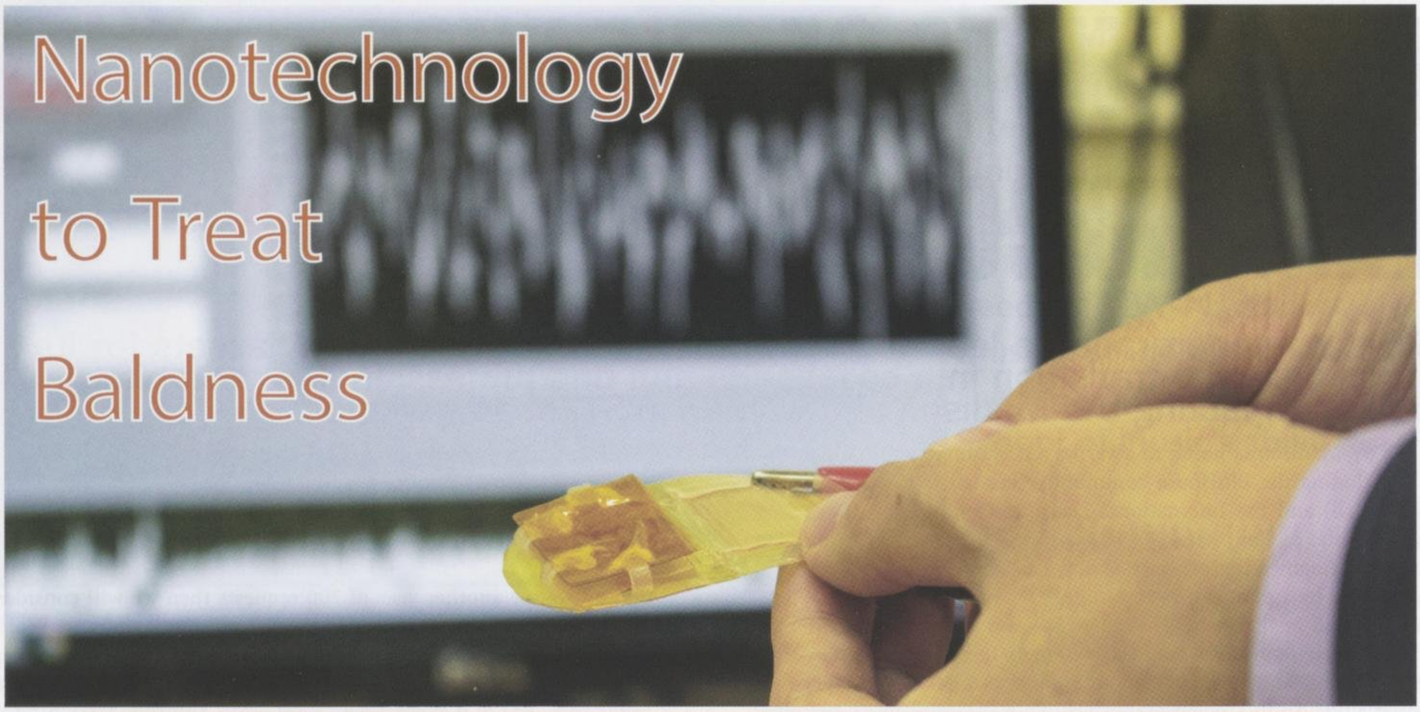
In the past couple of years there has been a demand of over 200 women who have wanted to be a part of WISE. "Ideally we want to accommodate everyone who is interested in being in WISE, so if demand goes up and we see another year of 200 requests then we will consider expanding again…I see us growing to meet the demand," says Professor Babcock. "[WISE] benefits [UW-Madison] and [the] state by keeping people who are interested and talented in STEM by keeping them engaged in STEM, if it is what they want to do, and then launching them out into the community." The women of WISE are able to go forth with a foundation of academic confidence and a peer group as sophomores, juniors, seniors, and beyond. Fostering a connection with people in the same major and developing a support system with such individuals can greatly benefit students in all aspects of life.

The Women in Science and Engineering learning community is a crucially important organization here at UW-Madison as they help provide women with tools to support them not just in their first year, but throughout their college experiences, and even into their future careers. The WISE community has a positive impact on the students in it, on the university, and on women in STEM everywhere. Women in STEM all benefit by supporting each other, and WISE provides a foundational opportunity for this support.

Professor Sue Babcock, faculty director of WISE

Written by: Paige Dollevoet
Photography by: Rung Shih
Design by: Hannah Smoot

Nanotechnology to Treat Baldness



Nanotechnology may be a new, promising way to treat baldness, as Professor Wang tells us how it can transform small random movements into electricity that stimulates hair growth.

Millions of people who suffer from baldness may now have good news. Professor Xudong Wang from the department of materials science and engineering at UW-Madison has devised a new way to treat this problem. His research group uses a piece of nanotechnology called motion-activated electrical stimulation device (m-ESD) to transform mechanical movements into electricity that stimulates hair follicles to grow new hair. The m-ESD was tested on rats and yielded promising results: higher hair density and longer hair in a shorter time.

The m-ESD consists of an omnidirectional triboelectric generator (OTG) and an electrode. The rats in this study first had their hair shaved. The m-ESD was then fixed onto a rat's skin with several stiches, so any upper body movements can be captured and transformed into a voltage by the OTG. The OTG contains three layers that are responsible for electricity generation: copper charge generation electrode (CGE), gold charge transfer electrode (CTE), and a polytetrafluoroethylene (PTFE) layer. When body movement occurs, the CGE is displaced. Then positive charge is induced on the CGE while negative charge is induced on the PTFE layer. The opposite charge builds up a voltage at the CTE. The voltage is then transmitted to the electrode in the m-ESD, which can create an electric field to stimulate hair follicles. The reason why CGE and CTE are in concentric rings is that "we want to catch any random translational movements," explains Wang. In this way, more movements can be caught, and ideal and stable voltage can be generated.

After receiving the voltage, the electrode will create an electric field that penetrates the skin and reaches hair follicles. Previous studies have found that electric fields can stimulate the cells in hair follicles to promote hair follicle proliferation. Wang's study used thisprinciple to treat baldness and compared it with other traditional treatments such as Minoxidil, a popular drug to treat baldness. They found that their electrode method yielded better results. After the electric field penetrated through the rat skin, the density and speed of hair growth was greater compared to the results of other treatments. He also notes that their device is relatively safe. "We haven't found any side effects so far," says Wang. "The strength of the electric field is so low that it only penetrates two mm into the skin to stimulate hair follicles."

"We have created a self-powered wearable device that may provide an effective solution to reversing baldness."
-Xudong Wang

The results on rat skin have encouraged further exploration of the m-ESD on human hair follicles. Wang informs that head motions will be caught to generate electricity, which means that a different design from that used on rats will be needed. In the rat study, the device is directly sutured onto rat skin to catch mechanical energy. When using on human skin, however, it will not involve any surgery to suture the device onto human skin. According to Wang, the device will be wearable and small enough to put under a baseball cap. Despite the distance between the device and hair follicles, the device will still generate an electric field that can reach and stimulate hair follicles.

The study on human hair follicles is waiting for experiment approval. Wang and his team are confident that their device has a promising future. If successful, this device, with no power source and no observable side effects, may be the most effective treatment to baldness. Millions of people suffering from this condition may now have a better choice to treat this issue in the future.

Written by: Daniel Yao
Photography by: Jacobo Kirsch Tornell
Design by: Laura Rodricks

THE IMPORTANCE OF COATING

Metallic Cold Spray Coating is less of a "spray," but rather a coating of miniscule particles covering another surface. The machine takes metallic powders, with diameters less than forty-five microns, and shoots them at super-sonic speeds with the assistance of hydrogen and nitrogen gas onto a surface material, a substrate.

Rows of pressurized nitrogen gas canisters that are used in the acceleration of metal powder through the barrel of the cold spray device.

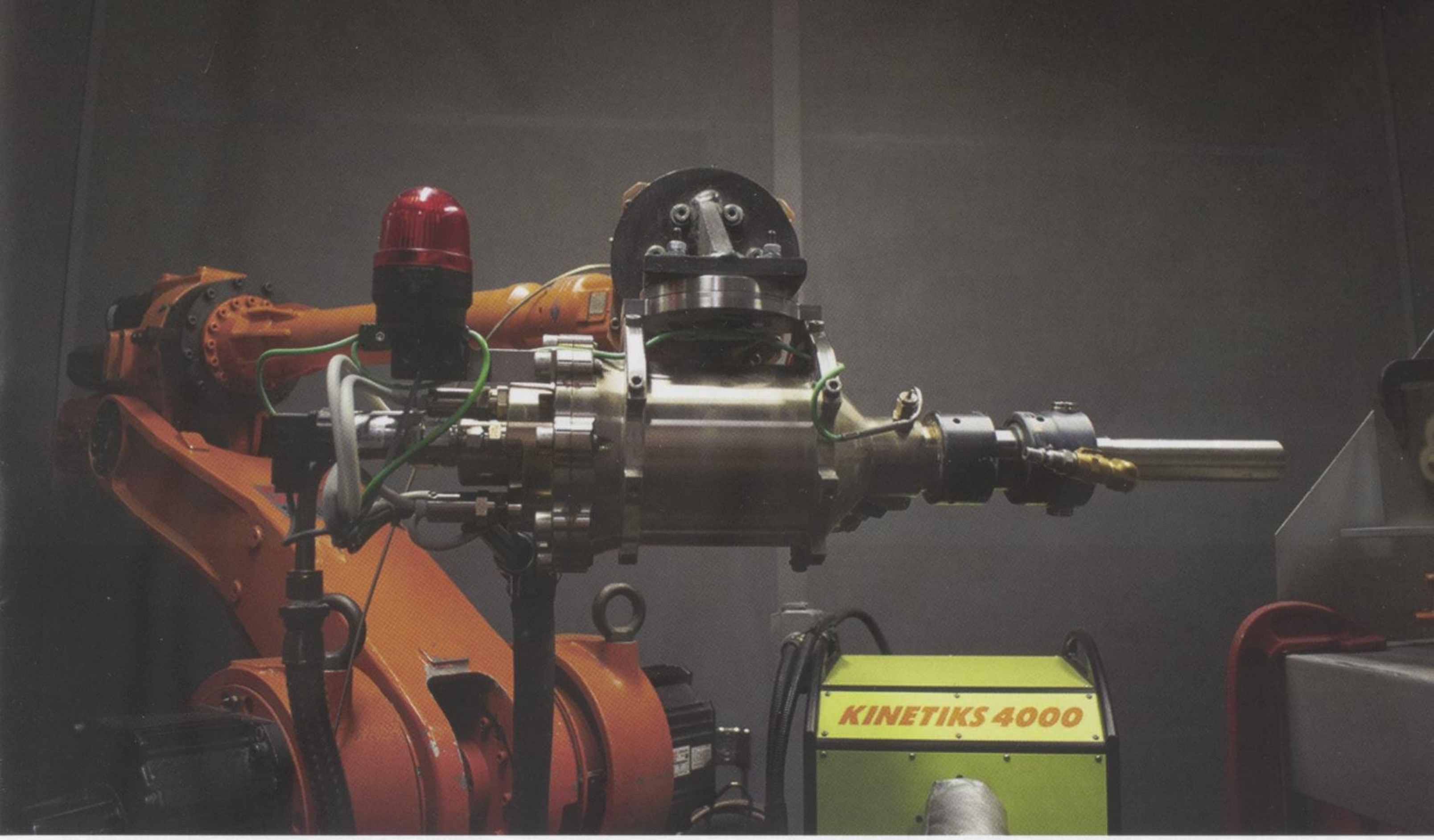
Scientific research exists to shape our world in new and beneficial ways. In the case of Kumar Sridharan, his research is a prime example of how science improves the world. Sridharan, a professor and researcher in Engineering Physics at UW-Madison, is creating a new way to remake high-quality surfaces efficiently. Sridharan's research focuses on Metallic Cold Spray Coating and its applications to nuclear energy. Metallic Cold Spray Coating is less of a "spray," but rather a coating of miniscule particles covering another surface. The machine takes metallic powders, with diameters less than forty-five microns, and shoots them at super-sonic speeds with the assistance of hydrogen and nitrogen gas onto a surface material, also known as a substrate. The smaller the particle the better, this way the particle can gain enough speed to "stick" to the substrate and keeping a uniform material. The Metallic Cold Spray Coating can be used on materials ranging from a boat to a five-foot tube of metal. The coating is versatile and allows for improvement in many categories.

The particles are 3D spheres, but as they hit the substrate at high velocities, the powders deform and flatten. As Sridharan says, "it starts out as a three-dimensional particle then it hits the surface and pancakes out. More particles bond to the substrate and join with each other and form a contiguous coating." These powered particles are usually metal alloys. Metal alloys are more commonly used due to their mechanical properties of interest for specific projects. Sridharan continues, "metal particles have a high deposition rate and low process temperature." The reason for its name "Cold Spray" is due to its ability to keep the metal intact. During this process, the metal will not melt since the process is done at ambient temperatures. No heat is added or needed for the process. In the end, the particles can stick to the substrate without the aid of any high temperatures.

"In theory, you can create a lot of new materials with this process." – Kumar Sridharan

The machine itself is a moveable robotic arm within a sound booth controlled by a researcher and a computer program. The process takes about thirty minutes to complete, followed by the researchers analyzing the substrate to ensure the material has a uniform thickness. Sridharan says, "we measure the thicknesses throughout, and we know what the initial dimensions are, and then we can measure after the coating. We look at the uniformity around the length and the circumference." Finally, the coated surface is sanded and polished, making it appear no different as the substrate had started.

An important aspect of this research is efficiency. This machine could allow for on-site repair of different devices or equipment. This is especially helpful for remote locations, such as boats used in the Navy. If there is an issue or damage to the boat, the machine would allow for a quick fixing. The coating is also efficient with time, as the whole process takes around one hour. This includes checking particle size, programming the machine, running the machine, and then checking for faults. Within a short span of time, researchers can fix the material that might have been damaged with use. Another facet of Sridharan's research relates to nuclear reactors. In order to control the temperature of the nuclear reactors, researchers needed to find new ways to cool the temperature within the reactors. Sridharan uses his Metallic Cold Spray to make a coating around the nuclear reactor tubes to ensure the reactors are cool within.



The chamber of the cold spray device. The chamber is air-tight to allow for the pressurized gasses to accelerate the metal powder.

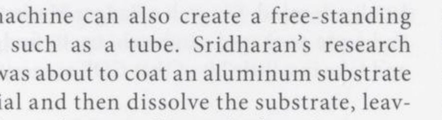
The machine can also create a free-standing object such as a tube. Sridharan's research team was about to coat an aluminum substrate material and then dissolve the substrate, leaving being a free-standing rod of coating material. The new tube, just like any other material the spray is used on, was uniform and durable. This could allow scientists to create their own materials if needed. Sridharan states, "in theory, you can create a lot of new materials with this process. You can mix and spray things together."

However, just like any other research project, the cold spray coating is continuously being reengineered. One way is through different uses of materials. There are some particles lost within the machine and not used in the coating. Sridharan and his team recognize this issue and are adjusting and finding new ways to use the chemical properties of materials, making sure they are getting the most use out of them. "It does require a lot of optimization. The first time never works, the first ten times never work, but then you truly start to be able to do many things with the material."

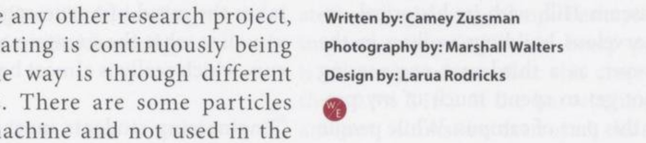
Written by: Camey Zussman

Photography by: Marshall Walters

Design by: Larua Rodricks

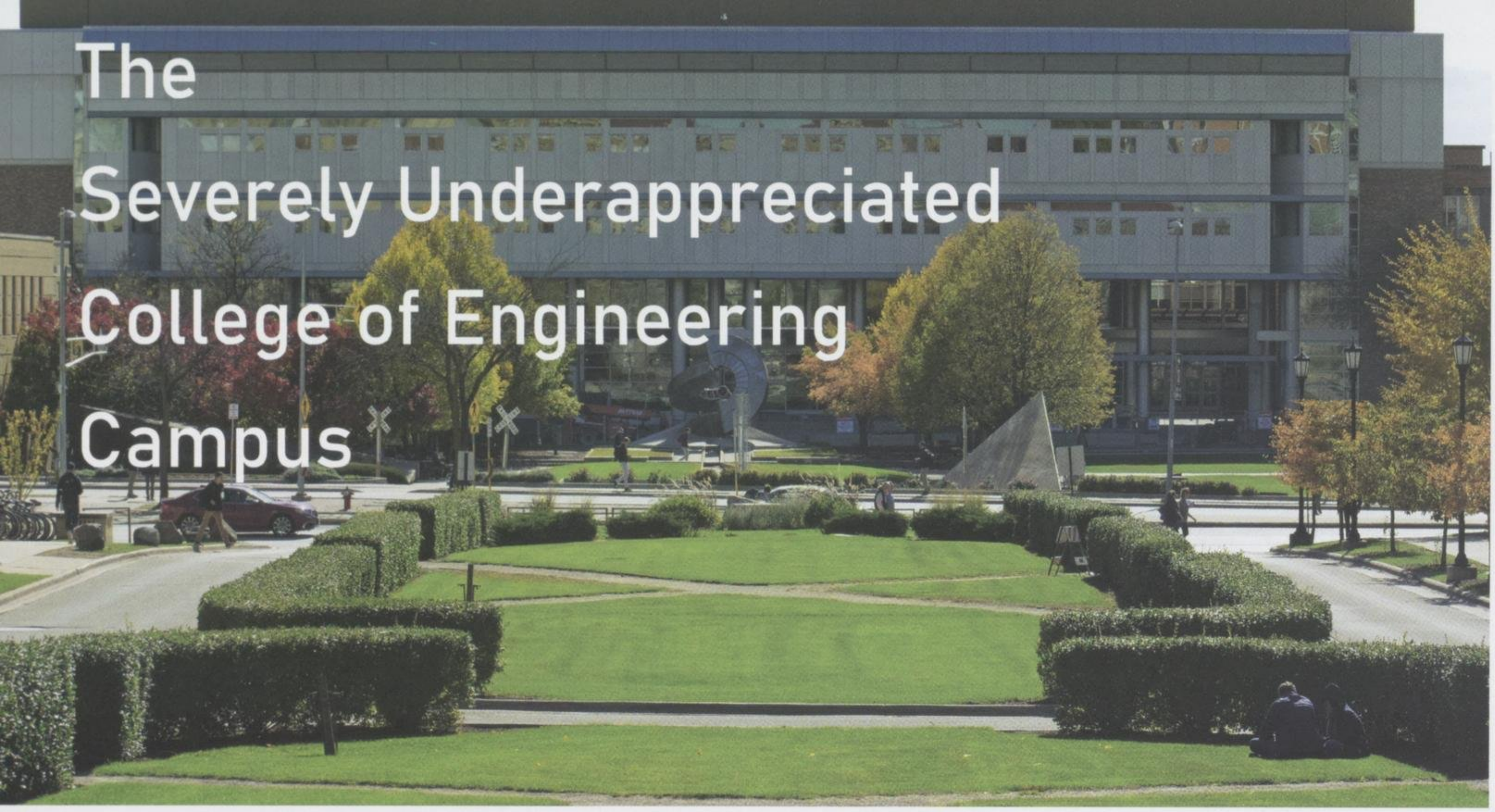


Close up of the calibration plate used at the beginning of every cold spray run.



View down the barrel of the cold spray robot.

The Severely Underappreciated College of Engineering Campus



As the Jon Snow of Game of Thrones once said, "Winter is coming". At least it is to the UW-Madison campus. For many people, including myself, the excitement of snow blanketing the campus and creating a wonderful winter scene is tremendous. The snow is especially beautiful on Bascom Hill, with its historical, architecturally marvelous buildings walling in the hill itself. However, as a third-year engineering student, I do not get to spend much of my precious time near this part of campus. While people flock to Bascom Hill for the annual snowball fight, I stay at the College of Engineering campus for the severely underrated scenery.

From the beautiful Descendant's fountain, to the Engineering Research tower, what's not to love about the College of Engineering campus? First, the main attraction: Engineering Hall. A masterfully planned building with cohesive additions. Getting lost in the building trying to find your classroom or even a bathroom is like getting lost in a wonderland of science and technology; rooms that do not go up in sequential order, despite being side by side, and staircases that seem to change floor patterns like those in Hogwarts.

When not attending class, Engineering Hall (E-Hall) is a great place to study, allowing for maximum efficiency as you sit perfectly upright at your barstool and a desk with just enough space. It's almost a fun game to find a table to study at, as you're not quite sure if you're in the mood for a couch, chair, table, barstool, or a recliner. Enjoy the masterfully crafted bathrooms with the hand dryers articulately placed right against the entrance door.

When you get tired of studying, it's a common occurrence for any engineering student to take a step outside and look at the wonderfully constructed fountain sitting out front, almost like the Statue of Liberty: a beacon of hope. However, despite its beauty, the fountain doesn't work. It takes the mind of a true engineering student to visualize what the fountain would be if it could run, which really is almost better than if it ran.

"Engineering students must relax somehow, so games like 'Dodge the icicle' from E-Hall's roof are common in this part of UW-Madison's campus," says some engineering student.

After enjoying what Engineering Hall has to offer, it is often nice to go across the street to the Engineering Research Building (ERB). That is, if you can find your way out of E-Hall. ERB has some of the most forward-thinking architecture - windows that come in a random order, surprising students with sunlight after hours in the dark, a sky walk to a building that not one person uses, and some of the slowest elevators this campus has ever seen. The building itself, quite the beast, blocks the rest of the surrounding area from sunlight, creating a nice overcast to glorify the importance of the building.

This goes for almost every building on campus at the College of Engineering, except for the Engineering Centers Building. That building is downright ugly. To be frank, it just has too much glass, and too much natural light. As well as too much open space with too many places for students to study. The building has no reason to be so easily navigable. It just does not fit in on this part of campus.

The College of Engineering campus is arguably the most advanced part of the UW-Madison campus as a whole, and to be honest, the rest of campus should really take note from the architects and civil engineers that planned this, as it is obvious that it was created with the students and faculty in mind. So, grab a Badger Market coffee and a pre-packaged sandwich, try to find a seat, and take in a little bit of that COE scenery.

Written by: Jared Vahrenberg

Photography by: Jared Vahrenberg

Design by: Laura Rodricks

CBD:

What we know, what we don't know, and what UW-Madison is doing about it

CBD hit a high on the public market, but will it last?

CBD oil, CBD chocolate, CBD shampoo, and even CBD beer have all become popular products on the market in recent years. But what CBD, or cannabidiol, can and cannot do is shrouded in mystery for most. With conflicting opinions and surrounding political turmoil, the uncertainty is understandable. Acknowledging what science has said about the uses of CBD is important for both consumer safety and the advancement of plant-based medicine. Furthermore, understanding what it will take to produce CBD large-scale adds an additional layer of complication.

Though CBD was first isolated from the cannabis plant in the 1940s, it wasn't until the 1980s that CBD's medicinal effects were first brought to light. CBD's initial use was the treatment of two rare forms of epilepsy, and this remains the only federally supported application. In June 2018, the FDA approved Epidiolex for the treatment of Lennox-Gastaut syndrome and Dravet syndrome, making it the first cannabis-based drug on the pharmaceutical market. More recently, results have been released exhibiting CBD's potential as a relapse prevention therapy for those struggling with substance abuse disorders. In May 2019, The American Journal of Psychiatry published results outlining CBD's ability to reduce anxiety, stress hormone levels, and cravings among people with opioid addictions. However, CBD's touted benefits as an antidepressant, antipsychotic, or sleep-aid have little supporting clinical evidence.

On the other hand, ingesting excessive amounts of CBD has been linked to liver damage, which is included in the FDA drug's label as a serious side effect. In Epidiolex's clinical trials, several patients had to be withdrawn from the study due to dangerously high levels of liver enzymes, an indicator for liver toxicity. Another significant concern with current CBD products is the lack of regulation by both the state and federal government. One study found that 1 in 5 CBD products contained THC, the psychoactive compound in the cannabis plant. As CBD is derived from cannabis, it is currently a Schedule 1 substance, meaning it has been classified by the Controlled Substances Act to have a dangerously high potential for abuse. This federal label has made studying CBD difficult, leading to the scarcity of solid, scientific knowledge.

"It's very exciting, but also very risky."
-Shelby Ellison

What is UW-Madison doing about this? Before the medicinal effects of CBD can be studied, it first needs to be produced. Though both major types of cannabis, marijuana and hemp, produce CBD, hemp can produce a high concentration of CBD with only trace amounts of THC. This makes hemp growth the key to CBD production, according to Shelby Ellison, assistant faculty associate in the department of horticulture. Ellison is leading the charge in the growth of industrial hemp for CBD oil at UW-Madison. Ellison wants to breed the hemp plant for optimal CBD production in the midwestern climate. She is also the much-needed bridge between the university's knowledge of hemp and the Wisconsin farmers who need it. After the 2018 Farm Bill removed hemp-derived products from the Schedule 1 status of other cannabis-derived products, farmers in the state took an immediate interest in this exciting new crop. "There was a tremendous need to have someone at the university to help field all the questions we were getting related to hemp science," says Ellison. Last year, approximately 250 farmers registered to grow hemp in Wisconsin. This year, over 1400. "And well over 90% is grown for CBD," Ellison adds.

The support in Wisconsin continues to increase, despite the considerable risk associated with growing hemp. Perhaps the most important regulation on hemp production is the requirement that the crop have less than 0.3% THC. If the harvest has over this amount, it must be destroyed. As an acre of hemp can cost between $5,000 and $10,000 to grow, "farmers are taking major losses," Ellison admits. "It's very exciting, but also very risky. There is a lot of uncertainty because we have no idea what's going to be happening in hemp or cannabis in five years," she adds. In five years, the industrial growth of hemp will likely depend on growing clinical evidence, which depends on the changing state and federal laws. If regulations regarding CBD production do not change, there will continue to be a lack of scientific understanding related to this growing industry. In the end, it's a cycle of risk and reward for all involved. What we do know is that we don't know enough about CBD right now. And only time will tell how readily we will be able to learn more in the future.

Written by: Sydney Heimer

Design by: Laura Rodricks & Erin Clements

Photo Contest

2020

Categories

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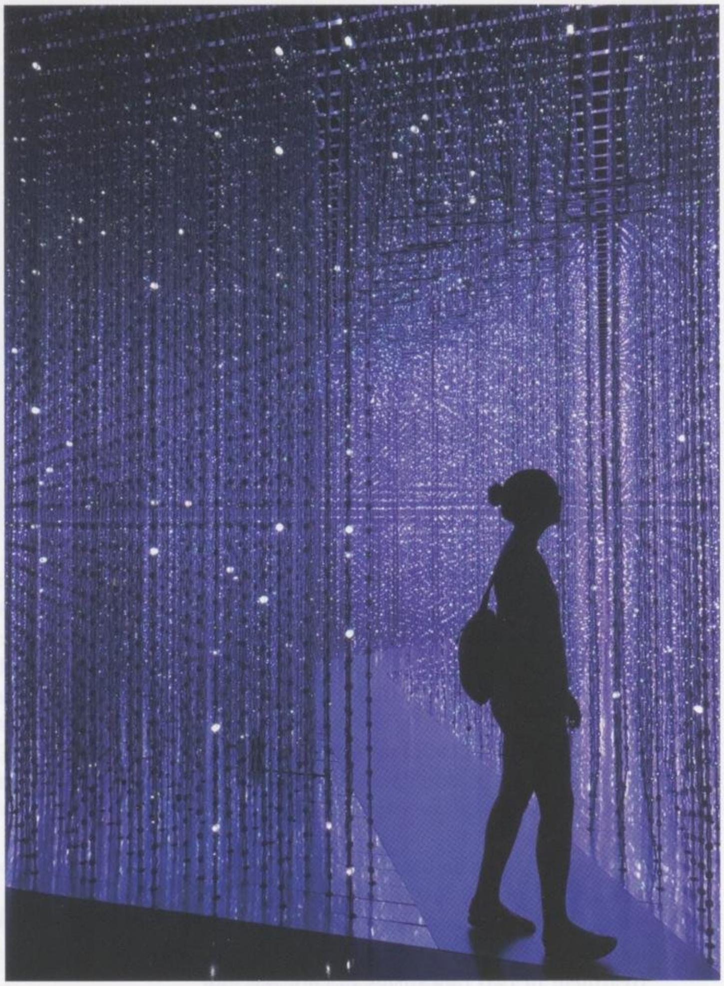
CITYSCAPE
PORTRAIT
STILL LIFE
MISCELLANEOUS



2019 Photo Contest Winner: Megan Parker

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