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wisconsin engineer

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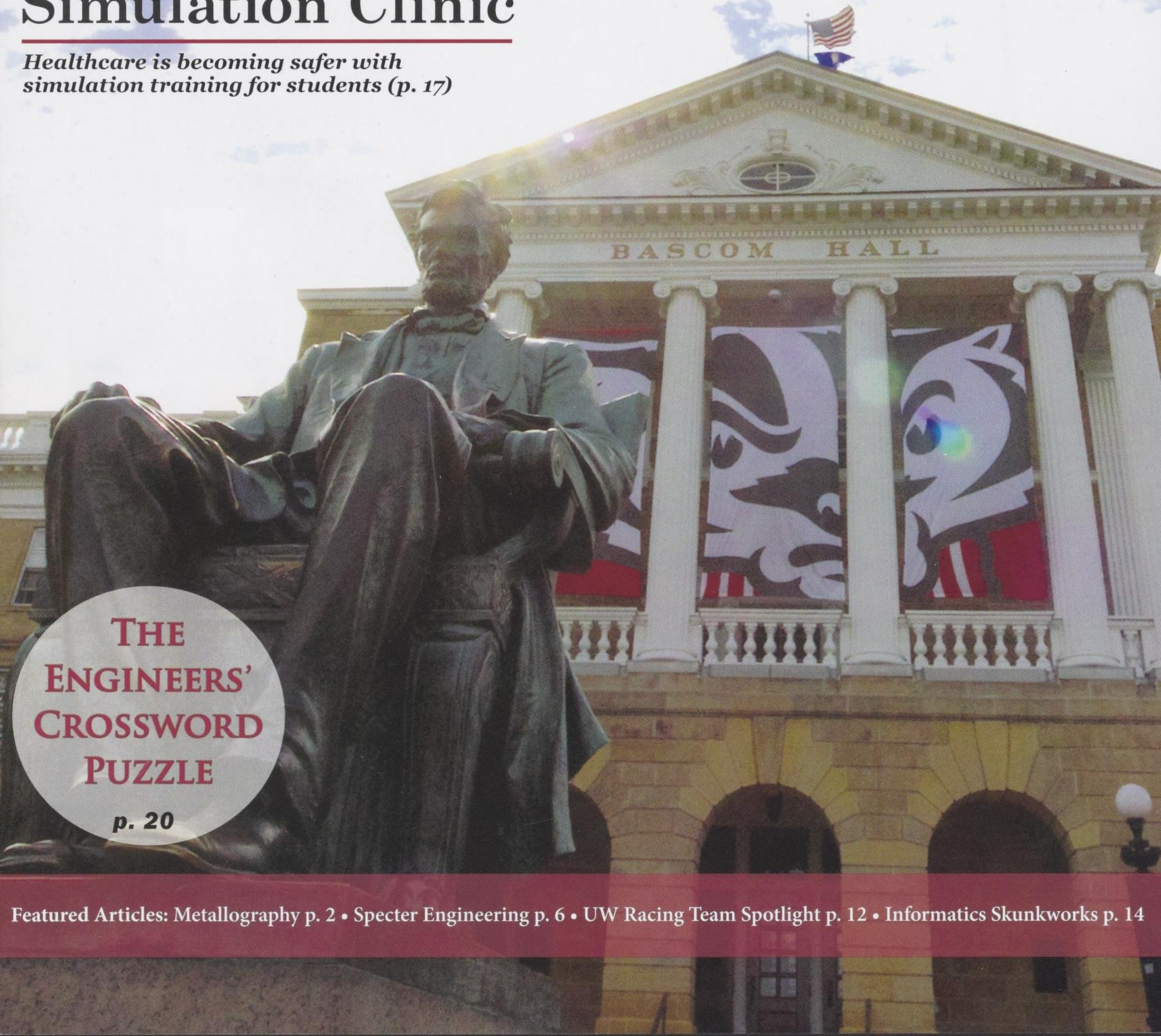

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The *Wisconsin Engineer* Magazine, a member of the Associated Collegiate Press, is published by students at UW-Madison. Philosophies and opinions expressed in this magazine do not necessarily reflect those of the College of Engineering and its management.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

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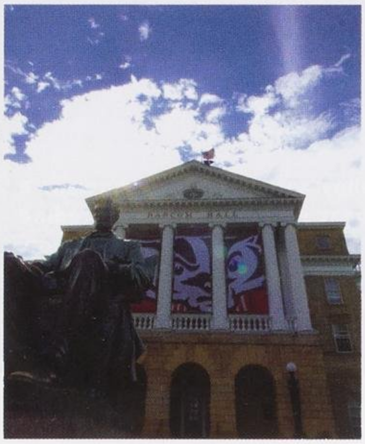
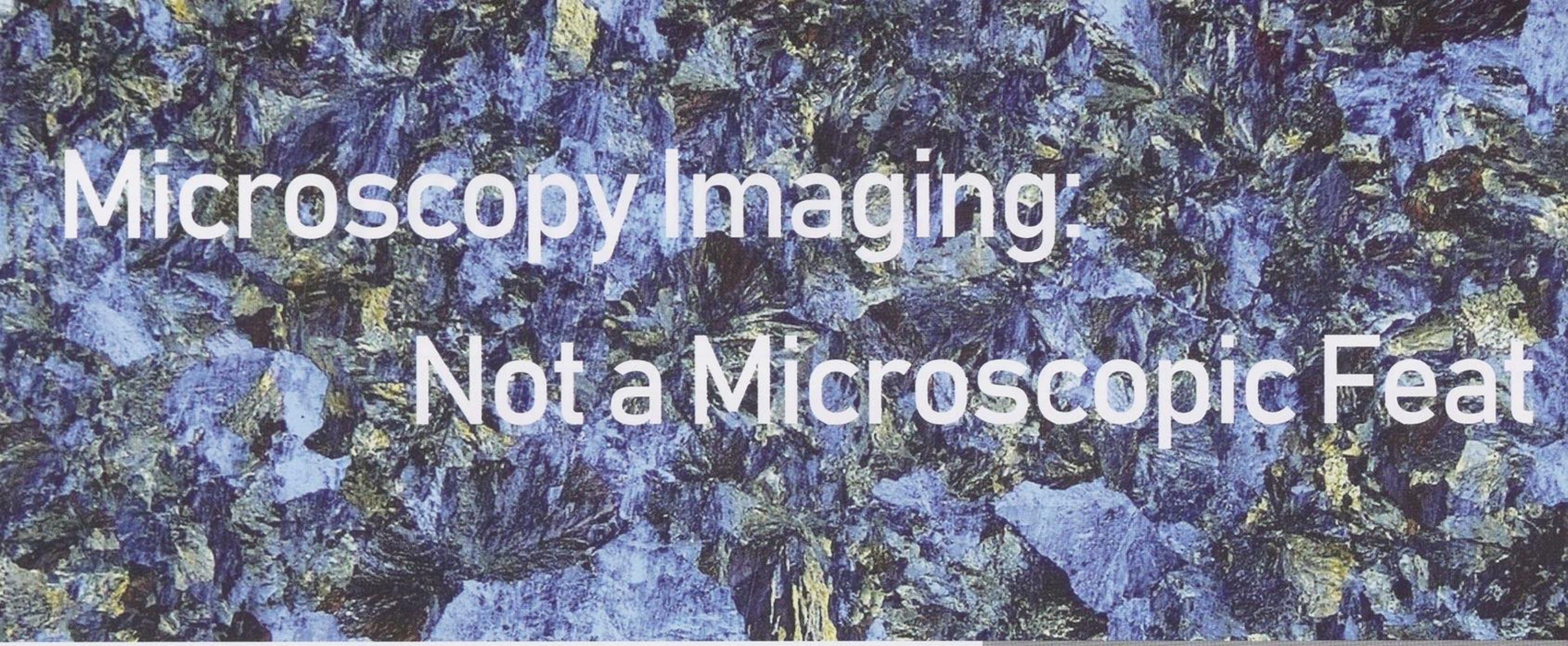
General



"Bascom Hall"
Cover photo by
Hamoud Alshammari

Microscopy Imaging: Not a Microscopic Feat



A 5160 steel alloy sample that underwent a normalization heat treatment. This procedure created a dense lamellar pearlite microstructure, which produced this beautiful mosaic of colors under polarized light.

UW-Madison materials science & engineering junior and writer for this magazine, Johnathon Brehm, received honorable mentions for two of his metallographic images in the International Metallographic Society Photo Contest.

Johnathon Brehm, a junior at UW-Madison majoring in materials science & engineering and also a member of the writing department at the Wisconsin Engineer, received honorable mentions in the International Metallographic Society photo contest for his incredible microscopy images. The annual contest aims to advance the science of microstructural analysis by giving an opportunity for captured metallography work to be displayed. Brehm captured these stunning images this past winter during his co-op work at Scott Forge, a prominent manufacturer of custom open die forgings and seamless rolled rings.

Metallography is the descriptive science of the structure and property of metals through microscopic imaging, but capturing these images is no microscopic feat. First, the sample must be properly mounted in a durable substance to separate a small surface to be studied. Next, the surface of the sample is ground through multiple grit sizes of sand paper to level the sample's face and isolate a single plane of the substance. Then the sample is treated with a polishing agent and buffed out on smooth pads. This allows for a much clearer picture in the final images. After the sample has been ground and polished, the piece is treated with an etching agent to corrode select microstructural features observed during imaging.

Brehm's image of a 5160-steel alloy received an honorable mention in the colored artistic microscopy class. The image featured a beautiful spectrum of blues from a 5160 alloy, or chrome-silicon spring steel. The alloy is typically used in the automotive field for heavy spring applications as it has a high level of ductility, toughness, and fatigue resistance. For Brehm's image, the sample was etched with a 4% picral solution followed by a 2% nital solution and imaged under polarized light. The picral etchant brings out the carbides, in this case, the pearlite colonies of the structure while the 2% nital etch reveals the ferrite grain

This image was taken from a railroad spike off of an old Milwaukee Road Railroad bed that was built in the 1870s. Given the general time period of its origin and the streaks of slag material in the microstructure, this spike was most likely manufactured using the puddling process.

size and grain boundaries of the sample. The etching agent, 2% nital, is especially suitable for revealing the microstructure of carbon steels as it enhances the contrast between the surface colors. In combination with polarized light, the etchant reveals each pearlite colony, the layered structure that appears in many steel alloys, at a different angle, while the light brings out the hues of blue by reflection at the various angles.

Brehm also received an honorable mention in the black and white artistic microscopy class with his second image, named "Wrought Iron from the Milwaukee Road Railroad." The sample was taken from a railroad spike found behind Brehm's childhood home where the Milwaukee Road Railroad used to run. Brehm was interested in learning about the material that the spike was made of and used his spare time at Scot Forge to create a sample and take images. With this, in combination with research online, Brehm was able to determine the spike was made of wrought iron, an iron alloy with a very low carbon content. The alloy is semi-fused mass of iron with fibrous slag, which gives the material a "grain" resembling wood that is visible when it is etched. Brehm used his sample to find the composition of the material and investigate its properties, such as hardness and durability. The sample was also etched with 2% nital solution; however, unlike the steel alloy, it was not etched under polarized light, resulting in the black and white image with heavy visual contrast. "It was really cool to learn a bit more history and gain a lot of perspective on the origins of my hometown," says Brehm.

> **"You are using art to determine information about samples. Things like the sample's microstructure and grain size can reveal a lot about its past." – Johnathon Brehm**

For Brehm, who was originally not a materials science & engineering major, the opportunity to produce metallographic images during his co-op gave him a better understanding of what it meant to be a materials scientist, and he learned how metallography can be used to investigate how and why a metal piece may have failed during an experiment. Brehm became extremely interested in metallography as a diagnostic tool to help recognize problems with metal alloys so that they don't fail in the field. Entering the contest with his images made him more aware of the beauty aspects of materials and how alloy properties can be manipulated on a microscopic scale. "You are using art to determine information about samples. Things like the sample's microstructure and grain size can reveal a lot about it's past," says Brehm. It is through these microscopic images, the foundation of metallography, that engineers continue to revolutionize materials and understand their properties to manipulate them for future use.

Written by: Makenna Hall

Photography by: Johnathon Brehm

Design by: Suzanne Kukec

Introducing an Industry-Oriented Master's Program to UW-Madison

During the fall of 2017, Executive Associate Dean James Blanchard launched the accelerated Master of Science programs within the College of Engineering. Originally offering only 10 engineering disciplines, the programs have now grown to 17 fields of study, including new options such as electrical, mechanical, and biomedical engineering. The most popular specializations tend to be signal processing and machine learning, systems engineering and analytics, and automotive engineering. The new programs are small, made up of less than 70 students. 20% of these students are from UW-Madison and 60% are international students. Program Director Lee DeBaillie elaborates on why more students should consider enrolling in these accelerated graduate programs.

"The accelerated masters programs are faster and require more coursework," DeBaillie stresses. The programs proceed in an efficient way so that 30 credits of coursework is compressed into fall, spring, and summer semesters, 12 months in total. In other words, "students pay for fewer terms in these programs while still earning the same Master of Science degree as with a traditional program." The format is coursework based; unlike a traditional two-year master's program, no thesis research is involved. The goal of these programs is to familiarize students with professional and technical skills applicable to industry.

"Students pay for fewer terms in these programs while still earning the same Master of Science degree as with a traditional program"

– Program Director Lee DeBaillie

These programs are not only cost-effective but also administratively flexible. According to DeBaillie, UW-Madison undergraduates who have applicable graduate credits can transfer up to 6 of them, with graduate advisor approval, into the accelerated master's programs, potentially shortening their time of study into two semesters. For Wisconsin residents especially, such a short study period combined with resident tuition rates means a very inexpensive master's program. On the other hand, if a student in the accelerated program realizes that they want to pursue a path toward academia, they can switch to the traditional master's program with an advisor's approval. Furthermore, students in some programs are encouraged to take on summer internships to practice their knowledge, prolonging their study period to 16 months. Another advantage of these programs is that students are more certain of their degree completion date, unlike traditional master's programs where research makes the date less predictable.

Some programs offer flexible coursework plans where "students are able to tailor their custom course plans," DeBaillie informs. While there are no big research projects, students can choose independent study courses where they can do semester-long projects or work with their academic advisors, usually professors, who help with course selection and academic plans.

With respect to applying for admission, many of the accelerated master's programs waive the Graduate Records Exam (GRE) requirements for UW-Madison engineering undergraduates. A few programs waive the required letters of recommendation, too. If undergraduate students already know which field they are going to pursue in the future, they can choose related elective courses that benefit their job applications. DeBaillie adds that planning these things beforehand really helps the application.

DeBaillie also mentions some weaknesses of these programs compared to the traditional ones. The first is the rigor of the coursework, making other commitments such as part-time employment very difficult. Teaching or research assistant positions are therefore mostly unavailable to students enrolled in these programs. Secondly, due to the compact schedules, students should consider their choices of courses prior to enrollment. Some courses, as DeBaillie explains, are only offered specific semesters; if students miss them, they may not repeat that semester to take the course.

As mentioned previously, the accelerated master's programs offer the same degree that the traditional ones offer. Hence, for job positions that are not research-based, the accelerated programs might be a better option as they are specialized and industry-oriented, preparing students to pursue careers in fields such as automotive engineering.

Even though total enrollment in these programs is less than traditional programs, DeBaillie thinks that these programs are very promising, with the likelihood of more options and adjustments based on students' interests. In the next few years, the accelerated master's programs will grow larger, and more and more students who want to work in industry after graduation will benefit by enrolling in one of these programs. The accelerated Master of Science programs should strongly be considered by UW-Madison undergraduate students who want to acquire a solid background in their specific engineering field within just one year.

Written by: Daniel Yao

Photography by: Hamoud Alshammari

Design by: Patricia Stan

Engineering students now have an excellent opportunity to graduate faster and earn a Master of Science degree at UW-Madison.

Specter Engineering - A True Marvel

Revolutionizing the electric market, Specter Engineering optimizes and designs electric propulsion systems from the ground up.

Have you ever looked around and marveled at the wonders of engineering around you? Have you ever felt inspired by the works of Tesla or General Electric? Have you ever thought of actively helping the community by making the world a more efficient place? Jason Sylvestre, current UW-Madison graduate student and CEO of Specter Engineering, has done just that by starting his own firm, Specter, along with Max Liben, another UW-Madison graduate student. Inspired by the pressing need to develop sustainable transportation, Specter's mission is to "help emerging companies bring their electric dreams to life through the design and optimization of their electric propulsion systems."

At face value, it would seem as though the name 'Specter' was chosen for its cool Iron-Man and Elon Musk vibe. However, Jason revealed a much deeper meaning to the name. "A specter is defined as something that is widely feared as a possible unpleasant or dangerous occurrence; this is what we believe advanced electrified powertrains will be to the conventional combustion and transportation market in the coming years." After noticing the persistent and time-consuming manufacturing trend of solely optimizing designs at a component level, Jason and Max developed a newer, more adaptable design philosophy: to craft solutions that are optimized in a symbiotic and cohesive manner, thereby optimizing the system as a whole. You may have heard the phrase "the whole is greater than the sum of its parts," and at Specter, this saying is more than just an idea: it's their design philosophy. Most companies focus on selling a product that has already been designed and is thus unable to accommodate different customer's requirements. However, by focusing on designing systems from the ground up, Specter works closely and efficiently with their partner firms in order to create an optimized product that will stand out from those of their competitors.

After having co-founded UW-Madison's Formula SAE Electric Team in 2016, Jason and Max lead a team of 30 passionate engineering students to successfully develop and build the first electric all-wheel-drive race car in the United States within one year. "Starting the Formula team was very much like running an engineering firm. We had to raise money, build a team, and ultimately deliver the product on a very short timeline. It was by no means easy, but it prepared us very well for starting Specter," Jason says. After ruminating on the idea of this company in his fourth year of undergraduate studies, Jason took the first step by conducting comprehensive market research and created his advanced electric transport firm's website during fall 2018. "I really was trying to figure out if there is a need for this kind of service." Jason says. "Building our website was a great way to get the ball rolling because it forced me to think about everything from our value proposition to the marketing segments we were targeting." Starting a firm in a competitive and growing market is not easy. By utilizing the extensive resources this university has to offer for entrepreneurs, Jason was able to streamline his process of launching Specter.

Along with the success that comes with starting a firm, "balancing [time] is tough. As a current graduate student, my research at the Wisconsin Electric Machines and Power Electronics Consortium holds number one priority and any free time I have after that is dedicated to running Specter," Jason says.

"At Specter, we craft solutions that are not only optimized at a component level, but are distinguished in their cohesive design at a system level so that your product takes on a life of its own." – Jason Sylvestre

An interview with the CEO of an energetic, enthusiastic, and ambitious firm isn't complete without asking for advice for budding entrepreneurs. "Just do it," exclaims Jason, "The first step is always the hardest. It's okay if you have no idea what you are doing at first. That is how learning happens. Fail fast, identify the root cause, and then move forward with that new-found wisdom. Your success is determined by how you respond to failure." Why should this advice be heeded? Specter is a firm which stands out from its competitors due to its speed, precision, and design philosophy. By working with newer companies looking to enter the electric transport space as well as larger companies looking to diversify their product portfolio, Specter supports designs for a wide variety of applications - from electric skateboards to electric aircraft - all of which pave the path to a more sustainable future.

Companies like Specter are the ones that succeed because they focus on what is important in the future by catering to the needs of the market and creating these products in an efficient and sustainable manner. Jason, Max, and their team act as a true inspiration to all students - graduate and undergraduate - showing them that they too can help create a better, more efficient future. At the end of the day, all companies can make money. But companies like Specter? They make a difference.

Written by: Nandan Venkatesan

Design by: Patricia Stan

Annual Photo Contest

Wisconsin Engineer

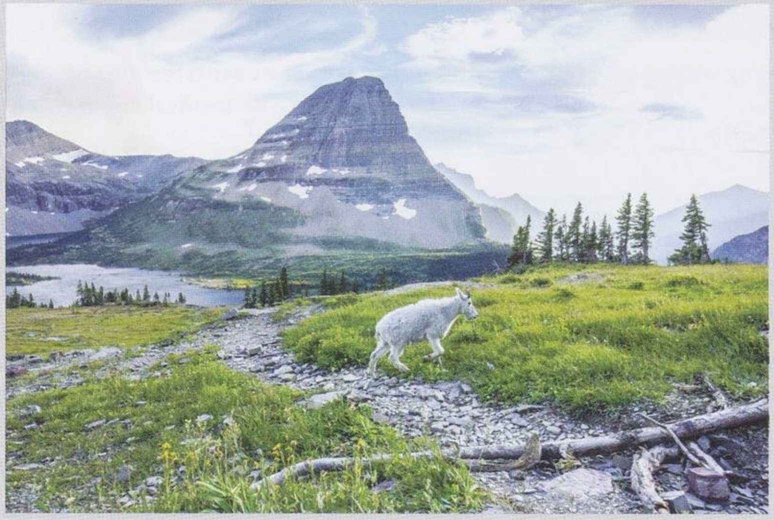
Deadline: April 1, 2019

Grand Prize: $100 Amazon Gift Card

+ their winning photo on the cover

**5 runner-ups win smaller prizes*

2018 Overall Winner: Joseph Harter, “Glacier National Park”



Categories:

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• Please include a title for each photo you submit • Up to 3 submissions per person • No Wisconsin Engineer staff members are allowed to enter •

2018 Category Winners:

Still Life

Alec Schultz

Portrait

Courtney Lynch

Cityscape

Joseph Harter

Landscape

Evan Bauch

Giving High School Students a Jump Start into STEM

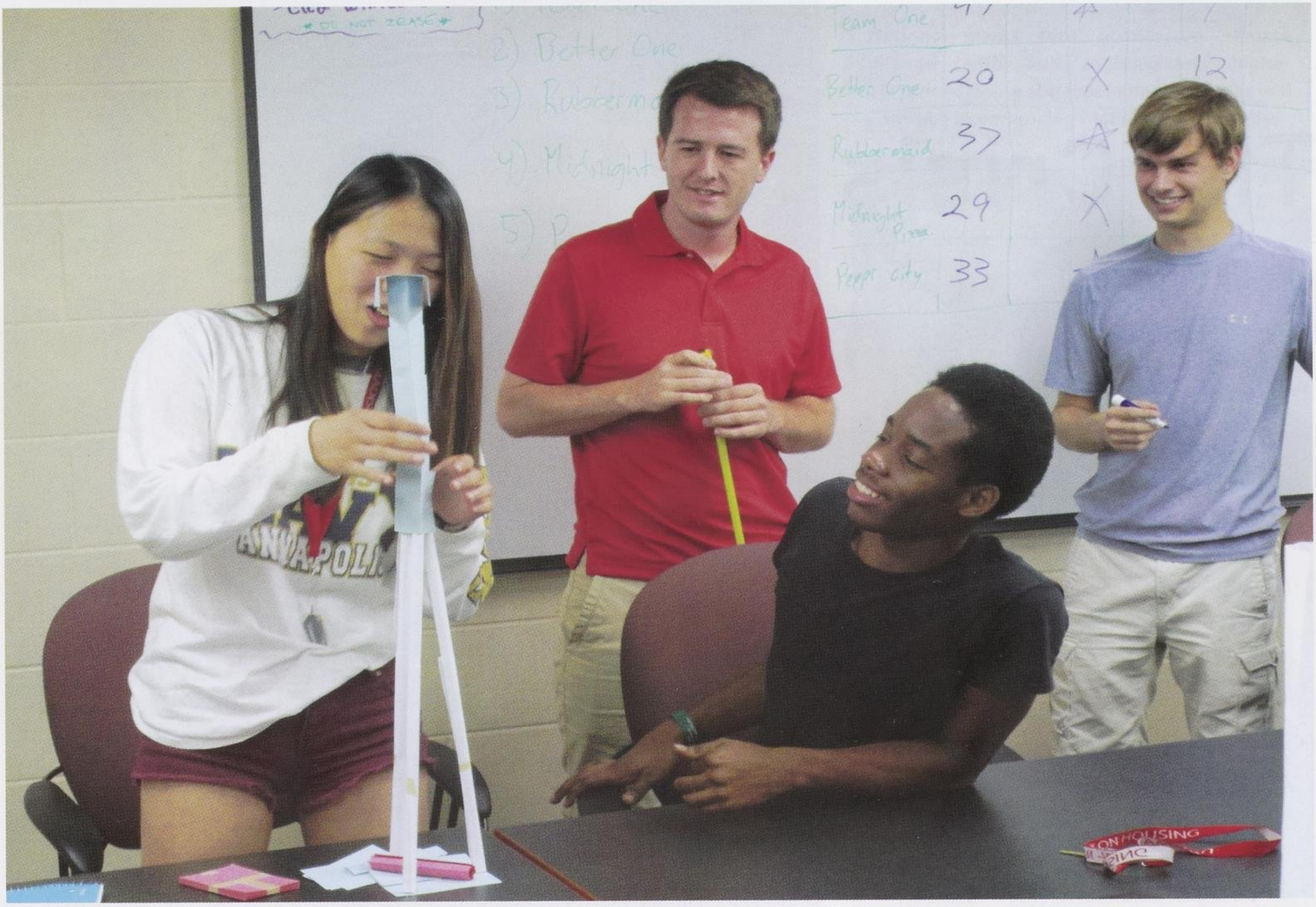
Above: Two ProCSI students testing out their products made in a biomedical engineering lab.

Promoting Computational Science Initiative (ProCSI) helps advance diversity in STEM fields by creating a free summer program to introduce STEM to underrepresented students.

Research is an integral part of university education for many students, but few high school students know how to get involved. University-level research, especially in STEM, may seem even further out of reach for low-income students. Promoting Computational Science Initiative (ProCSI), an educational summer program at UW-Madison, is hoping to change that. Over the last eleven years, the program has been making huge strides to help high school students, especially underrepresented minority students, have chances to get involved in STEM research and education after high school.

Above: ProCSI students visit the Virtual Environments lab at the Wisconsin Institute for Discovery to learn about applications and research in Virtual Reality.

Running a program such as this is not cheap and needs lots of effort, but Professor Dan Negrut, leader of ProCSI, recognized that many low-income families cannot afford to spend $1,000 to $2,000 to let their children stay in a summer camp on a college campus to learn about college life and opportunities that come from attending a college. To combat this problem, Negrut applied for a grant for research through the National Science Foundation called CAREER to help alleviate the cost of the program. Through college-based courses provided by ProCSI, high school students experience real lectures, labs, and seminars of a typical higher education institution. This unique experience gives students a more comprehensive understanding of how fundamental high school courses, such as math, physics, and chemistry, will aid them in their future academic careers. Seeing the outcomes and purpose of the knowledge they are struggling with firsthand can motivate students to study harder and focus on exploring different fields of study they might be interested in. To help students target the subject that most excites them, the program allows students to explore the differences between various fields within STEM. The program enables students to choose career paths and majors wisely, and can



Above: High school students participate in an engineering team building exercise as part of ProCSI hosted by SBEL.

become a major turning point for the future of their lives. In short, ProCSI is a summer program that not only serves as science-based learning opportunities for high school students, but also a source of guidance for students entering their college career.

"It's good for them to see what research means and how young people engage in research and work toward making a difference in the world" – Professor Dan Negrut

At ProCSI, communication is considered an essential component of making progress and building an exceptional program. Every year, ProCSI has an "all-hands" meeting at the end of the summer to gain feedback from students and better their future schedule. For example, the program has changed its end-of-summer event for the first time in its 11-year history, which used to entail a program-wide picnic. Students now create presentations about what they have learned throughout the course of the camp to share with other program members as well as their parents. This presentation, analogous to final exams for college students, motivates students to truly focus on the courses, review material, and apply their newly-acquired knowledge. "It's good for them to see what research means and how young people engage in research and work toward making a difference in the world," says Negrut. This change helps to ensure that students retain what they learn and that the program's resources are being fully utilized. Based on the feedback given by students, ProCSI strives to improve their scheduling and resources to give students appropriate help in jump-starting their STEM education.

Overall, ProCSI is a remarkable program loved by its students who may not otherwise have guidance entering their formal STEM education. Professor Negrut gave examples of some low-income students that have entered the program in past years, all with appreciable enthusiasm for STEM. Some of the students come from various countries, such as Guam, or are required to work long hours instead of studying to fulfill their family's economic needs. For example, one student from Los Angeles needed to wake up every day at 4 am to help his family get ingredients ready for their food truck business. Another student that entered the program came from Arkansas with Hmong family background, and he detailed his mornings as getting up with his parents around 2 am every day to take care of the chickens in their farm. Despite the difficulties these students have encountered throughout their lives, they come to ProCSI where they can put their strong work ethic into use for their academic futures.

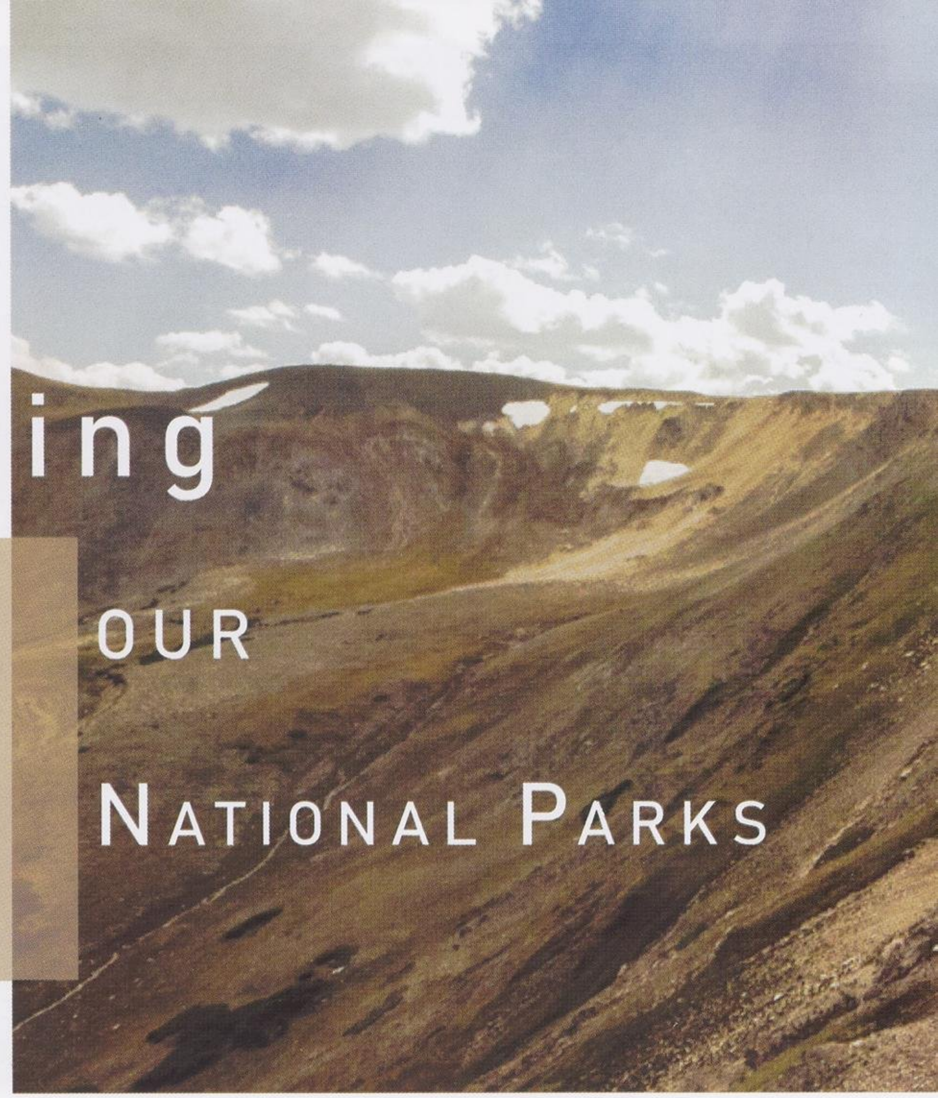
Looking forward, Professor Negrut hopes to continue the program for as long as possible with the funding from the National Science Foundation. Although the program is rather small, consisting of only 20 students each summer, it is run solely by Negrut and his lab students. These dedicated undergraduate and graduate students make the program possible by volunteering their time and guidance to the high school students. Professor Negrut says, "I'm very grateful to my students and I couldn't have done this without their help." By giving low-income students the resources they need, Professor Negrut hopes that programs such as this will be able to increase diversity in STEM fields within academia.

Written by: Whitney Huang

Photography provided by Dan Negrut

Design by: Laura Rodricks

The Crisis Surrounding Our National Parks



Professor Jack Williams and assistant researcher Fuyao Wang, with assistance from UW-Madison's Nelson Institute Center for Climatic Research, contributed to the first ever complete analysis of our national parks.

From their large glaciers to their enormous cliffs, the United States' National Parks system can captivate even the most experienced adventurers. Some people consider the national parks an escape from everyday life, and for others, they are sources of inspiration. Professor Jack Williams falls into the latter category. Growing up near California's Sierra Mountains, Williams fondly remembers family camping vacations in Yosemite National Park. His experiences there helped shape his career path and guided him toward becoming a professor in UW-Madison's Department of Geography where he is an expert in paleoclimatology and the responses of plant species to past and present climate change. Throughout his career, Williams' relationship with the national parks has changed drastically; as a child, he roamed Yosemite with a carefree attitude, but as an adult, as the world warms and rainfall patterns shift, he is now concerned about the parks and the cultural and ecological treasures that they preserve.

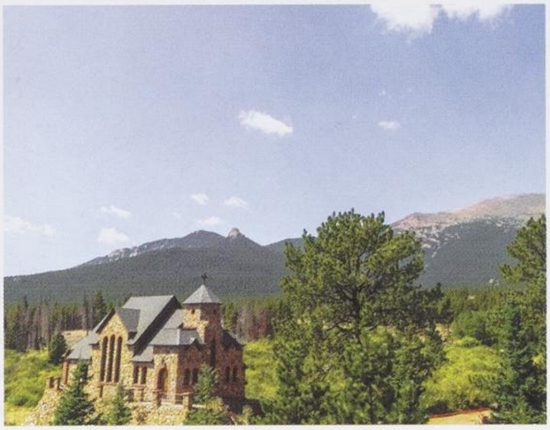
Williams's opportunity to research national parks originated out of a fellowship that he pursued with the Aldo Leopold Leadership Program (run by Woods Institute, Stanford University). It was here where Professor Williams was a part of a cohort of 20 mid-career academics, mostly from the fields of environmental sciences and economics. The fellowship ran for two one-week training sessions designed to enhance skills in media communications, leadership, and engagement with policymakers and stakeholders. During a visit to Washington, DC, Williams met with Patrick Gonzalez, an ecologist and climate scientist based at the headquarters of the United States National Parks system. From this collaboration, Williams and Gonzalez teamed up to evaluate the condition of all the national parks: an unprecedented feat.

> **"National Parks are an invaluable asset not only to the United States but to the whole world."**
> **– Fuyao Wang**

With such a daunting task before them, Williams and Gonzalez turned to a few exceptional scientists here at UW-Madison (and at UC-Berkeley) to assist with the project. Fuyao Wang, a postdoctoral researcher at UW-Madison's Nelson Institute Center for Climatic Research (CCR), hails from China, yet was drawn to the United States' national parks after reading about the adverse effects of climate change and taking a visit to Hawaii's Haleakalā National Park. Daniel Vimont, the director of the CCR, and Michael Notaro, a professor at the CCR, were also integral components to the team. Together, they took on the challenge of analyzing each national park and by doing so upheld CCR's mission to advance the understanding of the climate system and make this information available to society. The team employed climate simulations from physics-based models of the Earth system and analyzed them to generate high-resolution projections for the future of our national parks.

A notable aspect of the study was that the team analyzed each and every park separately, using historical climate data collected only from each respective park. By isolating each national park's climate, the

National parks face accelerated climate change, with arid regions and higher elevations being the most affected. Parks will continue experiencing higher temperatures.



researchers were able to determine exactly how each national park's climate was changing. The results of this analysis were astounding. Between 1895 and 2010, national parks' temperatures rose at twice the rate of the rest of the United States. Over that same time, precipitation has decreased by 12%, compared to the 3% average across the rest of country. This helped reveal that national parks are being impacted by climate change much more than in surrounding areas.

Why are national parks being affected by climate change more than other areas? The biggest reason is the location of the parks. A lot of our national parks are located in very arid areas, for instance. With climate change, these parks' environment will only intensify. As Williams puts it, climate change will make the "wet get wetter and the dry get drier." The climates of national parks often exist in a delicate balance of circumstances. The intensification of these climates will disrupt this balance and endanger the parks' environments and the wildlife that calls it home.

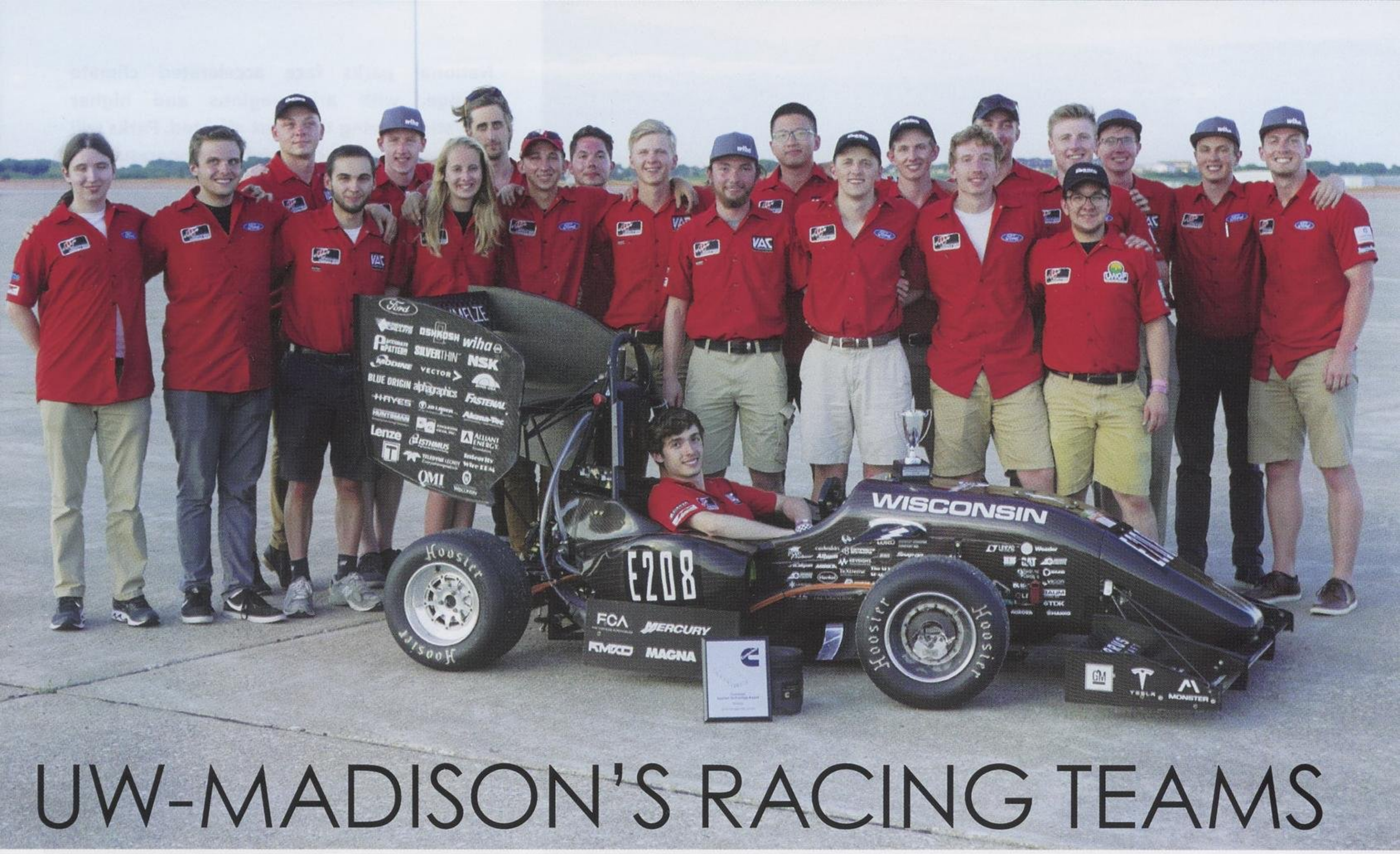
National parks at higher altitudes are experiencing the most drastic effects of climate change. With the planet warming, higher altitudes are experiencing higher temperature increases that cause the snow to melt. Snow is a great reflector of sunlight, so as more snow melts, the surrounding environment absorbs more sunlight, which is converted to more heat. This phenomenon has been afflicting Glacier National Park for decades now, and many experts project that soon there will be no glaciers present at the park. Imagine traveling to Chicago only to find out that the skyscrapers have disappeared. That is what is happening to Glacier National Park– its identity is slowly being melted away.

We must not underestimate the value of our national parks, and the threat climate change poses to their wellbeing should not be disregarded. According to Williams, "The national parks system is one of the cultural jewels in the states. They contain heritages and wildlife for both current and future generations." Our national parks connect the past to the future. The countless historical sites located within national parks need to be maintained in the present, so that they can be enjoyed in the future by everyone. After all, Wang notes, "National parks are an invaluable asset not only to the United States but to the whole world." W/E

Written by: Johnathon Brehm

Photography by: Hamoud Alshammari

Design by: Patricia Stan

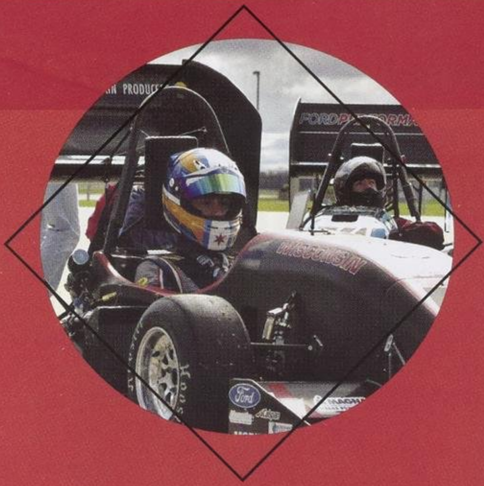


UW-MADISON'S RACING TEAMS TAKE ON NEW CHALLENGES

UW-Madison's Racing Teams have one thing on their minds throughout the winter months: improving their vehicles from last year to win the Formula Society of Automotive Engineers' competition this upcoming May and June.

During the cold winter months, rather than playing in the snow, the Wisconsin Racing Student Organization is busy working to improve their race cars from the previous year to compete in the Formula SAE (Society of Automotive Engineers) competitions in May and June. Wisconsin Racing is a multi-disciplinary organization of students making up three teams: Combustion, Electric, and all new this year, Autonomous. Each team designs, builds and competes with a ⅓-scale Formula One style car. Students at Wisconsin Racing do not stick to the status quo when building their vehicles. Instead, they constantly work to create new designs to be on the cutting edge of technology. At the end of the year, they release their designs to the world to enable more teams to participate competitively. By working together and sharing certain design features, the organization is able to build two entire race cars (and now an additional autonomous car) in one year. Each car is broken down into groups of mechanical, electrical, business, marketing, and operations students that must work together for the cars to be built. Time spent by members can be as little as a few hours per week or can even exceed 20 hours per week to ensure the success of the cars. It's not an easy task, especially when one must balance classes and other life events outside the org, but it is a worthy one. The knowledge, skills, and networking opportunities gained by the students allow them to land internships and enter the workforce a step ahead of other students.

The Electric Car is entering its third year, and the Combustion Car, its veteran counterpart, is continuing into its fourth decade. To create a sustainable program for many years to come, focus is being put on two areas: member development and knowledge transfer. Previously, the team leaders were contributing the majority of the work in order to design and build the car, and found it difficult to find time for knowledge transfer to the newer members. This year, the leaders are spending more time teaching the newer members by encouraging them to ask questions and express their own ideas. "Since we have now established an architecture for the [electric] car, we have more time for the leaders to actually be leaders instead of doers…we think this will foster continuing improvement within our teams and help propel us into the future," says Kevin Byrne, one of the team leaders. To help support this effort and to improve the relationships amongst the hundred sponsors that make the cars possible, the organization leaders are focused on creating a



Above: WR-218e at the Fromula Electric competition in Nebraska Summer 2018 proudly displaying the first place trophy in engineering design and Cummins trophy for Applied Technology. Left: SAE member tests (one?) of the comubstion and electric cars at a fall testing day.

"Since we have a set architecture for the car, we can spend more time for the leaders to actually be leaders instead of doers…which we think will foster a big change within our teams and help propel us into the future as a team."

– Kevin Byrne

dedicated business and operations team this year. The new business and operations team will allow the student engineers to focus on the vehicle design while creating new opportunities for students across campus. This new team will focus on maintaining the team's budget, crafting the business presentation to sell the car at competition, sponsor relationships, and media management.

The dedicated students of Wisconsin Racing work around the clock to improve both the efficiency of the team itself and also their vehicle design wherever possible. Each year after competition, the students identify weaknesses in the cars and how to improve for next year. Immediately after last year's electric competition, the team began to work on these points while incorporating new creations and ideas into each design. The team is refining its completely custom powertrain including in-hub motors, battery pack, and motor controllers while making iterative improvements to the chassis and aerodynamics of the vehicle. The goal of this year: more testing time. Michael Siem, another team leader, noted that the team is placing even more emphasis on testing time this year. "We aim to arrive at competition with a vehicle that is fully tested and tuned to our liking so that we have the best chance at winning," says Siem.

The completely custom powertrain makes Wisconsin Racing's Electric Car really stand out. Wisconsin Racing is unique because they are one of the few teams in the international competition that builds their own electric motors. This, as Byrne states, "…is a very ambitious thing to do." Wisconsin Racing makes their own motors in spirit of its motto "Have fun, Learn, Win." Full customization over their car allows for better and more complete optimization which in turn provides the most opportunities to learn. As a result, Wisconsin Racing students develop a deep understanding of engineering and manufacturing principles. This gives them the upper hand in the design portion of the competition, in which the Electric Team has placed first in the past two years.

With teamwork and ambition, Wisconsin Racing Students have their eyes set on being the best team at the next round of competitions. Cheer on Wisconsin Racing at the Combustion Competition, May 8th to 11th at Michigan International Speedway and at the Electric Competition, June 19th to 22nd in Lincoln, Nebraska. Follow them at www.wisconsinracing.org, Instagram: @wisconsinracing, and reach out to formula@go.uwracing.com with interest in joining the team.

Written by: Camey Zussman

Photography provided by UW Racing Team

Design by: Patricia Stan

Information Overload: Skunkworks

Above: The UW-Madison Informatics Skunkworks team.

Examining how the UW-Madison Informatics Skunkworks Team is transforming science and engineering

There is no doubt that the unparalleled power and capability of our modern age is largely due to the increased quantity and quality of information available at our fingertips. As data is quickly becoming the newest form of currency, people everywhere, specifically the Informatics Skunkworks group at UW-Madison, are rushing to take advantage of the many opportunities that data science, machine learning, and other related fields have to offer.

Headed by Dane Morgan, professor of Materials Science and Engineering, the Informatics Skunkworks group was created in 2015 to directly encourage undergraduates to get involved in research. Since then, the program has grown into a large group of over 40 undergraduate students that explores a variety of different research topics, including the interpretation of medical images (angiograms) with machine learning, the ductile to brittle transformation of irradiated alloys, the prediction of properties for unknown molecules, and the use of perovskites for more efficient energy generation.

These are no trivial tasks, and the work that these undergraduates have done has the potential to be truly transformative. As a matter of fact, Skunkworks has just published its first paper this year, "which helped predict thousands of new data points related to materials diffusion using machine learning and saved potentially hundreds of thousands of dollars in funds that would have been required to obtain all this data by other means," says Morgan. Today, several Skunkworks alumni are transferring their contributions to the workforce. Some are applying their technical skills to graduate programs and companies such as Google, but all students benefit from the program by developing the skills to navigate a world dominated by the ever-increasing presence of machine learning.

> **"These tools are so new and so powerful that students with relatively little experience can make a meaningful impact quickly."**
> **–Dane Morgan**

Despite the intensity of the program, beginners shouldn't be discouraged from joining! The field of informatics has certainly made some massive strides, yet we are really only just beginning to learn how to apply these new methods and discoveries. In fact, this is what motivated Professor Morgan to guide undergraduates toward informatics in the first place. Since "these tools are so new and so powerful, that students with relatively little experience can make a meaningful impact quickly, often much more easily than in many other more established areas," says Morgan. This year the program has created an educational on-boarding group specifically designed to address the somewhat intimidating learning curve involved with the work. This "course", which students can earn credit for as MSE 299, is a self-paced tutorial in many of the concepts and software that are applied by the actual research groups, and is how I personally became involved with Skunkworks during this fall semester. As a first-year undergraduate, entering with a limited knowledge in Python, statistics, and machine learning in general, I am already on track to join the medical imaging analysis project in my second semester. Therefore, I can confirm Professor Morgan's sentiment that the members of Skunkworks are able to learn a great deal in the way of both technical skills and the research process quickly.

Undergraduates aren't the only ones benefitting from this program, however. Benjamin Afflerbach is a graduate student studying Materials Science and Engineering with the goal of later pursuing a career in academia. In his position as Research Mentor for Skunkworks, he states that he continues to "learn more and more about how to properly divide up complex research tasks into smaller, more manageable chunks," and that he views his role as "an amazing opportunity both get to do research and to teach students about machine learning."

Ultimately, Skunkworks is equipping undergraduates with a unique opportunity to not only engage in some "hands-on, project-oriented learning" says Morgan, but to conduct that learning under a strongly mentored yet self-governed environment where they can be surrounded by support from their peers. Without a doubt, informatics is, according to Afflerbach, "closing the loop" in scientific research. As Afflerbach explains, "by using a computer model's predictions to guide an actual experiment and then feeding those results back into the model to further improve it, [we are] removing a lot of the slowdowns that occur in research due to human limitations…thereby accelerating experimental progress." The work of Skunkworks is exciting, and they will only continue to become more so as they continue to expand and grow to cover more topics and disciplines.

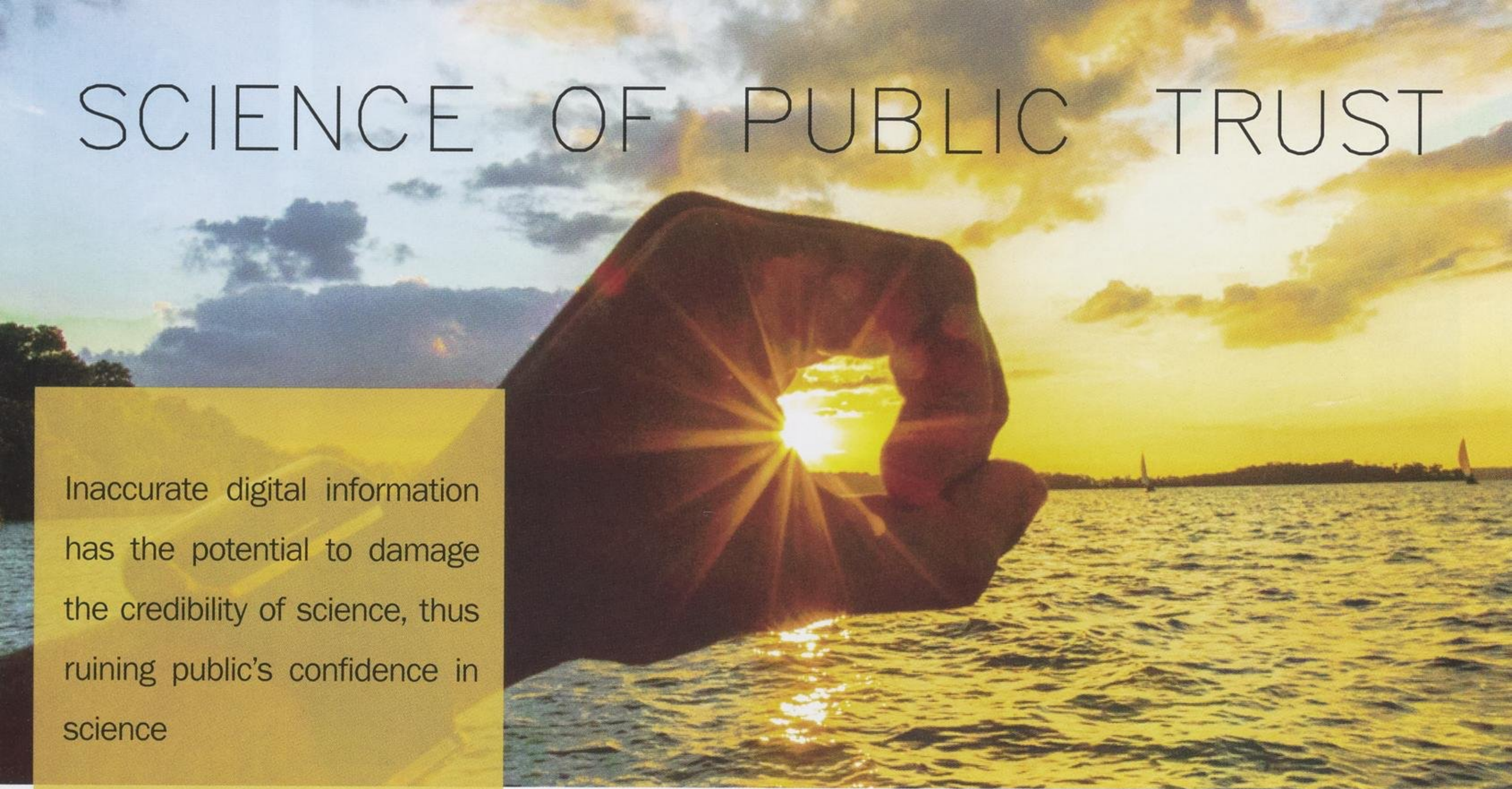
If you are interested in joining or would like to learn more, please visit https://skunkworks.engr.wisc.edu/ or contact Dane Morgan at ddmorgan@wisc.edu.

Written by: Brianna Tobin

Photography by: Brianna Tobin

Design by: James Johnston

SCIENCE OF PUBLIC TRUST



Inaccurate digital information has the potential to damage the credibility of science, thus ruining public's confidence in science

Public trust has become crucial to the advancement of various scientific fields, which depend on the funding associated with high levels of public confidence in their research. With necessary funding available, researchers have access to resources that allow them to conduct experiments and further the progress of science. Thus, it is paramount for science to earn the trust of the public.

However, in the age where digital information is increasingly accessible, not all of it is presented with the intent of accuracy. Some information neglects to consider solid scientific evidence or even tries to dispute it. For example, many articles attempt to disprove the fact that the Earth is round through false claims and unreliable scientific evidence of a flat Earth. Misleading information such as this has the potential to threaten the public's high opinion of science that has carefully been constructed through research that is conducted according to established standards, whose full results are published, and interpretations peer-reviewed. The proponents of a flat Earth are not the only ones promoting poor science by exploiting the ease of disseminating digital information.

There are also the rising number of people who have refused to give their children necessary vaccines based on weak claims of negative side effects. Yet another would be the many who have denied human factors as a cause of drastic climate change and global warming. How do scientists and researchers regain the trust of the public? What can students and faculty members of UW-Madison do to help with this process? The magazine explored these questions with Kelly Tyrrell, a research communicator and science writer at UW-Madison.

According to Tyrrell, despite the massive amounts of misleading information that surrounds us, the level of public trust in science still remains high. Based on her findings, more than 70% of Americans at any given time still believe that science has brought positive impact on society. She firmly believes that in order to boost the confidence of general public in science even higher, media and policy-making are the two main elements that need to be optimized, as they have significant potential to directly impact the public opinion. Tyrrell adds that when reporting scientific breakthroughs, media outlets should hire journalists with a science background or, at the very least, have some level of understanding in science, so that the articles produced for the public are accurate. In addition to the involvement of media, Tyrrell also emphasizes the importance of having scientific experts involved in lawmaking. These experts would be able to mobilize research into action through policies, allowing the potential benefits of research to reach the public and, at the same time, support future research.

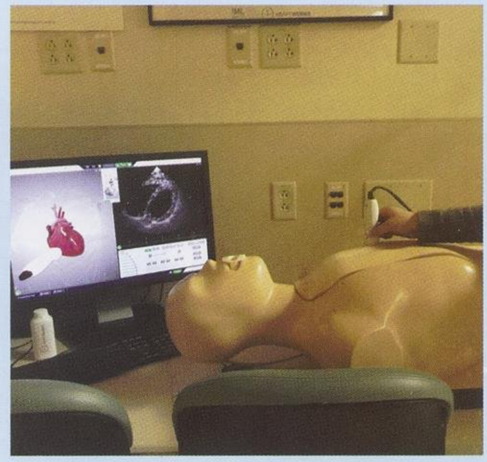
> **"Media and policy-making played a crucial role in increasing public trust in science."**
> **- Kelly Tyrrell**

At UW-Madison, Tyrrell states that there are several approaches that both students and faculty members can take to boost public trust in science. Organizations such as Associated Students of Madison (ASM) and Wisconsin Engineering Student Council (WESC) provide platforms for involvement for students who are interested in science and decision-making on campus. Another potential strategy to boost public trust would be to allow STEM faculty to run for seats on university executive boards. All these actions can further ensure that executive boards apply the right policies. In addition to leading organizations, students and faculty members can also attend workshops and seminars on how to better communicate science to a general audience, so accurate and evidence-based science can be made readily accessible to the public.

From Tyrrell's interview, it is clear that media and bureaucracy are the two crucial components for the future success of increasing public confidence in science and that this can only be achieved through the collective involvement of scientists, public officials, and journalists. To increase the public's trust in science, communication should be the foundation of all future endeavors. Without communication, all attempts will go to waste. Hopefully, using these methods, more people will be able to put their trust in science and learn how it can benefit not only their lives but the whole of humanity.

Written by: Alfred Sunaryo
Photography by: Hamoud Alshammari
Design by: Patricia Stan

SIMULATION IS REVOLUTIONIZING HEALTHCARE



Above: A manikin is used for an imaging simulation at the UW simulation clinic.

Innovative simulations at UW-Madison hospital provide healthcare professionals and students with realistic, state-of-the-art training.

"The more simulation gets integrated into higher systems, the better we are going to be at healthcare, the safer we are going to be at delivering healthcare, and the safer patients are going to be." – Krystle Campbell

Simulations allow students to practice medical procedures in a realistic environment without patient involvement. Simulation training initially began in the military and aviation as a method to learn skills without real-world repercussions. The practice entered healthcare when doctors started practicing stitches on fruit, and it became more popular throughout the 1980s. Since then, simulation has grown exponentially. In 2011, the UW-Madison Health Hospital joined the movement by opening a simulation clinic for a variety of healthcare professionals to train students and faculty in new techniques and procedures.

Krystle Campbell is the manager of the simulation program at UW-Hospital and has been working with the program for five years. "I started as a coordinator and got exposed to so many different specialties quickly," says Campbell. "I like the side of management and leadership, but I have always been heavily involved in arts… and in a weird way simulation allows you to express that too." Campbell takes on many different roles within the program, which lend themselves well to the variety of simulation types within the clinic. Some of the featured rooms include a mock operating room, a mock intensive care unit, virtual and augmented reality spaces, and a skills lab for computer-based learning. In the virtual reality section of the clinic, there are three virtual reality simulators, and the lab is looking to purchase a fourth. "We have one [virtual reality simulation] that does bronchoscopy, and then lower and upper GI, and they can do biopsies as well," says Campbell. "What happens is they utilize a probe that goes into the actual computer model itself, and on the screen is virtual reality… and then on the right-hand side is all of the vital signs."

Virtual and augmented reality also makes use of the up-and-coming practice of surgical simulation. In the past, it had been difficult to repair materials used for surgical practice as replacement of those materials can be expensive. Now, virtual reality is a popular and economical alternative for practicing surgery. Oftentimes, surgical or other medical devices that are new to the market are brought into the clinic to allow healthcare providers to learn how to use them. "Let's say a new device gets released– it's not great to train for how to use that device on a real patient," says Campbell. "They will bring in a simulator specific to that device and we will do the trainings down here."

Beyond surgery, the clinic is open to any group that is interested in using it. Such groups often include nursing, medical, and veterinary students. It is also common for practicing students to return to the simulation space to learn new procedures. About half of the student groups have a regular standing appointment, but a simulation can be scheduled for one-time sessions, such as for practical exams for students. Opening these simulations to students allows them to add a realistic and unique learning experience to their education.

Healthcare simulations are still relatively new. The field is constantly growing and developing, thanks in part to the growth of the biomedical engineering field. "We have had an exciting collaboration that I'm hoping will continuously grow, and that is with our clinical faculty and biomedical engineering students, through any year, to use them for projects," says Campbell. Recently, a team of biomedical engineering students created a humeral head intraosseous model because there was not one on the market yet. "We are always interested in biomedical engineering and simulation, especially the development of simulators and testing the new devices, [they] walk hand-in-hand, Campbell says. "In the future, I hope that just grows even more."

Before the creation of the simulation clinic, each hospital department had its own simulation training, and many experienced doctors were apprehensive about combining simulation techniques. However, after seeing the program in action, they began to realize its benefits, especially after the Central Line initiative. This initiative required professionals from all departments to complete training through the clinic before performing a central line procedure, in which a healthcare provider inserts a central venous catheter into a patient's vein.

"I think the importance of simulation in health care has yet to be fully understood. With that, I will say patient care and patient safety is at the forefront of everything we do," Campbell said. "Simulation offers us a way to practice, and practice, and practice until we are good enough to actually do it on a live patient… The more simulation gets integrated into higher systems, the better we are going to be at healthcare, the safer we are going to be at delivering healthcare, and the safer patients are going to be." With these innovative simulation methods, the healthcare field will continue to save lives as it becomes more standardized, effective, and safe.

Written by: Isabella Wegner
Photography by: Beth Enright
Design by: Patricia Stan

Society of Hispanic Professional Engineers:

Building a Community of Hispanic Leaders On and Off Campus

The Society of Hispanic Professional Engineers (SHPE) is an organization that empowers the Hispanic community to impact the world in STEM through its core values of family, service, education, and resilience.

The UW-Madison chapter of the Society of Hispanic Professional Engineers (SHPE) was established in 1991 as a way for Hispanic engineering students to find a sense of strength, support, and community on campus. Today, its vision is "a world where Hispanics are highly valued and influential as the leading innovators, scientists, mathematicians and engineers." Currently, the chapter is under the supervision of Professor Osswald who is co-founder and co-director of the Polymer Engineering Center at UW-Madison. Professor Osswald is originally from Bogotá, Colombia, and is an Honorary Professor of Plastics Technology at the University of Erlangen-Nuremberg in Germany and the National University of Colombia. Under his guidance, along with support from the Diversity Affairs Office and current members, the organization is a way for Hispanic engineering students to come together and support one another within academia and the professional workplace. As a community, SHPE aims to increase awareness about the importance of Hispanic engineers on campus and throughout Wisconsin.

The organization was originally founded in 1974 in Los Angeles, California. SHPE has since grown to have over 10,000 current members amongst seven regions throughout the country. A vital component of the group is to serve as a social network for Hispanic engineers across the nation and to serve as role models within the Hispanic community. Enrique Guzman, an electrical engineering student and president of the SHPE chapter at UW-Madison, states, "SHPE itself is trying to show that there is more in the Hispanic community than what is portrayed in the media and our society."

SHPE is establishing a strong presence at UW-Madison to empower the growing numbers of underrepresented engineers on campus. One of the main goals of SHPE is to provide various academic and professional resources for its members and to create a sense of community on-campus. SHPE hosts resume workshops, study tables, meetings with companies, and social events to develop a unified community of professional Hispanic engineers. Guzman explains, "We really just want to become a resource for the advancement of our members and create a sense of family unity." On January 24th, SHPE hosted a Diversity Spring Welcome for students. The event was aimed towards encouraging underrepresented students in their professional careers by providing them the opportunity to meet with employers and company representatives.

One of the primary goals of the UW chapter has been to expand the organization by connecting with other SHPE chapters in Wisconsin. Consequently, the UW chapter has recently developed a partnership with the Milwaukee School of Engineering's chapter of SHPE. Guzman explains, "We are trying to build community within the Wisconsin area to show our members we are not the only ones doing what we are doing." In the past, the chapters have hosted banquets together to connect members from the two schools. By associating with other schools, SHPE hopes to create a more unified community throughout Wisconsin and to inspire its current members by showing them the growing strength of the community.

Not only does SHPE work to empower students on campus, but it also supports Hispanic communities within Dane County. Recently, SHPE has been exploring outreach initiatives in the Madison area. SHPE partners with Centro Hispano, an agency in Dane County that provides resources and community for Latino families, and serves an average of 4,000 individuals each year. Centro Hispano has youth programs within the Madison Metropolitan School District (MMSD) that provide academic support and mentorship to encourage young Hispanic students in their studies.

Specifically, SHPE partners with Centro Hispano's Escalera Program (High School Academic Program) and Juventud (Middle School

Academic Program) to form a chapter of SHPE Junior at Madison East High School. SHPE members at UW-Madison frequently volunteer at the school by hosting events that inspire the students to study STEM. In the past, members have lead students through hands-on engineering projects which introduce students to the design thought process. In addition, the members teach the students about the current challenges faced by engineers, such as climate change and automation. The members also host Engineering Info Sessions where the members talk about their experiences in engineering and their career paths. Guzman emphasizes that these workshops provide a safe space for young students to learn what it means to be an engineer and how they can become leaders of their generation.

"We want to show that we as Hispanics can make an impact in our world and our nation." - Enrique Guzman

Not only do SHPE members teach the students about college life, but they also prepare the students for college through College Readiness Workshops. In the sessions, members will talk to students about what colleges they should apply to, how to pay for college, and how to prepare for entrance exams and coursework. Also, every spring, SHPE organizes an event on campus for the middle and high school students called Latinxs Exploring Engineering Professions (LEEP). During LEEP, members give the students tours of the UW-Madison campus, host workshops, and provide a space to talk about being an engineering student. Guzman highlights the importance of youth outreach in Latino communities. "In these sections of the city, because of their background, a lot of students aren't aware of what education can lead to," says Guzman. "We believe that by being a presence in these communities, we can show them there is more than they had been led to believe."

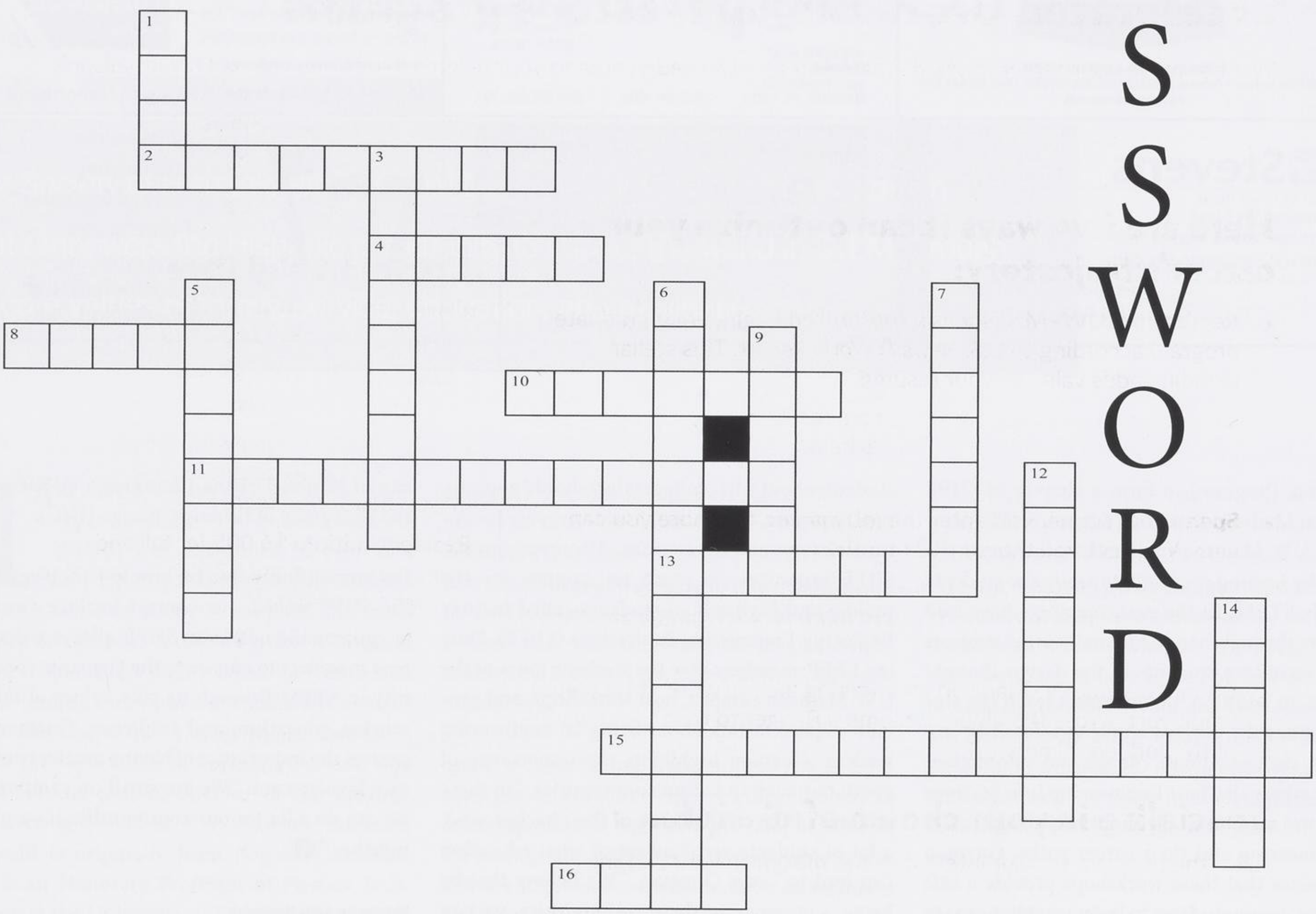
Looking forward, SHPE is working to build more of a presence on campus by gaining more members and connecting with other groups. SHPE members hope to continue to develop and strengthen relationships with other groups under the Diversity Affairs Office such as the Society of Women Engineers (SWE) and the National Society of Black Engineers (NSBE). Outside of campus, SHPE is looking to further expand their partnerships by working with other community organizations like Centro Hispano, and universities in Wisconsin and Illinois such as the Milwaukee School of Engineering (MSOE), University of Illinois Urbana-Champaign (UIUC), and the University of Illinois-Chicago (UIC).

For more information on how to join, please visit the SHPE website, or contact Enrique Guzman at eguzman2@wisc.edu. SHPE always welcomes new members to empower the Hispanic community in STEM through its core values of family, service, education, and resilience. Guzman expresses the importance of having greater community involvement: "We are small on campus, but we can do a lot for our communities if we group together."

Written by: Sofia Noejovich

Design by: Suzanne Kukec

THE ENGINEERS' CROSSWORD



Across

2. A dollar-for-dollar amount that taxpayers can subtract from their taxes owed.

4. A simple two-dimensional filter used to detect edges in an image.

8. A combination of metallically bonded metals.

10. The SI unit of capacitance.

11. The process of translating objects into a form that can be stored, transmitted, and reconstructed later.

13. Overflow The reason you can't count to infinity in Java.

15. The body's way to convert amino acids to glucose when it has no other source.

16. Resistance to motion in a fluid.

Down

1. The SI unit of power.

3. Type of amino acid that humans cannot synthesize and must be consumed.

5. Organelle which contains digestive enzymes that break down old organelles or initiate cell death.

6. Type of retirement account where taxes are deferred until money is withdrawn.

7. A substance with a molecular structure consisting of a large number of similar units bonded together.

9. A theoretical ______ engine is perfectly efficient.

12. A mechanical device that allows for the storage of energy through rotation.

14. A ______ circuit has only one path for current to flow.

Design by: James Earley, Eric Shumaker, and James Johnston

Solutions can be found at: wisconsinengineer.com/crossword

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Questions?

Contact Program Director Lee DeBaillie, at 608-262-2329 or debaillie@wisc.edu.

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