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wisconsin engineer

FALL 2018 VOLUME 122, NUMBER 4

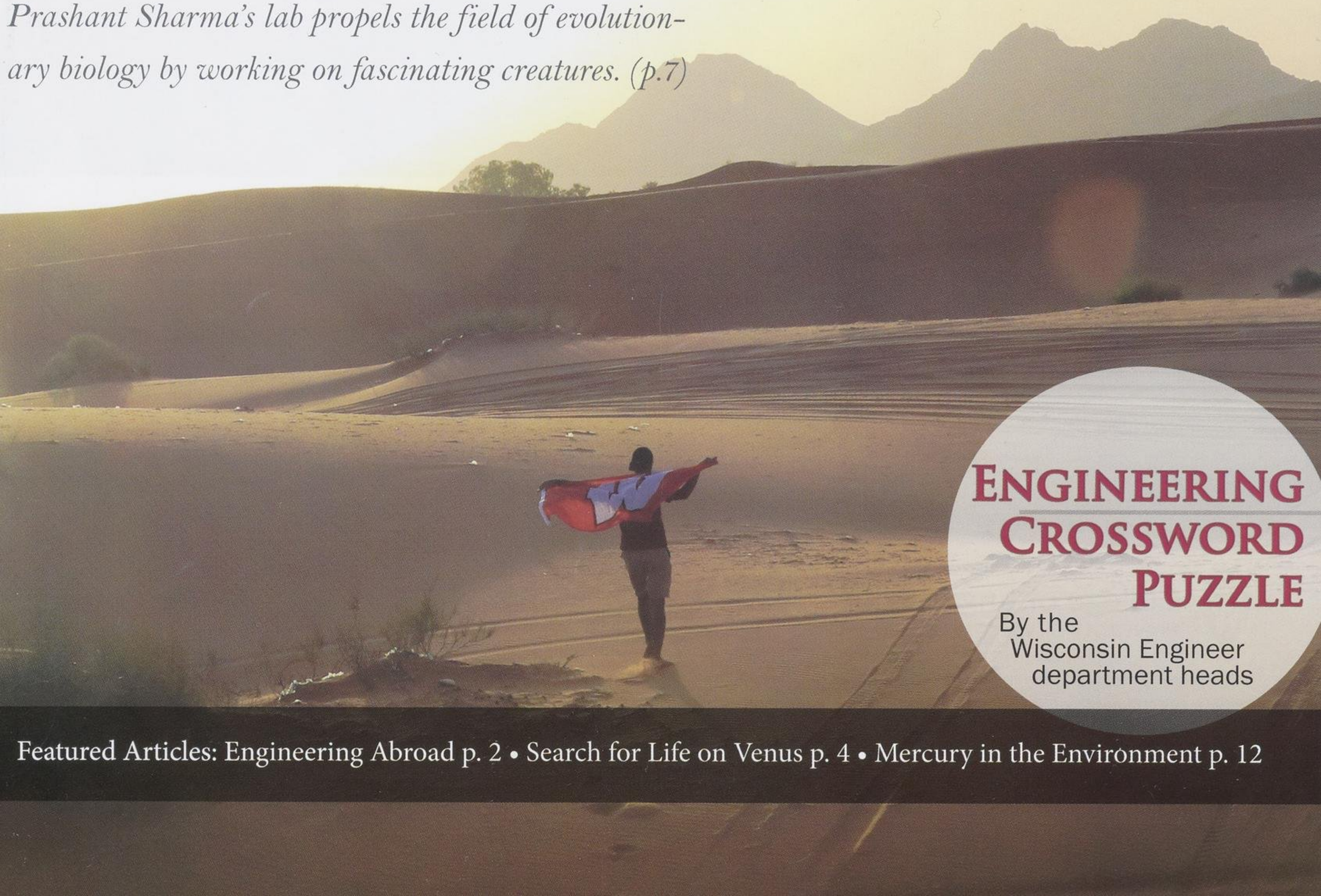
GLOBAL PERSPECTIVES

Engineers change the world.

Why not see the world you're changing? (p.2)

NOT YOUR AVERAGE LAB

Prashant Sharma's lab propels the field of evolutionary biology by working on fascinating creatures. (p.7)



ENGINEERING CROSSWORD PUZZLE

By the Wisconsin Engineer department heads

Featured Articles: Engineering Abroad p. 2 • Search for Life on Venus p. 4 • Mercury in the Environment p. 12

More stories and exclusive web content:

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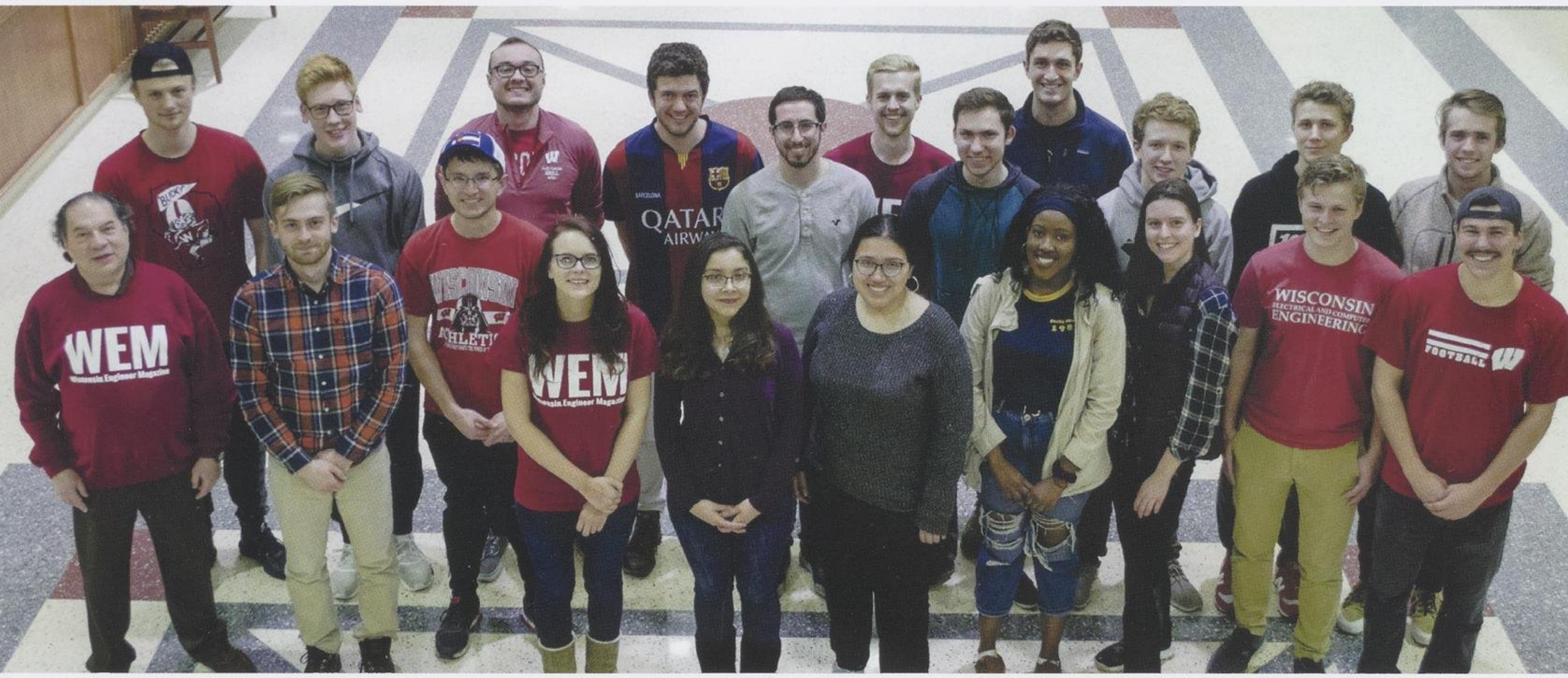

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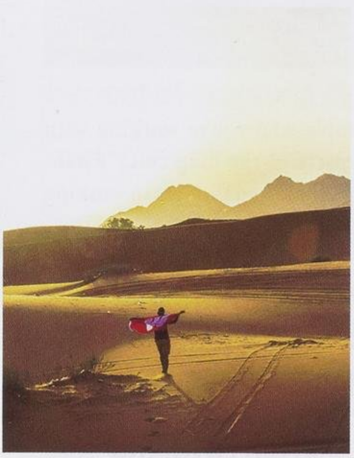


"Global Perspectives"
Cover photo by
Hamoud Alshammari

Engineering, It's a Global Job

As engineers, we change the world. Why not go see the world you're changing?

As engineers, we do more than just sit in the classroom or the office, we change the world. The work we do spans all of society: from pollution mediation and water treatment to eco-car design and advancements in airplanes, there are global implications to engineering jobs. This vast influence has made it more common for engineers to not only work on products that reach people in other countries, but also to work directly with global populations. In a time of increasing division and disagreement, connections formed through international engineering relationships could make a difference in promoting tolerance between cultures and advance quality of life around the world.

For many engineers, their first time traveling abroad is as an employee for their company, but there are plenty of opportunities to go abroad as a student, too. At UW-Madison, an easy way for students to live in foreign countries is through a study abroad program. Many students from the College of Engineering study all around the world every semester through International Engineering Studies and Programs (IESP). IESP has partner programs in places ranging from Hungary to Hong Kong, offering classes taught in English, Spanish, and several other languages.

As I can attest to from personal experience, these programs are a fantastic way to visit new places and meet people from every background imaginable. While abroad in Budapest, I took some fascinating courses which juxtaposed my education system with the Hungarian system. Although they were interesting, those studies were not the most important things I learned while traveling. The most impactful lessons came from adjusting to living in a different culture. Appreciating that the way I was accustomed to doing things might not be the best way— and certainly wasn't the only way— has changed how I approach interactions in my day-to-day life back in the US. It's this ability to keep an open mind and listen to others' ideas which is the truly invaluable takeaway from spending time abroad.

Even if a study abroad program cannot fit into your academic schedule, there are plenty of other ways to get this kind of multicultural experience. Students often can find internships and co-ops abroad, do research at a university in another country, or can travel for fun over winter or summer break. One example of a great short-term trip can come from joining a group like Engineers Without Borders, who often travel to visit their project sites in places like Ecuador, Guatemala, and Uganda. This kind of project combines valuable real-world engineering work with a structured way to go abroad where you don't have to figure out all the logistics on your own.

For ways to best handle your experience abroad, I spoke to Susan Ottman, one of the Program Directors for the Department of Engineering Professional Development. Step one: "Try and learn a few words," recommends Ottmann. She has spent more than 25 years working and traveling abroad as a part of global teams and finds that knowing a few words really can help and the local people may appreciate your interest. Step two: "Try and spend time with folks who are non-English speakers as their first language," suggests Ottmann. Nothing beats firsthand experience, and she recommends making friends with the local people. Investing this time getting to know the personalities and customs of the people who you're working with can pay off immensely in the long run. "Establishing that relationship when they get to working abroad is going to be so important."

"Establishing that relationship when they get to working abroad is going to be so important." -Susan Ottmann

Regardless of the path you take to get international experience, learning how to appreciate other cultures and work in diverse settings is a valuable quality for any engineer. While rigorous courses typically prepare students quite well for the technical aspects of an engineering job, that's not all you'll need to succeed after graduation. "The question is the communication piece … can you communicate to different folks across the organization? That's probably going to be the success factor," says Ottmann. She explains that mastering these communication skills while abroad can set an engineer apart from the others and make them especially valuable in any career they choose. "Going abroad is one thing, but if you look at the US, we're very diverse… You can really get a unique experience across our United States as well." Whether experiencing new cultures abroad or finding them within our own country, the era of the international engineer has arrived, and we must embrace it.

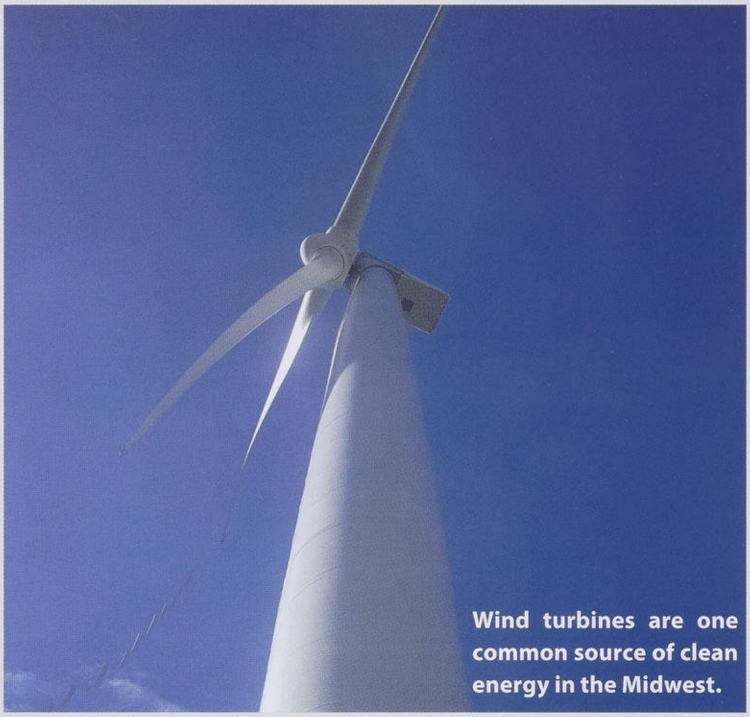
Written by: Ben Zastrow

Photography by: Hamoud Alshammari

Design by: Suzanne Kukec

Improving Air Quality through Clean Energy

Using efficient, clean energy as a means of controlling our air pollution offers the additional benefit of negating climate change, providing jobs, and providing domestically-produced energy all throughout the country.



Wind turbines are one common source of clean energy in the Midwest.

As temperatures continue to rise and the demand for energy grows, the need to improve air quality becomes more apparent. The issue of air quality does not stand alone as it pertains to energy, climate change, and health. According to PhD candidate David Abel, the United States spends nearly 50 billion dollars each year to meet the air quality standards set by the Environmental Protection Agency (EPA), yet roughly half of the country's population is still exposed to levels of air pollution above what is deemed safe. The consequences of air pollution are severe and widespread, ranging from work dissatisfaction and poor test scores to respiratory illness, heart disease, and diabetes. The billions spent each year are meant to alleviate the negative effects of air pollution, and since 1970 when the Clean Air Act was passed, significant progress has been made. Abel states that for every dollar spent in reducing air pollution the population receives thirty dollars' worth of benefits. Looking to the future, there is much room for improvement as air pollution still causes 100,000 deaths in the US each year. Fortunately, there are actionable solutions to improve air quality, even in our Madison community.

The most common solution being implemented to improve air quality is technical control. With power plants, installing devices to capture the harmful emissions significantly improves air quality. While this is highly effective, there are still two issues that could be improved. First, this technology is very expensive. Second, and more importantly, this technology decreases power plant efficiency resulting in increased carbon dioxide (CO_2) emissions. Although CO_2 is not directly hazardous to health, it is a greenhouse gas that contributes to climate change, and no economical technical control currently exists for CO_2 like it does for other pollutants.

Abel works at the Nelson Institute Center for Sustainability and the Global Environment researching this very issue. Abel's work recognizes that air pollution caused by power plants is a problem that gets worse in hotter temperatures. Using traditional controls to capture emissions has been highly effective. Using low emissions or emissions-free energy and improving energy efficiency as a means of controlling our air pollution may offer additional benefits including mitigating climate change, providing jobs, and producing energy more locally. Abel notes that "power plants are a big source of emissions that contribute to air pollution" and that going forward "things like clean energy can offer similar air quality benefits with co-benefits to climate and jobs and the economy."

Air quality is the fourth largest risk factor for death globally, causing seven million deaths each year,

according to PhD candidate David Abel.

As temperatures rise in the summer, we must turn on air conditioners inside of buildings to stay cool. In response, power plants must work harder to compensate for the increased energy demand. This increase in demand means our power plants burn more fuel and release more chemicals into the air. In the eastern states, a roughly 1.9% increase in emissions occurs for every degree Fahrenheit the daily average temperature increases in the summer. Because of this fact, power plants can have a compounded impact on air quality on hot days.

Our Madison community offers opportunities to utilize clean energy. Madison Gas and Electric offers an option to purchase 100% renewable for a small additional fee. Taking advantage of this opportunity can directly improve public health in our community and home. Other ways to individually combat air pollution include turning down the thermostat and switching to energy-efficient light bulbs. These small acts offer direct benefits beyond climate change mitigation, including improved air quality.

Looking forward, research could be expanded to other regions of the world that have much worse air quality than the United States. Globally, air quality is the fourth largest risk factor for death and causes seven million deaths each year, according to Abel. The impacts are often worst in places with a heavy reliance on coal and solid fuels to meet energy demand. According to the World Health Organization standards, 92% of the world population does not live in regions with clean air. Converting to renewable energy sources and improving energy efficiency could improve air quality while also providing economic gains and progress in slowing climate change.

Written by: Sarah Gerarden

Photography by: Jason Hakamaki

Design by: Suzanne Kukec

The Answer to Life's Biggest Question

The extensive search for extraterrestrial life may end at Earth's closest planetary neighbor, Venus.

During our time inhabiting Earth, many humans have asked the same basic questions: How did life on Earth begin? Is there life beyond Earth? Scientists have theorized the potential of life existing in distant exoplanets, and the public has imagined life in galaxies far, far away. The crux of the issue is that we cannot determine if there indeed is life in these environments without traveling to these destinations. Without light speed travel, a journey to Mars would take nine months, a journey to the outer part of the Milky Way would take over a decade, and a mission to another galaxy would take centuries. Yet there exists another alternative, a closer planet to Earth that harbors the potential for life in its thick atmosphere. And it would take only four months to travel there. To answer the age-old questions about the origin of life on and beyond Earth, what better place to start than Earth's closest planetary neighbor— Venus?

> **"If life is found on Venus, [it] will revolutionize the way we think about our place in the solar system and our universe."**
> **- Rosalyn Pertzborn**

Sanjay Limaye and Rosalyn Pertzborn, of UW-Madison's Space Science and Engineering Center (SSEC) have engaged in research, outreach, and education with an emphasis on understanding the environmental conditions on Venus. Recently, these scientists and their colleagues have been considering whether Venus may harbor life in its clouds. Since the first images captured of Venus by the US and Soviet probes sent there in the 1960s and 1970s, speculations have existed about the composition of the atmosphere. Researchers have created models from these missions that indicate the possible existence of water on Venus for 2 billion years, and point toward a suitable environment for life for a 750 million to 2 billion year span. Venus is a terrestrial planet with a thick, gaseous atmosphere composed of too much carbon dioxide for humans to survive on its surface and sulfuric acid clouds between 48 and 72 km (30-45 miles) above the surface. With an average temperature of 872 degrees Fahrenheit and extremely high pressures, the planet's surface is an inhabitable zone even for many of the building blocks for life, such as amino acids and proteins. Yet, evidence shows that life seems to find a way to exist in even the most extreme environments as evidenced by microorganisms surviving in the hot springs of Yellowstone or oceanic vents.

These extreme environments on Earth resemble conditions found in areas on Venus, rendering the feasibility of life existing on the planet. "We don't understand where life started. If we had similar conditions on other planets, could life have started independently? That's what is behind the search for life," explains Limaye. There also exist some phenomena on Venus that can only be explained by a living entity, such as the dark patches on the surface that look "like algae blooms in Lake Mendota in the summer," according to Limaye. Limaye, as well as other scientists, have come up with many hypotheses for what these dark patches might represent. There is evidence that some substance or organism is absorbing the light on the surface to create the appearance of dark patches in the cloud cover of Venus. These dark patches are the result of absorption of incident sunlight. However, the identity of the substances which absorb the solar radiation have been a mystery since they were first noticed about a century ago. Most suggested substances cannot explain all the features of the absorption. The evidence that some organisms found on Earth show absorption characteristics similar to Venus was a reminder to consider the possibility of similar organisms in the Venus clouds. Another phenomenon occurring on Venus that cannot be explained with available

"We don't understand where life started. If we had similar conditions on other planets, could life have started independently? That's what is behind the search for life."
-Sanjay Limaye

data is the disequilibrium in abundances of trace species found in the Venus atmosphere. This data was collected from the early missions to this planet, and it has since puzzled scientists for decades.

For life to survive on Venus, much like on Earth, it needs liquid water, nutrients, and energy. These substances are available in the clouds on Venus, so this region would be most likely to provide a habitat for life. Since any lifeform observed on Venus would be only microbial and exist in the clouds, the public's perception of Venus differs from that of Mars. While there have been several rovers on Mars surveying the land and sampling the Martian soil, spacecraft have not traveled to Venus for many years. Though not as glamorous as studying Mars to the casual observer, studying Venus offers an opportunity that could provide results much sooner and with fewer challenges than presented by Mars.

Studying Venus can also help to answer key questions about Earth's trajectory into the future: what will happen to our water supply, and where will all the carbon dioxide stored on Earth eventually end up. "If you buy the argument that Venus had liquid water and was more Earth-like, it is the most likely conclusion that Venus is where Earth is headed in the future," remarks Limaye. Venus and Earth currently have approximately the same total quantity of carbon dioxide levels, but most of the compound on Earth is stored in rocks, whereas it primarily exists in the thick atmosphere on Venus. One way for carbon dioxide and water to rise to the clouds is through air sweeping across mountains, creating an upwards movement of particles. This process occurs in some regions on Earth, including Tso Kar Lake in India, and it could help to explain how life would travel from the surface of Venus to the clouds if the surface of Venus indeed once resembled an environment more like Earth's. Because this research from the SSEC is fully data-driven, more evidence must be collected to verify life on Venus exists.

This research, thus far, has determined that the environment on Venus suggests a strong possibility for life. However, to fully understand the conditions of Venus, a mission must be sent to the planet for more extensive data collection. One potential mission under development is the Venus Atmospheric Maneuverable Platform (VAMP) conceived by Northrup Grumman's engineers, which would explore the Venus clouds for potential microbial life. The semi-buoyant aircraft (filled with buoyant gas) operates like an airplane using solar powered propellers during the day and gliding during the night at differing heights in the atmosphere to collect molecules and analyze them for living organisms. "If life is found on Venus, [it] will revolutionize the way we think about our place in the solar system and our universe," explains Pertzborn. There are many qualities about our existence and place in the universe that we as a civilization have yet to understand. Many people believe that life must exist elsewhere besides Earth, but many skeptics think that life started on, and only exists on, Earth. Finding life on the closest planetary neighbor to Earth will create a new perspective on life, and it will bring humans one step closer to finding the answer to the question— how on Earth did we get here?

S. S. Limaye, R. Mogul, D. J. Smith, A. H. Ansari, G. P. Słowik, and P. Vaishampayan, "Venus Spectral Signatures and the Potential for Life in the Clouds," Astrobiology, vol. 18, no. 9, pp. 1181–1198, 2018.

Written by: Jordan Wolff

Photography by: Hamoud Alshammari and Jordan Mathewson

Design by: Patricia Stan

Going 'Viral' to Curb Disease

Professor Po-Ling Loh explains how statistical modeling of information transmission across networks is advancing medicine, especially diagnostic tools.

Rapid technological advancement in the 21st century has expedited global interconnectedness. The term "viral" has evolved to describe rapid information spreading over platforms such as social media. Po-Ling Loh, associate professor in the department of electrical and computer engineering at UW-Madison, has been devising models for the extent of information transmission. Loh attributes her interest in these models to a graduate student who was interested in statistical understanding of content spreading on Facebook. "You have a network, you know who's connected to whom and these are the only ways that people can see what…and how [information] is spreading," Loh states. The objective of Loh's research is determining the origins of certain information and deducing means to either spread or contain it effectively. She adds, "If you have people on a social network and you want to get the word out really fast, you can efficiently do so by targeting essential individuals with the most connections." Similarly, infectious diseases are transmittable over connected individuals. Studying the similarities between the spread of information and disease enables researchers to target the epicenter of the disease to contain and potentially eradicate it.

Professor Loh's work is a culmination of statistics, computer science, and engineering. Mathematical models and algorithms summarize the collected data from various networks. Since the models are primarily theoretical, Loh has participated in inter-departmental research collaborations. One such collaboration is with John Yin, professor in chemical and biological engineering, whose group is interested in virus-host interactions. In Yin's study concerning the spread of HIV in Malawi, he applied Loh's models to recognize the source of the deadly virus and possibly means of preventing it from spreading.

Professor Po-Ling Loh

> **"You have a network, you know who's connected to whom, and these are the only ways that people can see what, and how, [information] is spreading." -Professor Po-Ling Loh**

Loh's most recent work is with the department of radiology as a co-organizer of the Machine Learning for Medical Imaging Initiative (ML4MI), with the goal of developing solutions to key challenges in medical imaging. The initiative is using Loh's models for image reconstruction in compressed sensing Magnetic Resonance Imaging (MRI). "Imagine an MRI image of an organ like the brain, only a few pixels are typically crucial to a diagnosis," Loh explains. She adds that if the image is expressed properly, focusing on the most important region, the imaging process is accelerated.

As with any developing models, Loh's research is yet to overcome a few limitations. For instance, infectious disease models work under the assumption that all connections are known. However, in the case of Professor Yin's HIV studies in Malawi, the researchers found that some individuals failed to mention certain relationships, omitting crucial data from the network. This challenge necessitates assumptions and a degree of model shifting. Additionally, in working with high-dimensional statistics, excess data collection might occur. Consequently, researchers require further studies to narrow down the most crucial sources of data. "If you run a standard machine learning algorithm, it can tell you that everything in that data collection is somewhat relevant, which is not what you want," Loh elaborates. The researcher needs algorithmic modification to filter out the relevant findings, making the models as accurate and potentially impactful as possible for those suffering from the disease.

Nonetheless, the network models are advancing scientific research, and Loh aspires to collaborate with more medical practitioners to improve diagnostic technologies. With further studies and modifications, Loh foresees that medical researchers will apply the models to eliminate deadly epidemics. In a world rapidly becoming more interconnected, these models are bound to revolutionize scientific methodology.

Written by: Jemimah Mawande

Photography by: Jason Hakamaki

Design by: Suzanne Kukec

Not Your Average Lab

Prashant Sharma's lab propels the field of evolutionary biology by working on fascinating creatures

Despite a high degree of genetic similarity, various species of arachnid can differ greatly.

Feeling the slimy, wet outside of an earthworm, seeing copper sulfate burn a haunted green color, or witnessing plants grow from dormant seeds into a verdant countryside are some of the most exciting ways to experience science as a child. When we are still young, science is not limited to dense college textbooks, but is an avenue to exercise our curiosity about the world around us. On UW-Madison's campus, Professor Prashant Sharma and his lab in the department of Integrative Biology keep this youthful scientific sentiment alive by conducting research on some of the most fascinating creatures on the planet: arthropods. Their research not only takes them around the world but helps propel our knowledge of evolutionary development.

Arthropods are one of the largest groups of invertebrates, defined by their segmented body and hard exoskeleton. They are a diverse group of organisms that include ants, moths, spiders, and pretty much any crawling creature you could find in your house. Great research always starts with great questions, such as how biological diversity arises genetically. Although all arthropods are genetically similar, there are still vast differences amongst them, including different features, colors, and mechanisms. For example, spinnerets, the organ in spiders responsible for making and expelling webs, are a great example of the diversity of arthropods. Spiders are the only arthropod to use spinnerets, yet even within this single class, Arachnida, the way different spider species use this organ differs vastly as spinnerets use different proteins or make a variety of web shapes. Sharma wants to figure out exactly how these variances in function occur genetically.

"Studies like these sustain UW-Madison's reputation as 'the heart of arthropod evolutionary development in the world.'" -Prashant Sharma.

It is research like this that brings lots of attention to Sharma's lab. Recently, undergraduate researcher Emily Setton explored the genetics behind the jointing of spider's legs. Using knowledge from previous experiments, Setton removed the gene responsible for leg jointing early on in the spider's development and unexpectedly discovered that parts of the head did not develop either. These results help paint a larger picture for how arthropods reuse genes efficiently for multiple functions of development. Studies like these sustain UW-Madison's reputation as "the heart of arthropod evolutionary development in the world," says Sharma.

Not only is this research exciting from a purely scientific standpoint, but Sharma's stories of sample collection would leave any child in awe. Sharma explains his future adventures simply, "we're going to be rappelling into caves and finding bugs." These caves are all around the world from the dry desert landscapes of Israel to the winding, tropical rivers on the border of Vietnam and Laos. No matter the distance or the diverse landscapes he must conquer, Sharma will reach the living quarters of every insect he plans to study.

Professor Sharma's inspiring research is useful in many applications and crucial to other scientific efforts. Sharma's research efforts help validate preservation efforts by providing data on biodiversity and how it is changes overtime. Often, government agencies will refer to his data to get a sense of arthropod populations and how this effects ecosystems. In this way, Sharma helps to expand the field of biology by looking at the developmental genetics of species where large bodies of research are non-existent. Each future discovery in Sharma's lab not only brings humans that much closer to fully understanding evolutionary science but keeps the spirit of childhood scientific curiosity alive by investigating enigmatic eight-legged arthropods.

Written by: Ben Hayes

Photography by: Mayukh Misra

Design by: Julia Mauser

AT THE HEART OF ENGINEERING AND SAVING LIVES: MY INTERNSHIP EXPERIENCE AT CARDIAC SCIENCE

AN INDUSTRIAL ENGINEERING STUDENT RECOUNTS HER INTERNSHIP EXPERIENCE AT AN AED MANUFACTURER AND EXPLAINS WHY THE COMPANY IS CRUCIAL TO SAVING LIVES.

Sudden Cardiac Arrest (SCA) is a condition unfamiliar to many but is the third leading cause of death in the United States. Before interning at Cardiac Science this past summer, I had no idea what sudden cardiac arrest was, or that it was so prevalent. As a Quality Intern at the Cardiac Science manufacturing facility in Deerfield, Wisconsin, I was immersed in a wealth of information about sudden cardiac arrest. I also learned how easily a person suffering from SCA can be saved with an automated external defibrillator, commonly known as an AED. Cardiac Science takes pride in manufacturing these life-saving devices, and I too am proud to have taken a part in that process during my internship.

According to Mayo Clinic, sudden cardiac arrest is "the sudden, unexpected loss of heart function, breathing, and consciousness." Typically, it is caused by an electrical disturbance in the heart, which leads to ventricular fibrillation, irregular heart rhythm, and eventually prevention of blood flow throughout the body. Although sometimes confused for one another, sudden cardiac arrest significantly differs from a heart attack. During a heart attack, a blockage causes the heart to stop beating altogether. Heart attacks occur most commonly in older middle-aged adults, while sudden cardiac arrest can happen to anyone, regardless of age. The only thing that can save a person suffering from an SCA is an AED, which applies an electric shock to the chest, restoring the regular rhythm to the heart.

At Cardiac Science, I learned all these concepts and more. The company ensured that all interns were fully educated on Sudden Cardiac Arrest and how crucial AEDs are to save lives. They even provided CPR and AED certification training to its employees. I was impressed with how intuitive and straightforward their AEDs were to use; once opened, the device had step-by-step instructions on proper usage.

My role was based in the Quality Engineering department, and I truly felt that I made a few meaningful contributions during my time there. Quality Engineering is a type of engineering that ensures that a product performs according to expectations. In a medical device company, this means that the product must meet FDA standards to be sold. As a Quality Engineering Intern, I not only gained an in-depth knowledge about the principles of industrial engineering, but also a deeper understanding of how a medical device company works. As Cardiac Science is a smaller company, members of the executive board were easily accessible. I was fortunate enough to be able to learn from them and other em-

The summer intern team at Cardiac Science.

ployees while expanding my engineering skillset.

For the duration of my internship at Cardiac Science, I was given two projects to work on— one independently and the other in a team. As an industrial engineering student, I study processes and their improvement. My first project was within that realm of my industrial engineering knowledge. It involved mapping out the process flow of how to deal with nonconforming or defective raw material that suppliers sent to Cardiac Science. To accomplish this task, I learned how to use Microsoft Visio, a diagramming software, to create a process flowchart. Within Visio, I diagrammed the journey of the nonconforming material moving throughout the company from delivery to end destination. This mapping currently enables the company to identify problems in materials that need change or improvement.

During this project, I was also charged with gauging current user satisfaction with the Nonconforming Material Report (NCMR) process. Whenever a nonconforming material is detected, the defective part is investigated and dispositioned into categories such as Scrap, Return to Supplier, Use As Is, and Rework. This whole process is completed, supervised, and approved by many people in many different departments throughout the company. The entirety of this process is recorded on an internal database. To determine employee satisfaction with the process and the database, I learned how to create and administer an unbiased survey. After the surveys were completed, I organized survey responses in an Affinity Diagram, an organizational tool that sorts ideas by common theme. Essentially, I wrote down all relevant survey responses on sticky notes, grouped them by similarity, and determined overarching themes of those groups. To corroborate my survey findings, I needed to examine how long certain NCMRs had remained open. To that end, I learned how to use Minitab, a statistics software. Knowing Minitab helped me mine through NCMR data to determine how long the entire process took. The skills and various software I learned during my independent project will be critical in my future coursework and engineering career.

The second, team-based project involved creating a plan to raise awareness about SCA at UW-Madison. My fellow interns and I were charged with the task of creating an awareness campaign that not only informed the public but also inspired them to advocate for change. SCA awareness is important, especially on college campuses, because it can truly affect anyone at any age, even healthy young adults.

Outside of the industrial engineering skills learned from my main project, I received professional advice about networking and post-college career development. We learned about the ins and outs of the interviewing process from HR, as well as the many different turns a career can take from members of the executive board. I can now apply skills that I developed while interning, such as organization and time management, to my everyday life. In just one summer, I witnessed tangible growth in myself, both as an engineer and as a person.

Interning at Cardiac Science was truly the highlight of my summer. I learned a great deal during my time there, developed critical engineering skills, and had a great time doing it. I highly recommend this internship to any engineering student who is eager to learn more about the workings of a smaller company and help save lives while doing it.

Written by: Erica Calvache

Photography by: courtesy of Erica Calvache

Design by: Patricia Stan

Evolution's

Been Shot Full of Holes, Apparently

If you've lived in Madison over the summer, there's a good chance you've made at least one trip to the Dane County Farmer's Market. And while you were there, you probably saw it– a three-panel wire display, covered in densely worded sheets of paper and a few slightly faded diagrams. The rubber dinosaur up top likely caught your attention first. Anywhere from three to six elderly gentlemen were standing in front of it, all dressed slightly like your great uncle who's super into fly fishing. Have you ever wondered what their deal is? Fear not, dear reader– you read the Wisconsin Engineering Magazine, so you don't have to wonder.

I stopped by with the intent of interviewing one of them this past June, but my attempts were rather unsuccessful. The man I spoke to didn't want to be recorded or quoted and wouldn't give me his real name, so I'll call him Paul.

By Paul's description, the group's message was, in short, nuanced creationism. His pieces of evidence for the Earth being less than 10,000 years old were, in no particular order: the discovery of fossils which contained dinosaur soft tissue and therefore were not 65 million years old, the complexity of the cell and evolution as evidence for intelligent design, what he referred to as "genetic decline," which had something to do with cancer, and the very existence of information as proof of a creator. Yeah, he lost me with that last one too. The flow chart he had explaining this didn't help to clarify things.

"Didn't Bill Nye debate a guy about this on TV for like three hours back in 2014?"
– Some Dude

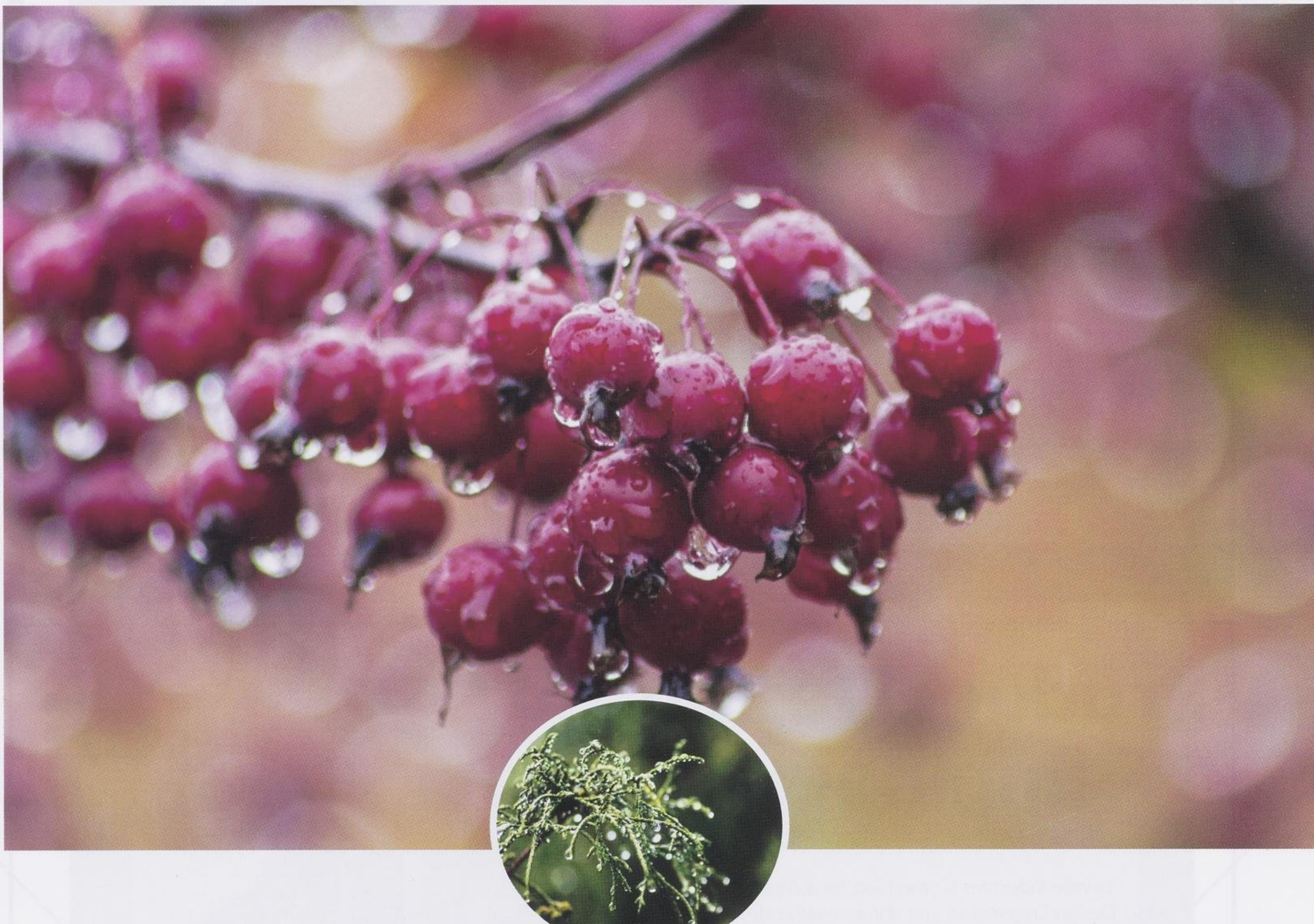
The conversation became more interesting when I got him off the topic of his message. Paul considers himself a scientist, and to him, his message is one of re-examining conventional science. He believed the theory of evolution up until a few years ago. Though much of his message aligns with Judeo-Christian belief, he doesn't consider it an explicitly religious one. Rather, he merely believed there was simply so much out there we just don't know about. Vaccines, he mentioned, were a good example.

To his and his group's credit, their approach was almost level-headed. A table in front of their display had a DVD copy of Evolution vs. God next to the book Evolution Shot Full of Holes (the two had opposing views– you can figure out which was which). Their literature did cite published papers. Overall, the pitch was less explicitly persuasive and more merely trying to get you to consider another perspective: that everything you know about the origins of the universe and life itself is wrong.

All in all, it was an interesting conversation even if not particularly informative. I would've talked to the other two men there, but they were deep into an argument about diamonds with someone vaguely engineering-student-looking, so I left them to it. I did grab a copy of Evolution Shot Full of Holes before I left. It's made an excellent coffee table book.

Written by: Patrick Byrne
Design by: Patricia Stan

MERCURY CYCLING AND REGULATION

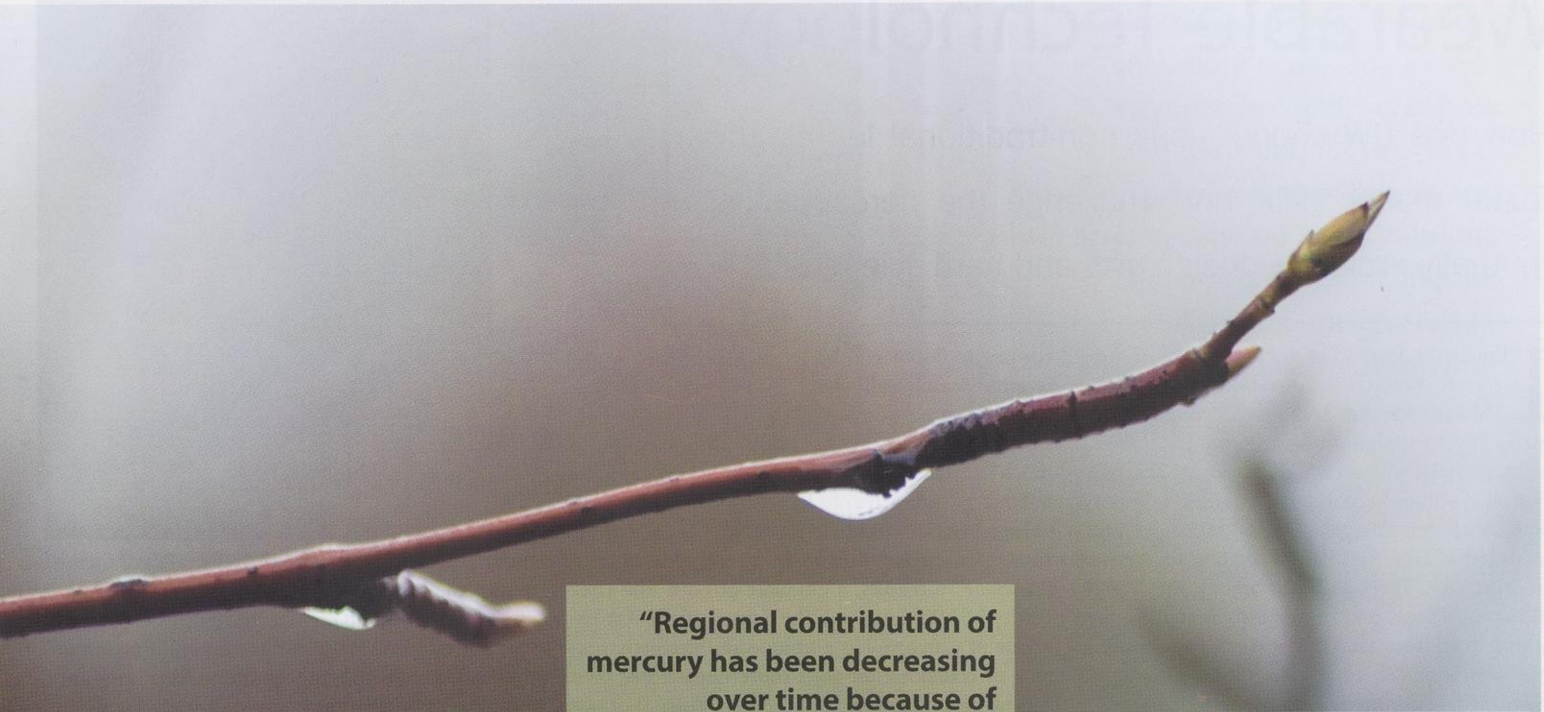


The Wisconsin Idea endeavors to apply university research to improve the quality of life and the environment throughout the state. Exemplifying this idea is the research of Dr. James P. Hurley, director of the UW Sea Grant, whose work is with novel methodologies in accurately measuring trace amounts of mercury in aquatic systems. The central issue in mercury regulation is the difficulty in measuring very low concentrations. Only trace quantities of mercury are found in these aquatic systems, and of these, only one to two percent is methylmercury— the form most commonly found in living organisms. Methylmercury starts as very small amounts in phytoplankton, concentrates through the food web, and eventually reaches potentially lethal amounts in fish that are consumed by humans. Hurley found a solution by taking a tip from oceanographers' methods on the open sea and applying them to other aquatic systems such as the Great Lakes. According to Hurley, his research is innovative in how it "continued to push the envelope on methodologies," Hurley says.

Hurley applies these new methodologies not only to measure amounts of mercury found in the environment but to also determine its origins. The principal sources of mercury are industry, atmospheric deposition (rain), and contaminated soil. As mercury undergoes chemical transformations from each of these sources, different isotopes become concentrated, giving each source a unique isotopic signature that can be identified through analysis. "[We] have to look at those sources and then back calculate where it might have come from, based on those signatures," Hurley says. Knowing which signatures represent the greatest percentage of mercury in fish provides information about which sources need to be most heavily regulated to best protect the environment and public health.

One signature of importance is atmospheric deposition. Mercury often exists as a gas, meaning that it can be transported large distances through the atmosphere and deposited elsewhere in rain. This characteristic means that any use of mercury is

New methodologies in trace metal concentration analysis provide scientific data to inform environmental policy, embodying the Wisconsin Idea.



> **"Regional contribution of mercury has been decreasing over time because of regulation"**
> **- James P. Hurley**

both a local and global issue. For instance, most mercury currently in the atmosphere results from small-scale gold miners forming compounds that extract gold from reserves. Once the gold has been obtained, the mercury in the compound is burned off, entering the atmosphere in surprisingly vast amounts. "Burning off the mercury from gold would be equivalent to a month of coal burning," Hurley says. Understanding the contributions from such sources is vital in creating policies that are most effective at preventing mercury from reaching dangerous levels. Locally, mercury deposition into the Great Lakes region has recently caused fishing advisories for many lakes in northern Wisconsin. Hurley's research therefore directly impacts the wellbeing of many local citizens.

Given the complex, global nature of mercury deposition, treating the problem is far from simple. In the United States and Europe, environmental regulations in recent years have curtailed direct deposition from products such as medical instruments. "We got rid of the point sources, now we have to get rid of the nonpoint sources," Hurley says. Regional efforts to decrease mercury deposition are showing positive results, but the metal will remain in systems, such as the Great Lakes, if it is still being introduced into the atmosphere and remains in contaminated soils. In the Great Lakes region, according to Hurley, "There has been a shift away from contaminated sites and more toward atmospheric deposition." For already contaminated soils and sediments, the primary mechanisms for remediation are dredging, disposal, and capping to prevent additional mercury from entering the food web. Cleaner methods for small-scale gold miners and coal burning will be able to decrease these levels of atmospheric deposition.

Research alone will not be able to implement these changes. Rather, policy makers must use the data that scientists and engineers provide to inform environmental regulations and prevent serious health issues. In areas with contaminated water sources, such as the Appalachian region of the United States, mercury in drinking water has been determined to have direct effects on IQ levels and neurological diseases in infants. "Regional contribution of mercury has been decreasing over time because of regulation," Hurley says. This decrease in concentrations demonstrates that when scientific experts inform conversations surrounding environmental policies, the impacted environment and local public health will see quantifiable positive results. "We did basic and applied research that lead to a measurable outcome," Hurley says.

As Hurley points out, the utilization of this work embodies the Wisconsin Idea. Applied interdisciplinary research at the university level impacts all areas of the state. "The University of Wisconsin is a great place to do research because people want to collaborate and answer these truly complex questions," Hurley says. Opportunities provided at UW-Madison for collaborative research make the acquisition of this kind of new information possible. While a better understanding of our natural world enriches scientific knowledge, it is the application of this knowledge that ultimately benefits our society, remediates our environment, and protects public health.

Written by: Katlyn Nohr

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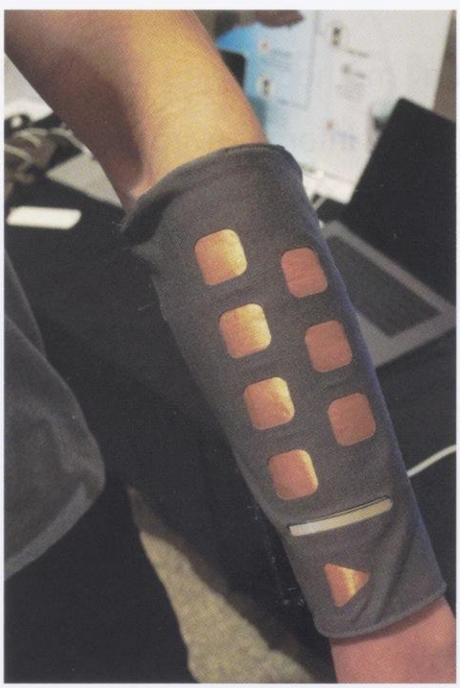
Engineers, Artists, and Wearable Technology

How one UW course uses non-traditional learning to foster maker skills and challenge the perception of mutually exclusive design arts and hard sciences.



The first indication of the uniqueness of Professors Kevin Ponto and Marianne Fairbanks' wearable technology course is its cross-listing in design studies, computer science, and industrial and systems engineering. The mix of enrolled students– computer engineers, kinesiologists, retailers, biological systems engineers, and one Master of Fine Arts (MFA) in glass and neon– is another clue. Through the course's content and philosophy, Professors Ponto and Fairbanks are working to address what they see as a greater need for collaboration between the sciences and the arts.

Professor Ponto, a graduate of UC-Irvine's Arts Computation Engineering and a veteran of many interdisciplinary projects, fully supports work that involves the combination of different fields. "There is a lot of data to support the fact that working and thinking in the arts spurs more creative thinking in the sciences," Ponto stated. The problem, according to Ponto, is that the requirements of many programs, especially those accredited by outside entities, cause students to be boxed into subject areas. "Oftentimes," says Ponto, "students aren't given much in terms of breadth… [which is] unfortunate but may be indicative of a larger issue in terms of the value our society places in the arts."

Professor Fairbanks, a graduate of both The University of Michigan and The School of the Art Institute of Chicago, has a unique and extensive history of collaboration with those outside her own artistic work with textiles, such as collaborations with chemists, materials scientists, and electrical engineers. Fairbanks also pushes back at the highly structured nature of many degree tracks at modern universities. "This is the chance for students to get exposure to the fields that make life worth living, like art, music, theater, and dance," she says. "If we don't give students at the university those things, then they should just go to a technical school."

With its atypical structure, the course challenges the misperception that STEM and the Fine Arts are mutually exclusive. Whereas many courses consist of instruction followed by a term project, this studio-based class begins with the students pitching ideas. For the remainder of the semester, the students develop skills such as programming, soldering, and sewing, and engage in project-specific independent research. The culmination of these skills enables them to manifest their ideas and create functional products.

"I think the advantage of the approach of metaphorically throwing people into the deep end and helping them swim out is that it hopefully enables students' self-efficacy with technology," says Ponto. "The idea is that they can come up with a project and learn the skills they need to learn to do it." Fairbanks adds that, "because they're all making something different, they don't all know the same thing at the end." Instead, she says, "I want them to be critical thinkers, to ask questions, and to be innovative with the projects they come up with."

The students gave their final presentations at the Masonic Center this past April, and their completed projects were genuinely impressive. Many projects aimed to address real world problems while others worked to address personal needs, and the students devised remarkable means of fulfilling their tasks.

"Science is a form of art. We think of art and we think of the fantastic, but I don't see a reason why something science-based can't be fantastic as well"
-Lillian Stenz

"If anyone is working in the arts or the sciences and doesn't cross over to the other side, they're missing a lot of advantages in terms of how one thinks about process... Crossover between arts and sciences can be really valuable to help you start thinking about different approaches to problem solving"
-Andrea Oleniczak

In true Da Vinci fashion, students combine art with science to design wearable technology that solves real problems.

Luke Piper, a senior majoring in Retail, created the Muscle Relax, a wearable device that uses heating and vibration to promote muscle recovery. Piper was inspired by the inflated cost of similar devices he currently uses. Lillian Stenz, a sophomore majoring in Kinesiology, was worried about visibility when running at night. Hence, she designed the Solactus shoes, which use reflecting fabric and LEDs that respond to footfalls. According to Stenz, this class adds to the artistic expression of her work: "Science is a form of art -- we think of art and we think of the fantastic, but I don't see a reason why something science-based can't be fantastic as well."

Other students aimed to address animal health needs. Taylor Kurrle, a grad student pursuing an MFA in Glass Blowing, designed the Lit Alert. Looking to further explore the relationship between law enforcement and everyday citizens, the Lit Alert monitors the body temperature of police dogs– an important role, given that 32% of police dog fatalities result from heat exhaustion in vehicles (the most common form of death, above gunshots and car strikes). Hanwook Chung, a graduate student in Biological Systems Engineering created the Milkbit, a wearable device for cows that monitors their body temperature. The Milkbit would allow farmers to collect concrete data on the effectiveness of their ventilation systems in dairy barns. The device additionally provides data to Mr. Chung's graduate research in agricultural ventilation systems.

Reflecting on her own interdisciplinary work, Professor Fairbanks wishes there was more interface between fields like materials science, engineering, chemistry, and design studies: "Classes like [this wearable tech course] do a good job about bringing those sorts of students together." From conversation with the students at their final presentations, they seem to be adopting the instructors' philosophies about collaborative work among seemingly dissimilar fields of study. Chris Hanko, a senior in Engineering Mechanics, mentioned that while a lot of science goes into the functionality of a product, "art is a huge part of product design, especially in terms of aesthetics and user experience."

A student from the artistic end of the spectrum, freshman in textiles and fashion Jordan Schilling, mentioned that with the interconnected nature of modern society, "it's beneficial for not just artists but everyone as a whole to become familiar with technology and how different things work." Andrea Oleniczak, a graduate student working with glass and neon, described the two as a natural fit for one another. "If anyone is working in the arts or the sciences and doesn't cross over to the other side, they're missing a lot of advantages in terms of how one thinks about processes. Crossover between arts and sciences can be really valuable to help you start thinking about different approaches to problem solving." This wearable technology course could be the link that technical and artistic students have been waiting for: the opportunity to immerse themselves in a multidisciplinary classroom to learn about their other abilities and implement them to solve real world problems.

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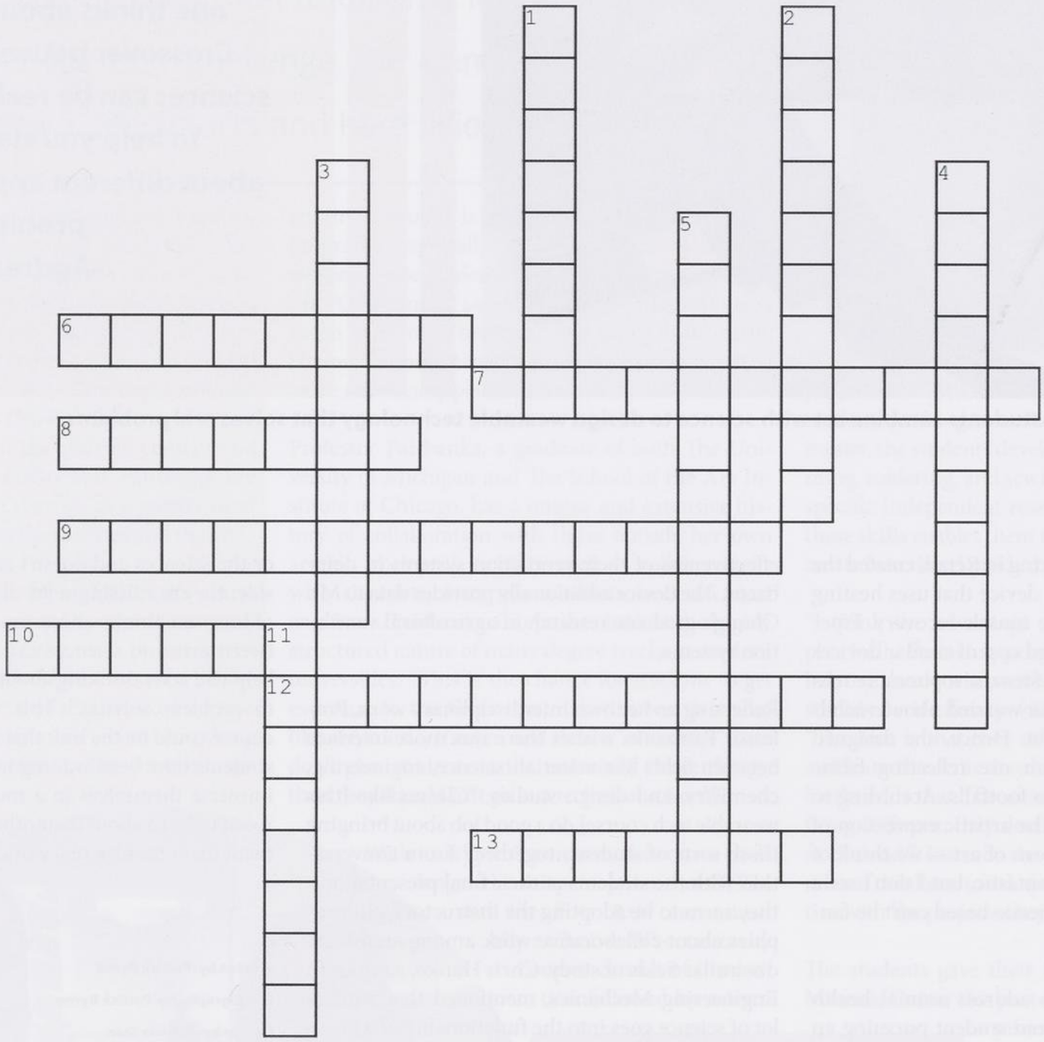
ENGINEER CROSSWORD



Across

6. The multidimensional generalization of a derivative.
7. Quality of stem cells; having the ability to give rise to many different tissue types.
8. A moving, electrically charged particle in the presence of electric and magnetic fields experiences the ______ force.
9. A common method for representing signed values in binary.
10. Java keyword to declare a data member to be shared by all instances of a class.
12. A test instrument used to view electronic signals on a two-dimensional plot.
13. The functional unit of the kidney.

Down

1. A network of hydrophilic, crosslinked polymer chains that swells in water and has applications in wound-healing.
2. Of a material, having different properties along different axes or directions, e.g. wood or bone.
3. Sorting algorithm which operates in O(N) time on sorted arrays and O(N^2) time otherwise.
4. A smooth, orderly flow of fluid near a surface.
5. A material that can exhibit properties of both a conductor and insulator.
11. Type of bond in which pairs of electrons are shared between atoms.

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