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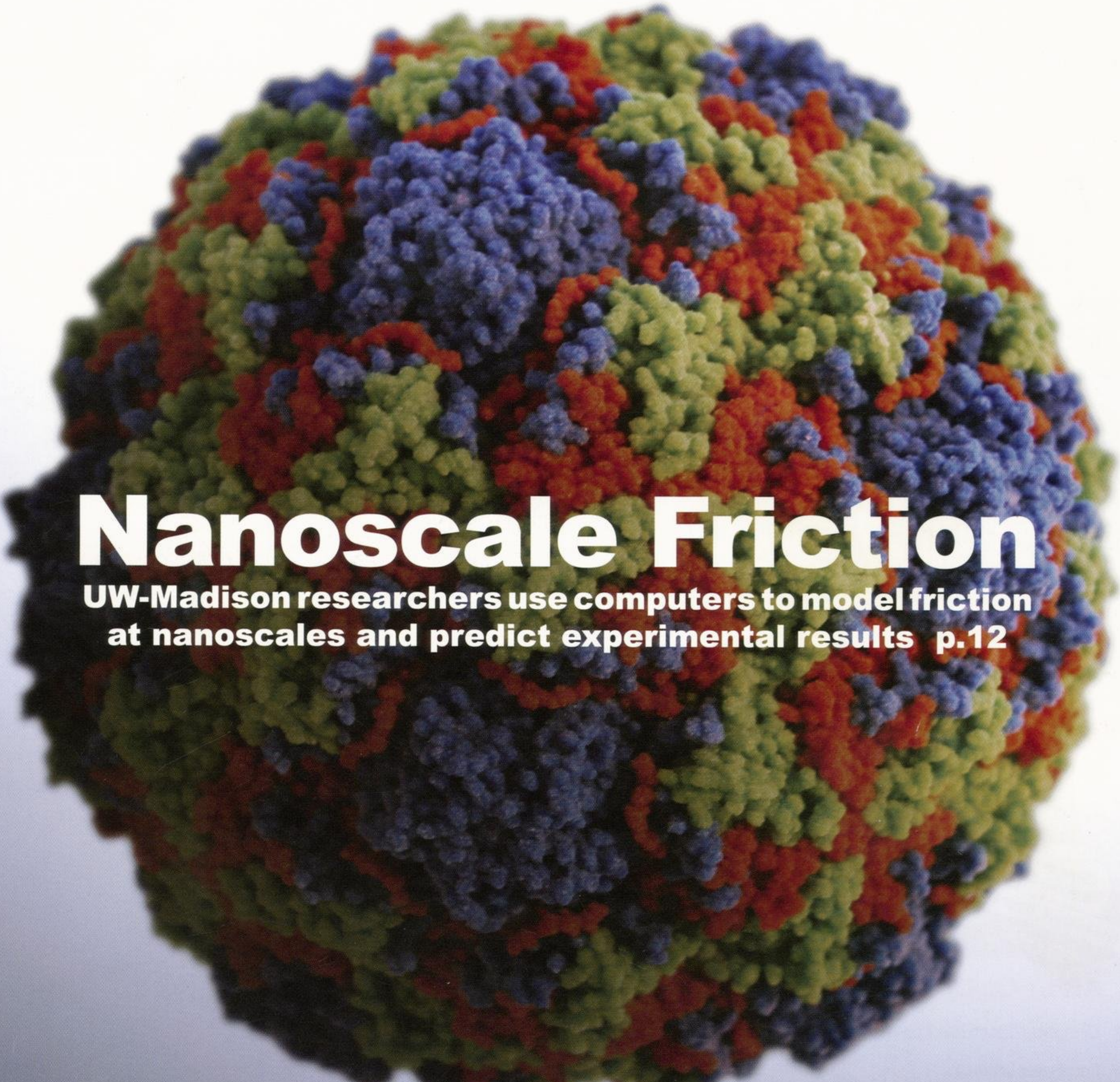

Nanoscale Friction

UW-Madison researchers use computers to model friction at nanoscales and predict experimental results p.12

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EDITORIAL

Traveler's bug

Photo by Anna Mielke

By Matt Stauffer

In today's increasingly global economy, it is imperative that engineers have a world-conscious view of the invaluable human resources. The best way to increase one's understanding of the multitude of cultural differences between people around the world is to immerse oneself in a new culture through personal travel.

UW-Madison is an excellent vehicle for travel —both nationally and internationally—for a long weekend, a short summer or an extended bout. There are a plethora of options for getting out and seeing the world beyond the borders of Dane, and there is no time like the present, being young able-bodied curious college students, to cut free and travel the globe.

I have been fortunate to catch the traveler's bug early in my healthy six-year undergraduate career, and have capitalized on most every opportunity to travel on a begged or borrowed dollar.

These are just a few of the many opportunities which I feel fortunate to have capitalized upon.

Student organizations are an engaging means of getting out for a long weekend of self-enlightening travel. At UW-Madison, we have the Hoofers organization which is about making friends, pushing your personal limits and traveling around this blessed country in search of an adrenaline rush. I have taken a weekend to go jump out of a fully functional airplane and jumped on a chartered bus to get up into the waist-deep powder of Jackson Hole. Whichever activity tickles your fancy, Hoofers is bound to have a club that does it and a trip that goes there.

Other organizations such as the Associated Students of Madison, Leadershape, Engineers Without Boarders, this magazine, and other esoteric organizations on campus have national, and sometimes international, conferences where you can meet peers from other universities. These excursions are a great networking opportunity, as well as a lot of fun. Also, they are often fully sponsored by the organization provided you are present for the educational bit of the long weekend. I have been imbursed to travel to Detroit, Pittsburg, San Francisco and Washington, D.C. through various clubs and organizations.

As international borders and the great expanse of water that separates America from Eurasia have become less of an obstacle to the great human shuffle, cross-cultural communication has become integral to many international education curriculums. With that said, English is becoming the global language. Being a native English speaker has been my key to free trips around the world. I spent one summer teaching in The Kingdom of Tonga and another in Japan. Many countries abroad including Japan, China, Korea, Spain, France, Germany and Mexico prompt their children to learn English in school. These schools often seek college students to teach their children to speak English and there are many programs which often include a living stipend and free travel; some actually come with a paycheck.

Engineers in training are encouraged to get hands-on experience through work-study internships. This is another great opportunity to get outside of the comfortable Wisco-shell and travel to a new location. A co-op with Kimberly Clark was my travel ticket to the Pacific Northwest, where I got my khakis dirty on the factory floor. Exploring options within a particular company will reveal these travel opportunities. If the company is large enough, chances are they will have available positions in national or international facilities.

Always popular amongst students is the semester abroad option. Whether the goal is immersion in a foreign language or just a change of pace, a semester abroad will undoubtedly lead to a new group of friends and broader world views. For engineers, this is a chance to work on an international engineering project or to crawl out of the engineering pigeonhole for a six-month breath of fresh liberal studies air. A semester in New Zealand allowed me to explore courses in biology and environmental studies, see an amazing corner of planet Earth and meet a gang of new friends, all while fulfilling several liberal requirements.

There are innumerable opportunities available to travel tangled up in the network of college life. It may seem overwhelming to sort the details out, but all of the resources necessary are available on campus or a click away on the net. With flexibility and compassion, few expectations and an open mind, these stints of world travel have become a glorious collection of collegiate memories and a valuable asset to my future career on the global engineering stage. WE

Happy travels,

Matt Stauffer

Matt Stauffer

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The globetrotting professor

By Mark Cigich

Years ago, James Schauer led a globetrotting career in the petroleum chemistry industry. Since coming to UW-Madison ten years ago, however, Schauer has made a name for himself in providing policy-relevant research in the areas of air pollution and lake mercury levels in Wisconsin. In 2008, Schauer was the recipient of UW-Madison's H. I. Romnes Faculty Award, given to faculty who demonstrate significant effort in policy-relevant research.

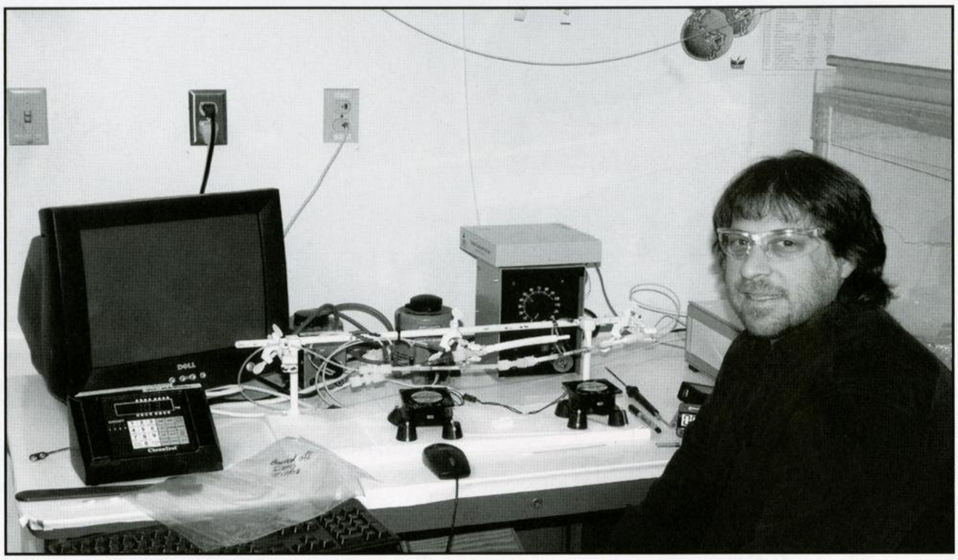

Photo by Rickey Dixon

Professor Schauer demonstrates the lab-based mercury analyzer, one of the tools he often uses when analyzing lake water in Wisconsin.

Additionally, Schauer's passion for collaborating with people from various backgrounds has allowed him to become an influential member in the Madison area. He has served as the director of the UW-Madison Water Science Engineering Laboratory and the program director of the Wisconsin State Laboratory of Hygiene.

"A big part of my job is to be a facilitator … I'm trying to help students learn about [pollutant characterization] tools so they can go on to work for the government or with researchers in universities or industry … but also to help with other researchers around the country," Schauer says.

Schauer's current research group uses chemical characterization tools to analyze pollutants in the atmosphere, find their sources and describe their impacts on human health. This information is then used by policy-makers when deciding which strategies to pursue to best reduce the impact of pollution. The challenge Schauer's group most frequently encounters is finding the sources of this pollution.

"Because we study the atmosphere, our laboratory is the world."

-James Schauer

"Because we study the atmosphere, our laboratory is the world," Schauer says. "When you go places there's lots of pollution … it's very difficult to do forensics to understand where those sources are." These sources can range from diesel exhaust to cholesterol released from meat processing plants.

"A big part of my job is to help us all as a team [and] advance our understanding [of pollutants]," Schauer says. In his role as a collaborator, Schauer directs the attention of policy-makers and researchers across the United States to relevant research papers to help them solve problems of characterizing pollutants.

Schauer's work has brought him across the globe, working with other researchers to find ways to decrease the impact of air pollution. He has served as a guest professor in China, where he worked with the government to find ways to reduce pollution levels while preparing for the Beijing Olympic Games. Schauer has also traveled to Mexico City, Los Angeles and Pakistan in an effort to reduce the impact of pollution.

The air pollution dilution source sampler aids Shauer in his environmental endeavors to reduce air pollution in Wisconsin and throughout the world.

Schauer's expert knowledge in building characterization models and collaborative experience was not gained overnight. He grew up intrigued with chemistry and math; these interests later fueled his desire to major in chemical and petroleum refining engineering at the Colorado School of Mines. "Engineering was much more attractive [than just studying science]," Schauer says of his undergraduate experience.

After graduation, Schauer decided to take on the challenges of a career in engineering and moved straight into industry. He managed to land a unique and challenging job working on huge petrochemical plants.

"When I was in my late twenties, I was responsible for starting up ... billion dollar complexes, [which] was a great experience," Schauer says. This job took him across the globe, allowing him to visit Greece, Austria, China, Nigeria and South Asia over a six year period. For Schauer, this tremendous experience improved his skills as a problem solver and allowed him to develop his role as a collaborator, which is how he sees himself today.

Schauer accrued enough vacation time working on these petrochemical complexes that he was able to take a year's paid vacation. This unique opportunity allowed him to switch to a field he found to be more rewarding: environmental engineering. After receiving his masters at the University of California–Berkeley, Schauer worked in China for six months in a research development center. It was not until a couple years later, while working for his PhD at the California Institute of Technology, that he became interested in teaching.

Underneath a fume hood, Schauer works with one of the rotary evaporators to prepare a sample for his research.

With a huge knowledge base in emissions characterization, Schauer moved to Madison and took up his current role as a professor, researcher and collaborator. Schauer and his research group also act as environmental ambassadors, providing policy-relevant research on mercury levels in Wisconsin and around the United States. Their recent work provided a scientific basis for The National Resources Board to pass a new regulation on mercury reductions in Wisconsin. He and his group have also studied mercury emissions from geysers in Yellowstone Nation Park, as well as in lakes around Detroit and St. Louis.

Schauer is a man to whom the department of civil and environmental engineering owes a few pats on the back. His work at UW-Madison has undoubtedly been appreciated by all who have had the privilege of working with him. Furthermore, his early success as an engineer can inspire us all to think that our next great opportunity may come sooner than we think. we

Author bio: Mark is a junior in industrial engineering. This is his first semester writing for the magazine.

There's no fountain like *Máquina fountain*

By Amanda Feest

Over the past fifteen years, the Máquina fountain has become an iconic structure for the college of engineering. The semi-circular arcs of the fountain are splashed across the college's websites and brochures. Many students even view the fountain as a symbol of their engineering education.

"It's a big graduation tradition to go get your picture taken in front of [the fountain]," Chris Meyer, a member of the student organization Enlight, says. Enlight is a small student organization interested in computer and electronic technologies. Members of Enlight tend to the 18-foot tall Máquina fountain. Despite its important status as the centerpiece of the engineering campus, little is known about the many characteristics that make the fountain unique.

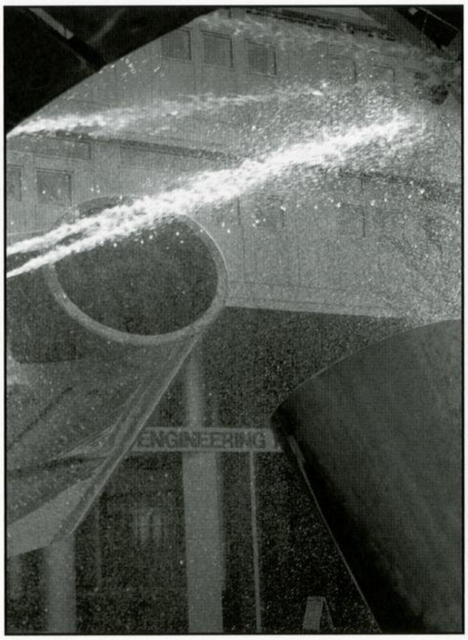

Photo by Mario DiBenedetto

Students are able to control the flow of the Máquina Fountain jets, either with the touch screen in Engineering Hall or by walking past the posts lining Engineering Drive.

The fountain was unveiled in 1994, the result of a collaboration between artist William Conrad Severson and former college of engineering dean John Bollinger. Severson, a UW-Madison alumnus, created a concept that merged art with engineering. The result is a massive steel structure with streams of water shooting out of the two arcs, which are designed to resemble calipers (an engineer's precise measurement tool). After spraying from the fountain, the water flows down a spillway, runs over small dams called weirs and then disappears underground. Another part of the fountain is independently controlled, sending water down a separate spillway that drains into a reflecting pool. Arching jets of water at the edges of the reflecting pool surround a bubble tower that introduces compressed air bubbles into a water column.

"For years, it just never ran. It was one of the big elephants on campus. Students would wonder 'Is it ever going to be on?'"

-Chris Meyer

The fountain was always intended to be a vehicle for practical design experience. During Bollinger's term, electrical engineering design courses challenged students to add new functions to the fountain. However, when Bollinger left, the fountain was handed off to other engineering staff members, and it eventually fell into a state of disrepair. "For years, it just never ran. It was one of the big elephants on campus. Students would wonder 'Is it ever going to be on?'" Meyer says.

The fountain remained dormant until Enlight took over as "fountain technicians," member Justin Beck says. Enlight's first objective was to get the fountain working again. This seemingly simple task quickly proved complicated, requiring the team to piece together the hardware left behind from past engineering students. When asked about their biggest achievement on the fountain project, Enlight members overwhelmingly respond, "[the fact that] it works."

Once the water started flowing again, Enlight members channeled their efforts into several new projects. First, engineering technology company National Instruments donated their CompactRIO control system to replace the old system. This massive change involved "ripping out the fifteen-year-old electrical system and upgrading it with a new one," Beck says. Second, new server architecture was implemented, which makes the controls much more user-friendly. "Small changes that used to take hours … can now be made in minutes without really having to know the guts of the system," Malinowski says.

The technological advances of the fountain's controls have paved the way for projects that allow public interaction with the fountain. Many of these interactive ideas were part of the original plan for the fountain that are finally being implemented. The first interactive project allows passersby to unknowingly control the fountain as they walk in front of the bollards, which are the five stainless-steel posts in front of the fountain.

"If anyone thought they were controlling the fountain with the bollards before July 2008, you were wrong. It was just a placebo," Malinowski says. The bollards are now programmed to detect infrared light emitted by pedestrians and send signals to the fountain, changing the spraying pattern as a person passes each bollard. "There's one that will turn everything on, there's one that will turn everything off, one [that] makes it go faster and one [that] makes it go slower," Malinowski says.

Another advance in the controls allows students to control the fountain from inside Engineering Hall. In August 2008, a kiosk was installed in Engineering Hall that allows students to turn specific jets on and off using the touch screen mounted in the lobby. Students can manipulate the valves and watch the results live through the large glass windows encasing the lobby.

For special events, such as home football games and Engineering Expo, the fountain turns into a musical display. On the day of a homecoming football game, for instance, Badger fans walking past the fountain can hear "If You Want to be a Badger" and other UW-Madison marching band recordings playing from speakers on Engineering Hall. As the music is played, the valves open and close, changing the spraying pattern in time with the music. Fans can change the song with a quick wave of the hand in front of the bollards.

The idea of combining music and water arose when the Enlight members discovered the speakers atop Engineering Hall. "[Malinowski, Meyer and I] had a history of doing music and lights. The fountain added a new twist to it, because now … we could do music and water," Beck says. They hope to continue this show during football games this fall, but the demolition of Union South will push game-day festivities onto Engineering Mall, leaving the decision outside the jurisdiction of college of engineering officials.

Photo by Mario DiBenedetto

The pipe system underneath the Maquina Fountain extends across the length of Engineering Mall, supplying water to both fountains.

Enlight members view their work on the fountain as valuable, real-world design experience. "[Most class work] is all in theory. We would never see it actually working. Here, we see the design process. We see how to program it, how to implement it and how the software interacts with physical devices," Enlight member Dustin Passofaro says. Throughout the design process, Enlight members rely on each others' expertise, helping each other gain "a jack-of-all-trades mastery," as Beck says.

"Small changes which used to take hours … can now be made in minutes without really having to know the guts of the system."

-Jason Malinowski

Thanks to the design work of past and present students, the fountain has become an enduring symbol of the engineering campus. The next time you're eating lunch on the steps of the fountain or snapping those memorable graduation pictures, take a minute to stop and appreciate the unique characteristics of the Máquina. WE

Author bio: Amanda is a senior in biomedical engineering. This is her first semester with the magazine.

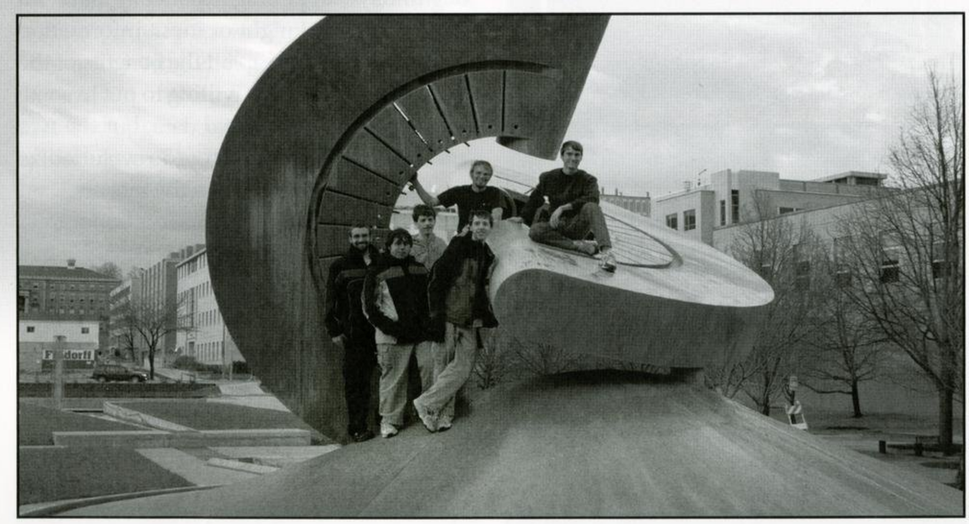

Photo by Mario DiBenedetto

Enlight, a student organization, manages and controls the Maquina Fountain. From left: Justin Beck, Christopher Beley, Eric Harris, Jason Malinowski, Chris Meyer and Dustin Passofaro.

Want to get a decent night's sleep?

There's an app for that.

By Roxanne Wienkes

The iPhone is putting the world at your fingertips. You can keep track of your expenses, create a to-do list and even find a restaurant. Thanks to two former UW-Madison students, you can now also get a decent night's sleep.

Daniel Gartenberg and his business partner, Justin Beck, looked for a way to improve how people sleep and wake up. "Sleep is basically unaddressed," Gartenberg says. "There are all these products for fitness and health but not really for sleep."

The duo's different areas of study made for a successful partnership to fill this void. Gartenberg, who has a degree in psychology and neuroscience from UW-Madison, has the knowledge and resources to improve the way people sleep and wake up. Beck, with his degree in electrical and computer engineering, takes those ideas and puts them to work through the tedious task of computer programming.

After an intensive amount of studying how sleep works and computer programming, Gartenberg and Beck entered their product, named Proactive Sleep, into the Innovation Days competition this February. Their design won first place—an award of $10,000—and the duo gained instant recognition across campus.

Illustration courtesy of Proactive Sleep

Proactive Sleep works like a normal alarm clock but knows when to wake the user so that he or she does not feel groggy. Once awake, the user can log the quality of sleep gotten that night.

Proactive Sleep, an application for Apple's iPhone and iPod touch, has several revolutionary functions. First, there is a sleep diary which allows users to track the amount of sleep received each night and the amount of times woken up each night. Then, there is a "vigilance task" each morning that measures alertness and judges response time to determine the quality of sleep the previous night. The alarm clock also works with the media on the iPhone or iPod touch to provide plenty of song choices to which users can wake up and fall asleep.

The sleep diary is a simple way for users to make sure they are getting enough sleep. "Americans are generally under slept," Gartenberg says, "Sleep affects every system in the body. You are more likely to get sick and to be overweight if you do not get enough sleep."

The diary tracks and graphs information on sleep duration, average amount of sleep per day, number of awakenings and the vigilance test score. There is also a function that allows the user to input information about day-to-day happenings that may have affected sleep that night or input information about dreams. To reap all the benefits of the system, users must be willing to put in some effort and regularly enter data, but the two creators fully believe it could revolutionize the way people wake up in the morning.

The vigilance task, is a game played when woken up in the morning. The user simply follows a moving ball around the screen with his or her finger. The quicker the user follows the ball, the quicker it moves and a score is given based on reaction time and alertness. The score is then logged in the diary and provides the key to determining how well the user has slept over time.

Once all of the information is stored in the diary, this application is an excellent way

Photo by Steven Shutt

Justin Beck and Daniel Gartenberg, creators of Proactive Sleep and recent graduates from UW-Madison, show off their innovative idea in their company headquarters (a.k.a. Justin's apartment).

Learn More:

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Beck's website:
http://www.perblue.com

More information on Innovation Days:
http://studentservices.engr.wisc.edu/innovation

Proactive sleep website:
http://proactivesleep.com

More information on the importance of sleep:
http://www.sleepfoundation.org

for a person to see how different activities or actions can affect a night's sleep. Therefore a user can self diagnose any problems he or she is having and correct them. For example, if a user logs what time he or she is eating dinner at night, it may be seen that there is a pattern with the number of awakenings or vigilance scores that correspond with a particular eating time. It is a tool for someone to optimize his or her life and get the most out of the sleep gotten each night.

A final function of the application tracks the amount of sleep the user is getting. It is a simple way for someone to make sure they are getting enough. The system takes the amount of sleep a person is getting over time and applies that to the suggested wake up time as well to have him or her sleep longer if needed. "If someone is sleep deprived, the application is not going to tell the user to wake up at 5:00 if they set 5:30 on their alarm clock," Gartenberg says.

An iPhone application is a feasible way for Proactive Sleep to reach the general public. "The nice thing is with the iPhone there are about 50 million devices in the world, and Apple allows you to basically ship an application to them and they distribute the application to everyone," Beck says. Moreover, people that own iPhones and iPod touches are a good market for this application. "People with iPhones are often trying to optimize their lives, and they have the desire to be productive," Gartenberg says.

"We just want to educate the world on how to get better sleep, provide them with a feedback tool for them to understand their sleep and build awareness about the issue," Beck says. Thanks to this dynamic duo's hard work, a decent night's sleep may soon be at your fingertips. WE

Author bio: Roxanne is a senior studying environmental engineering. She needs this alarm application to help her wake up ... but first she needs an iPod.

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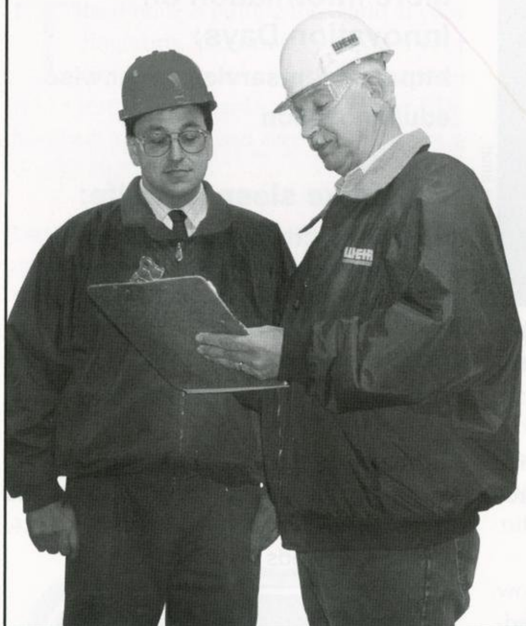

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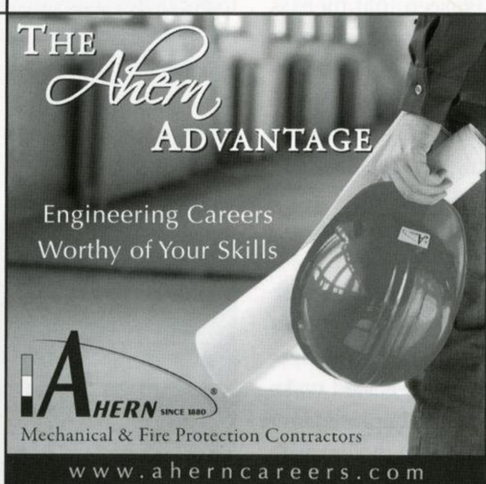

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Zooming in on friction

UW-MADISON RESEARCHERS USE COMPUTERS TO MODEL FRICTION AT THE NANOSCALE AND PREDICT EXPERIMENT RESULTS

By Melody Pierson

Most of us know about friction from our introductory physics courses. We are either told to calculate it by multiplying two numbers or just to completely neglect it in order to solve the problem. In real world applications, especially on the nanoscale, dealing with friction is not so simple.

In an article published in *Nature* in February 2009, two UW-Madison professors, Izabela Szlufarska and Kevin Turner, along with graduate student Yifei Mo, proposed their theory on the causes of friction and how to predict it at the nanoscale.

Since nanotechnology is such a rapidly growing field, these researchers are looking for ways to predict and control friction in nanoscale devices and potentially control the force's destructive effects.

"The ratio of surface [area] to volume [of nanoscale devices] becomes very large, and the surface forces become very important," Szlufarska says. "What we see is that they become even stronger than forces like gravity, and the pieces begin to stick spontaneously to one another."

This "stickiness" of the individual parts causes damage to nano-machines and greatly affects their performance. In order to tackle this problem, the UW-Madison team set out to investigate the fundamental causes of this phenomenon.

The team soon learned that its effort to improve nanoscale devices was actually the road to a breakthrough discovery of the fundamental elements of friction force. Discovering the ultimate causes of friction and consequently learning how to prevent it could mean that future devices have the potential to dramatically reduce energy loss and be much more efficient.

"We needed 20 days of computing on our high-performance computer cluster. The same calculations would take 46 years on a decent laptop."

-Yifei Mo

"The problem is people don't understand where friction comes from," Szlufarska says. The group proposed that the reason previous theories were not consistent with experimental data was because surfaces that were assumed to be smooth were actually rough on the nanoscale. Szlufarska explains that the problem with the previous theories about nanofriction, called continuum theories, was that they "assumed the contact was smooth because it's smooth if you look close. You don't have to treat the atoms explicitly, and that's why they are 'continuum' theories. What actually happens is that you go to a nanometer regime, then you begin to see those atoms and they begin to play a role."

Essentially, previous theories did not zoom in far enough and take into account the interactions between surface atoms. "You can think of [a surface] like a

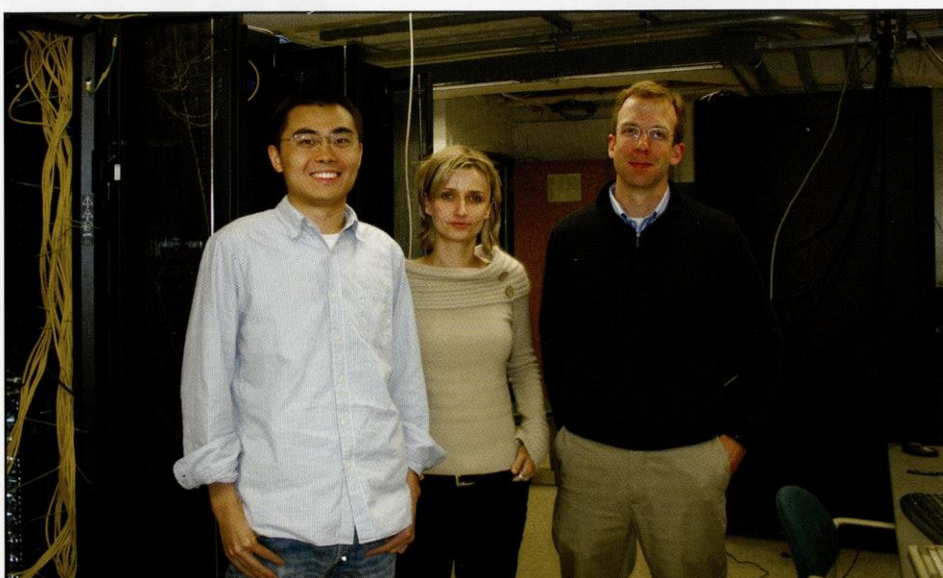
Photo by Emily Sorensen

Graduate student Yifei Mo, Professor Izabela Szlufarska, and Professor Kevin Turner research nanoscale friction with the aid of powerful computer processors.

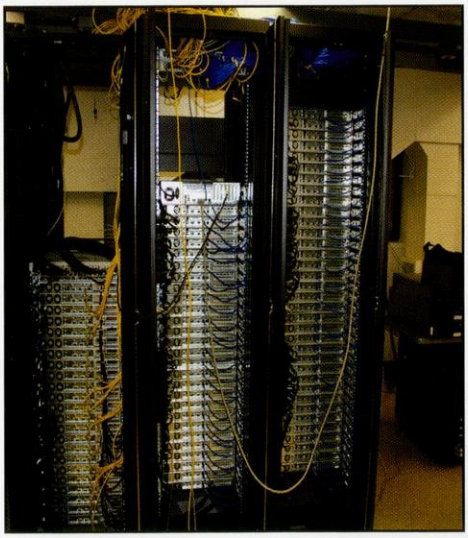

Photo by Emily Sorensen

A cluster of super fast processors are networked to carry out the massive calculations necessary to model atomic scale friction.

mountain range … when you put surfaces on each other and [slide them], the mountaintops will bang into each other. This is what's causing friction," Szlufarska says. Since friction involves the interaction of the surface atoms, the concept is further complicated. "There are many complex phenomena that underlie friction. This can be related to bonding, chemistry changes or some plastic deformation that happens in the material," Szlufarska says. "It is going to depend on the environment—whether you have humidity, what the temperature is and so on."

Another hump that the researchers had to overcome in addition to considering all of these details is the fact that nanoscale friction works differently than anything seen before. "It turns out that the laws of friction that work at the macroscale do not work at the nanoscale," Szlufarska says.

The professors have turned to computer simulation to help them describe what is happening. The magnitude of data involved in these simulations is tremendous since nanoscale friction involves individual atoms. As such, this is not the type of computer problem that can be done on a standard desktop or laptop computer.

The team uses what is called a high-performance computer cluster. "Take the fastest processor you can, then take the fastest network you can, put it between processors and design a software that works across all those computers," Szlufarska says. This computer system is so powerful when modeling friction under specific conditions that, as student Yifei Mo says, "to obtain one such function we needed 20 days of computing on our high-performance computer cluster. The same calculations would take 46 years on a decent laptop."

"If you can figure out new ways to reduce friction, you can have much more efficient power systems. "

-Professor Kevin Turner

"I think there's this general [problem] that a lot of people have been doing many experiments [measuring friction] at the small scale, and the [computer] models haven't necessarily kept up to this point. So there have been far more measurements and understanding of the measurements coming out now," Turner says.

The computer simulations allow researchers to observe aspects of nanofriction that could not be seen otherwise. "With these simulations, we can exactly track the movement of every atom; so it is basically in atomic-scale resolution, which is impossible in experiments," Mo says.

"But at the same time we try and compare [our simulation results] to experiments because we want to make sure whatever we are predicting is something that is consistent with experiment and realistic," Turner says.

In addition to its impact on nanotechnology, the team's findings have far-reaching implications for friction between all surfaces. "You really have to go down to this small level, look at this really simple asperity and try to understand friction there. Then you can take it back to the engineering surfaces," Szlufarska says. The significance of being able to model friction is that scientists can then design for it in order to reduce it. "Friction is just tremendously important. You can think about it in terms of everything from car bearings to energy efficiency. If you can figure out new ways to reduce friction, you can have much more efficient power systems. I think there are big implications if you can understand how to manipulate it," Turner says.

This work has provided a fundamental understanding of friction laws at the molecular level, and is a significant step towards controlling friction. Does the future carry devices that are truly frictionless? Is the dream of a 100% efficient system now a possibility? Szlufarska's, Turner's and Mo's research has laid important groundwork for the technology of the impending years and possibilities that, up until now, have been only theoretical. WE

Author bio: Melody is a junior majoring in nuclear engineering. This is her third semester with the magazine.

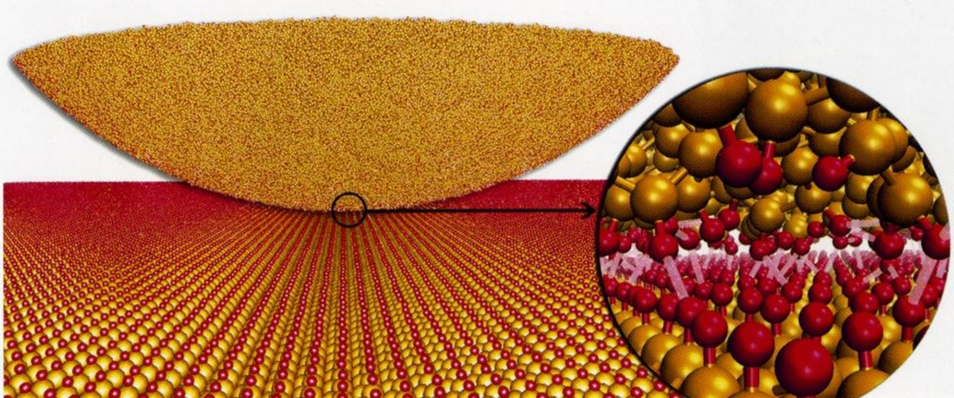

Illustration courtesy of UW-Madison

Using computer simulations, the interactions between particle surfaces can be seen at the nanoscale.

The *Wisconsin Engineer*

Annual Photo Contest finalists

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2nd

1st

3rd

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2nd

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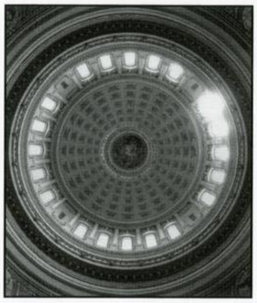

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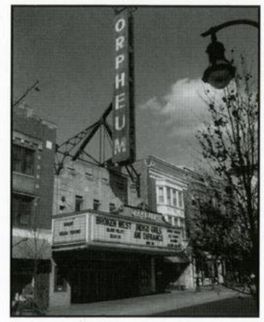
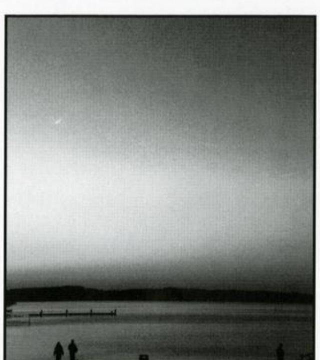
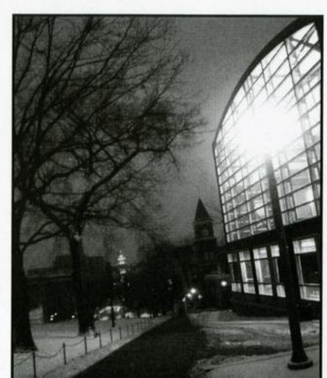


3rd

Honorary Mention





A CURE for the common cold?

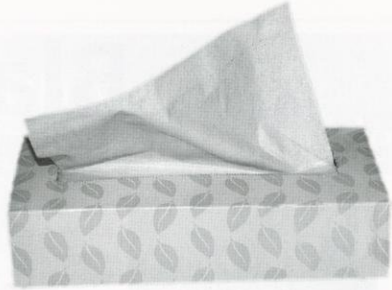


Photo by Dustin Walsh

By Matt Stauffer and Ben Weight

No one likes getting a cold, and the fact that there is no cure makes the situation all the more dismal. NyQuil and Halls can mask the symptoms of a viral infection, but these drugs do nothing to attack the virus itself. Recent discoveries about the genome of the common cold virus, however, could contribute towards a new immunization for this virus. So what's the problem? Well, it turns out that the side effects of a common cold vaccination could be far more unpleasant than temporarily suffering with a leaky face.

UW-Madison biochemistry professor Ann Palmenberg, along with teams of researchers from UW-Madison and the University of Maryland, successfully mapped and identified all 99 unique strains of the rhinovirus, the lead culprit associated with the common cold. New research methods, such as gene chip technology, have also led to the discovery of a third type of rhinovirus strain, which could offer greater insight into the development of vaccines against the virus.

The three different types of the rhinovirus are commonly called types A, B and C. The virus strains of types A and B cause symptoms of the common cold, while the type C strain—which has only recently been identified—tends to have more serious effects and often progresses into pneumonia.

Photo by Dustin Walsh

Brad Brown enjoys his work at the UW-Madison Institute for Molecular Virology at Bock Laboratory, despite the risk of contracting the avian flu, swine flu or rhinovirus.

Before more advanced viral assessment methods were developed, doctors used to take cell samples from sick patients who showed signs of a viral infection and then make a culture with those cells. If a virus grew in the culture, the symptoms would be attributed to the virus. When this process was used on samples of pneumonia—a known virus—the cells wouldn't culture any virus. It turns out that type C rhinovirus does not readily grow with common culture techniques. In fact, this whole strain of type C rhinovirus had been overlooked until gene chip technology came along.

Gene chip technology is a method that identifies viruses by their genome sequence. Once researchers began to employ this technology, they were able to identify the known A and B strains, but they also discovered other present strains. These new strains were clearly rhinoviruses, but they had slightly different genome sequences.

"Now that we do things with gene chips, we don't ask the virus to grow; we ask whether the gene sequence is there," Palmenberg says. After researchers discovered the viral material present in those samples that previously did not grow in culture, they went in for a closer look. It was then that, a whole new set of type C rhinovirus strains were identified by their unique genomes.

"There is a huge amount of biochemistry that comes out of this information," Palmenberg says. The discovery of the new rhinovirus strain is most useful in the development of a virus database, as well as diagnostic tools that doctors and researchers can use to accurately diagnose sick patients by identifying the specific viral strains from their genome. With the patient's case-specific viral strain identified, doctors will be better able to treat cold symptoms and have access to early warning signs of more serious cases.

"By understanding the sequence variations in the A's and the B's, we can extrapolate to what is going to happen with the C's … which are much more pathogenic. They don't just give you head colds; they give pneumonia, which, for someone with asthma, is a life threatening situation," Palmenberg says.

The next phase of Palmenberg's research is to separate and culture the C strains with new culture methods. Prior to this research, virologists and doctors had possibly misdiagnosed viral infections because they were unable to identify type C rhinoviruses with the widely used culture techniques.

The taxonomy, or family tree, of the rhinovirus includes some particularly nasty viral genera including polio, foot and mouth disease and hepatitis A. However, developing a cure for rhinovirus has been more difficult than it was for other diseases. With polio, for example, a vaccine was easy to develop because there were only three strains, as compared to the ninety-nine unique strains of the rhinovirus. Also, unlike most cases of the rhinovirus, the effects of polio are life-threatening, justifying a significant amount of acceptable risk for preventative treatment.

Photo by Dustin Walsh

Pharmaceutical companies rely on profits from the plethora of symptom masking over-the-counter drugs such as Robitussin and Sudafed. These products are currently the best option for those suffering through a cold.

Still, the similarities between rhinovirus and polio have led to a general misconception about developing a "cure-all" vaccine that would allow people to avoid catching colds. Preemptively going after the rhinovirus may not be a good option, as the risks currently outweigh the rewards.

"If you are going to treat a virus, you have to make sure that whatever you are doing is not worse than the disease itself," Palmenberg says. "With rhinovirus that is a problem, because almost all of the drugs we have that go after the various viral proteins will either make you sicker than the head cold, or will interfere with drugs you are already taking." Of course, there may be exceptions.

"If you've got a kid in the hospital with viral pneumonia and he can't breathe … then it makes sense to go after the virus," Palmenberg says. The balance between attacking the virus and risking other health problems associated with prophylactic treatment is different for such a serious case. In these rare instances, this new information acquired from the rhinovirus genome will allow doctors to attack the specific virus that is causing the illness.

Though we will all likely have to trudge through the doldrums of cold symptoms in the future, we can find comfort in the fact that doctors now have the tools to accurately diagnose rhinovirus infections, making us better apt to stave off these pesky microbes. WE

Author bios: Matt is a fifth year senior in materials science. Ben is a sophomore majoring in electrical engineering. No writers were infected with the rhinovirus in the process of writing this article.

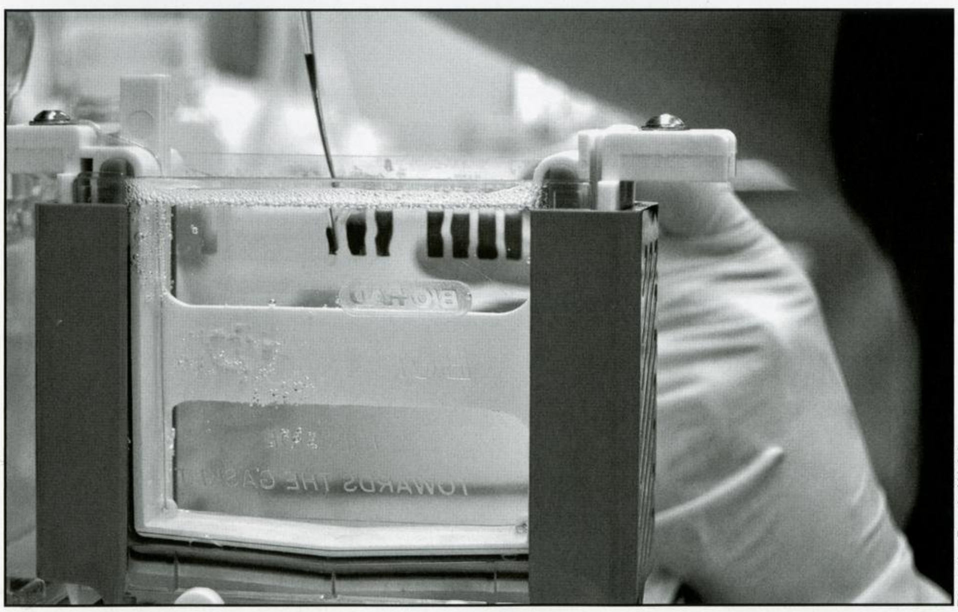


Photo by Dustin Walsh

Virus laden cell samples are placed in an electrophoresis unit to separate the genetic material for further analysis.

The moped gone green

By Anthony Lai

One of the most pressing matters facing our world today is that of energy—and, more specifically, oil. Used for agriculture, industry, commerce and transportation, oil has become our main source of fuel. Unfortunately, our demand for oil exceeds its supply, and we find ourselves searching for more efficient uses of this precious resource.

"I learned that with three and a half months, a small budget and excellent faculty guidance, a group of freshmen engineering students could rise to that a challenge and accomplish something truly worthwhile."

-Carl Schroedl

Photo by Evan Owens

Introduction to Engineering 160 Students worked together on interdisciplinary teams to increase the fuel efficiency of a Vespa scooter using electrolysis.

This energy issue was recently addressed by a section of Introduction to Engineering 160 (InterEGR 160), a first-year engineering requisite course that places emphasis on a hands-on, team-oriented experience while offering an overview of engineering and its diverse disciplines. Students in one section of this course decided to explore the benefits of reducing the environmental impacts of the moped, one of UW-Madison's most popular forms of transportation.

Professor Marc Anderson gave a group of students the challenge of improving the fuel efficiency of a yellow Vespa scooter, a vehicle that already achieves a fuel economy of approximately 90 miles per gallon.

Carl Schroedl, a freshman in chemical engineering from Minneapolis, was one of the students enrolled in Anderson's course. According to Schroedl, this project addressed pressing issues. "The world needs to change the ways it produces and consumes energy," Schroedl says.

In order to tackle these concerns with the moped design project, the class analyzed a variety of potential options. "The prospect of utilizing fuel cells and electric drive was mentioned. However, such a project would require a larger commitment of resources and time, and more extensive expertise than a group of freshmen engineering students could independently provide," Schroedl says.

That's when the students decided to try electrolysis.

"Electrolysis is the process of splitting water into its constituents, hydrogen and oxygen, via electricity," Schroedl says. In the end, this mechanism seemed to be the best option for the InterEGR 160 students. "The products of this reaction are fed into the scooter's fuel system, replacing some of the gasoline-air mixture that is

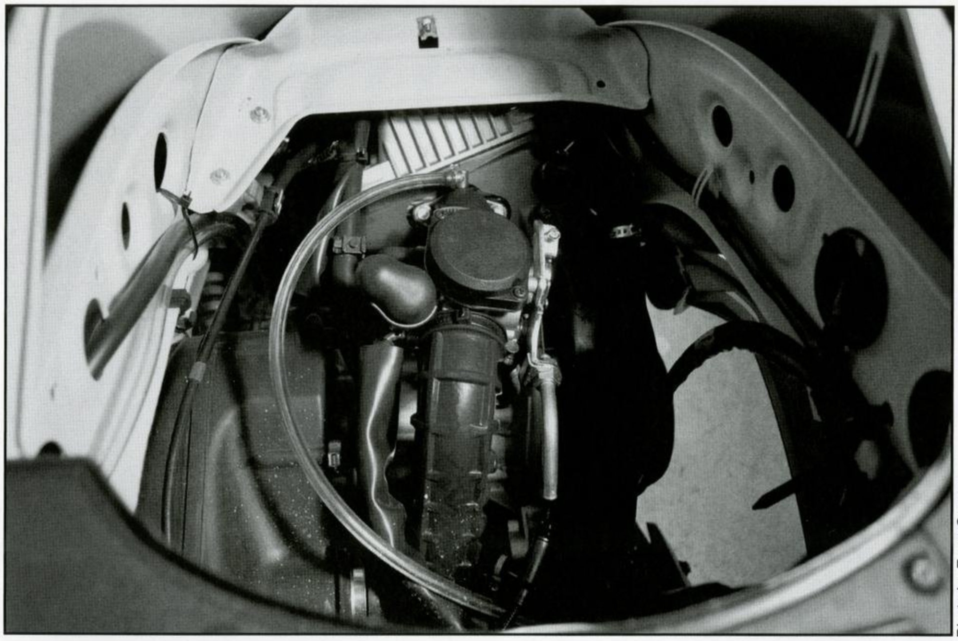


Photo by Evan Owens

The hybrid Vespa's internal combustion engine uses less gasoline than the original engine, creating a more eco-friendly model.

burned thus reducing the consumption of gasoline," Schroedl says.

The injection of hydrogen and oxygen enhances the combustion of gasoline in the engine, yielding a more efficient burning process and, ultimately, improving mileage on a per gallon basis. As a result, there are fewer emissions released from the vehicle, and fewer gasoline byproducts.

Anderson's class was partitioned into groups, each of which was responsible for a certain function of the electrolysis system. "In our lab, there were several subgroups that were assigned to various tasks. The two larger groups were the electrolyzer group and the delivery group," Schroedl says. "The electrolyzer group was responsible for the characterization of electrode materials and for the design, construction and testing of the electrolyzer. The delivery group was responsible for the reconfiguration of the moped's fuel system, the benchmarking of the scooter and for the evaluation of the effects of hydrogen on the scooter's performance." Other smaller groups helped with the presentation aspects of the project, including doing research, putting together the presentation and writing the project report.

Through collaboration, the groups final design employs a series of electrodes in conjunction with a set of carbon plates that are lined with a thin film. The plates are fitted into the electrolyzer casing and aligned near the engine. The moped's alternator provides energy to the electrodes that are used to separate the water into hydrogen and oxygen. Finally, the free hydrogen is channeled into the engine through stainless steel tubing.

After implementing the system, the students tested their work, and were pleasantly surprised by the results. "When tested on a dynamometer, the hydrogen-supplemented scooter consumed less gasoline than [the original] ... the fuel efficiency was increased by about 10 percent," Schroedl says.

The InterEGR 160 Vespa project offers just a glimpse of the possibilities offered by electrolysis. There is potential for this system to be implemented into other internal combustion engine (ICE)-based vehicles, as well as in applications that extend beyond this use.

"The ICE supplementation system could be scaled to larger vehicles. The gaseous byproducts of the electrolyzer can be utilized in fuel cells and in chemical industry," Schroedl says.

"One can only speculate how the energy issue will play out in the coming years, but the InterEGR 160 Vespa project offers some hope for the limitless possibilities that lie before us," Schroedl says.

"I learned that with three and a half months, a small budget and excellent faculty guidance, a group of freshmen engineering students could rise to the challenge and accomplish something truly worthwhile," Schroedl says. WE

Author bio: Anthony is a senior majoring in computer engineering and political science. This is his second article with the magazine.

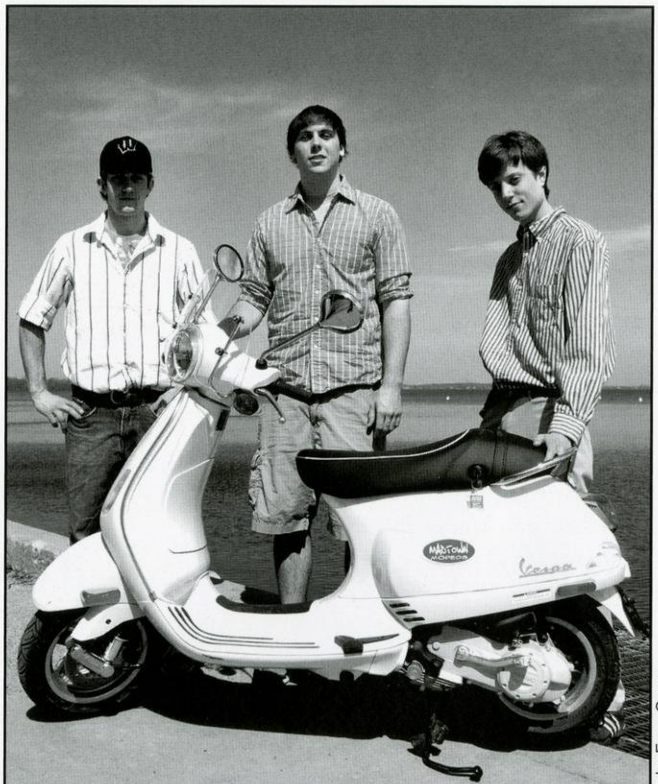


Photo by Evan Owens

Introduction to Engineering 160 students with their hydrogen Vespa scooter from left: Steve Burbach, Sean Kelly, and Carl Schroedl.

The BIG picture of tiny viruses

By Neal O'Meara

Aches, chills and a queasy stomach are just some of the symptoms we get from a bad case of the flu.

What is going on at the microscopic scale that causes our bodies to respond so violently?

This is the question that Professor John Yin of the UW-Madison chemical engineering department is trying to answer. He and his team of graduate students are using novel techniques to quantify some of the dynamic processes involved in viral infections.

Before delving into the finer points of Yin's research, let's take a brief look at what actually happens to our cells when our body is infected by a virus.

Photo by Rachel Dau-Schmidt

Professor Yin's team uses a method called flow cytometry. A fluorescent marker allows the team to identify cells that have been infected with the virus and quantify the rate of virus infection in the culture of cells.

A healthy tissue cell works tirelessly to take in nutrients and use its genetic material as a template to make proteins and enzymes, which will later be shipped out all over the body. Proteins and enzymes are the basis of the amazing harmony of chemical reactions that power life.

Every once in a while, however, a tiny virus particle floats by a cell and latches onto its membrane. This miniscule organism is one thousand times smaller than the cell, consisting of little more than a chromosome surrounded by a protective shell. Harmless as it seems, this little bugger has devious plans.

Quickly, the virus injects its chromosome into the cell. The virus DNA hijacks the cell's DNA-reading system and runs its chromosome through it. Soon, the cell is no longer able to go about its usual business of churning out useful proteins because its machinery is being used by the virus DNA to manufacture the virus's proteins and enzymes. Once created, these new virus proteins and enzymes form new shells around duplicate copies of the virus DNA, also made by the cell's own DNA copy machine. Soon, there are so many viruses inside the cell that it bursts open, releasing the spawn to wreak havoc on the surrounding cells.

"When you have a model that tells you how much virus is produced in how much time, you can then simulate effects of drugs."

-Professor John Yin

This amazing cellular story has been elucidated by decades of research by various biologists, geneticists and biochemists. But the physical and chemical pathways that govern virus proliferation remain shrouded in complexity. These pathways involve large and elaborate molecules such as DNA, RNA, proteins and enzymes. Thus, the movements and reactions of these species are complex and difficult to unravel.

The main goal of Yin's group is to gain a quantitative understanding of the timing of the overall processes. "By using the engineering tools, [chemical] kinetics and systems transport, we can begin to integrate the various components that come together and ultimately define the life cycle of the virus," Yin says. To do this, Yin's research team must measure virus reproduction rates under precise conditions.

The team uses a method called flow cytometry. A culture of cells is first infected with a small amount of viruses marked with a fluorescent dye. Before the viruses are allowed to grow, the cells are sent single file through a very small tube. A microscopic fluorescent camera will identify a cell with one fluorescent virus inside it, and a mechanism deflects the cell into a separate stream for collection. Rates of virus growth can then be precisely quantified.

Parameters such as nutrient levels, pressure and presence of certain proteins are varied in order to experimentally determine the virus's sensitivity to these factors. This method can help indicate which parts of the overall process require what amounts of certain resources. "Most biologists would agree, for example, that protein synthesis is very resource-intensive, but to be able to calculate it and say, 'it's using 80% of the resources' ... then we are able to think of the big picture," Yin says.

Photo by Rachel Dau-Schmidt

This microscope used in professor Yin's lab is encased to create a controlled environment by limiting the parameters that can affect the cell culture being studied.

"If I inhibit one of these hundreds or thousands of reactions, how will the virus grow?"

-Professor John Yin

Computational models with the ability to predict sensitivity to particular conditions is very useful to researchers hoping to simulate effects of antibodies and drugs. "When you have a model that tells you how much virus is produced in how much time, you can then simulate effects of drugs," Yin says. "If I inhibit one of these hundreds or thousands of reactions, how will the virus grow?"

Understanding how the virus hijacks a cell's DNA copy machine and protein assembly line has a broad range of applications. This includes not only creating better drugs to fight viruses but also the engineering of useful viruses for targeted drug delivery and gene therapy.

Yin's research also addresses the broader question of biology—that is, how do genes encode to create organisms? Every organism starts as a single cell with a particular genotype and then grows in its environment into an adult. The genotype and the environment determine an organism's phenotype, or its collection of attributes. Virus DNA might contain 10,000 base pairs, compared to the human genome which has three billion. "We study the simplest genomes ... that might [only] encode five or ten proteins, but nevertheless there is an aspect of genome interacting with environment," Yin says.

In prior research, Yin has shown principles of natural selection and rapid evolution through virology. By artificially introducing a protein into a sample, Yin observed proliferation of viruses that simply no longer had the gene to produce that protein. The mutated viruses with the shortened chromosome were able to reproduce faster and out-compete viruses with the original larger chromosome.

The molecules an organism can produce define all its vital life systems and its characteristics. "We think that by devising experiments and models to create the link between genotype and environment and phenotype [we will be able] to predict characteristics of an organism," Yin says. WE

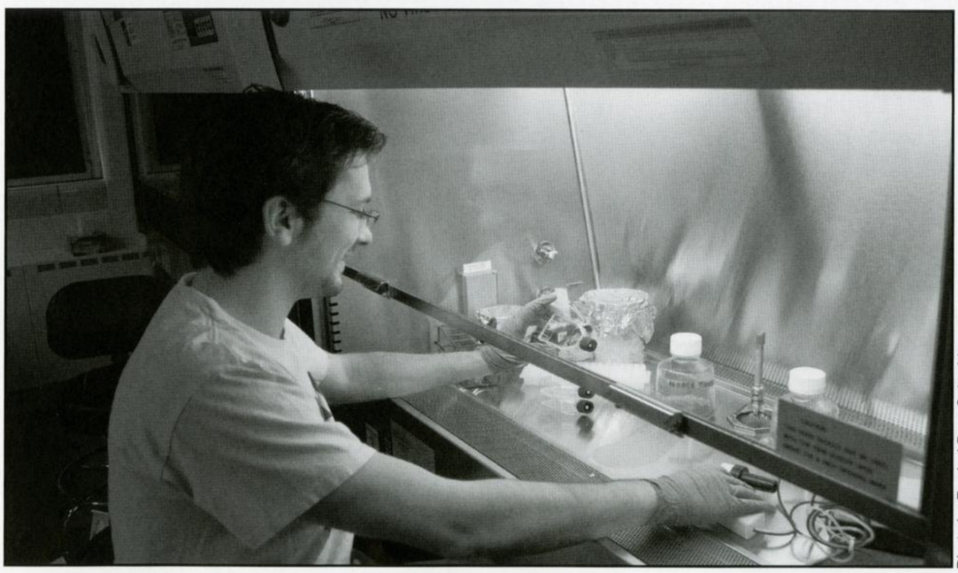


Photo by Rachel Dau-Schmidt

Collin Timm, a chemical and biological engineering graduate student in Professor Yin's lab, grows cell cultures with biotic parameters that can be varied to study virus's growth response.

Author bio: Neal is a junior studying chemical engineering. This is his first semester with the magazine.

Just one more

The finest in eclectic humor

Top Tips for Incoming Freshmen:

- Fashion advice: Pocket protectors are in this fall
- For lunch, try Union South... Oh wait, nevermind
- Caffeine pills - take two every four hours
- Don't walk alone - travel in groups of at least ten
- 7:45 AM and Friday classes are optional
- Get involved... just not with someone on your dorm floor
- Badger football has five quarters... four in Camp Randall and one on Breese
- J-walking is highly encouraged
- Mom's credit card has no limit
- Don't feel the need to put your phone on silent during lecture... that call is important!
- Library books are best used as your pet's chew toy
- When taking an online course, wait until the last week to watch all the lectures - You can watch them at 2X speed
- High school letter jackets are hip
- The best pick-up lines involve GPA and major
- Intramurals are best taken seriously - Yes, that t-shirt is VERY important

Disclaimer: The above tips should not be taken seriously.

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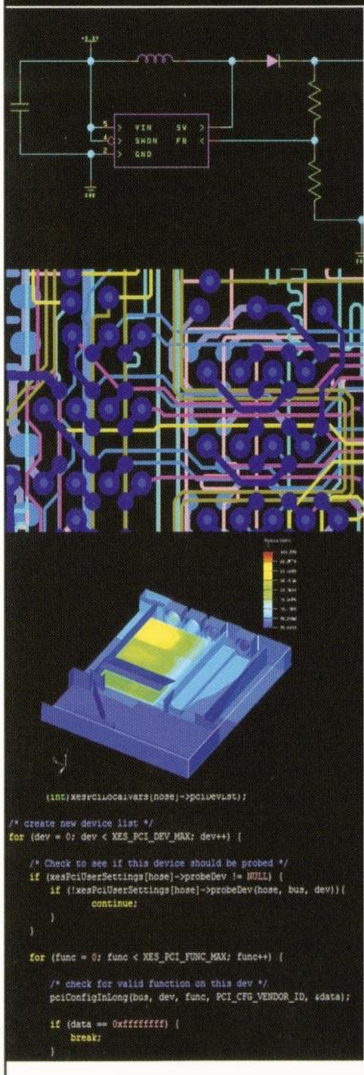

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