DEPARTMENT OF
Chemical and Biological Engineering
UNIVERSITY OF WISCONSIN–MADISON

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On These Foundations / Fall-Winter 2014

Major grant for bioproducts research

Researchers from UW-Madison, University of Minnesota, and Argonne National Laboratory will explore ways to produce renewable plastic precursors and other substances from biomass with a recently announced $3.3 million grant from the United States Department of Energy.

Part of a $13.4 million push by the Department of Energy to support the development of advanced biofuels and bioproducts, the grant plays to the strengths of a UW-Madison research community that already balances basic science with a focus on the processes needed to develop a diverse and economically viable suite of bio-derived chemicals.

"We're trying to make high-value commodity chemicals from biomass that can be used to make different kinds of plastics and plasticizers," says Professor George W. Huber. "So many people have been focusing on fuels, which are a pretty low-value product—$600 or $700 per ton—but we're going to be making products that are worth more than $5,000 per ton."

Joining George on the UW-Madison portion of the grant are Steenbock and Michael Boudart Professor Jim Dumesic; Professor Christos Maravelias; Research Professor Bill Banholzer; and Chemistry Associate Professor Ive Hermans. This team of researchers, who also are affiliated with the Wisconsin Energy Institute, brings to the project combined expertise in biomass conversion, process design, techo-economic modeling of biochemical and biofuels production, and catalysis.

Wisconsin Energy Institute

Researchers at Argonne National Laboratory will provide high-throughput tools for screening large amounts of catalysts used in the biomass-conversion process, and University of Minnesota researchers will contribute expertise in separating products from the reactants and solvents used in their production.

George says the three-year project will involve elaborating the basic scientific principles involved in converting biomass into useful

(Continued on page 3)

Water behavior breakthrough

A multi-institutional team has resolved a long-unanswered question about how two of the world's most common substances interact.

In a paper published June 30, 2014, in the journal *Nature Communications*, Paul A. Elfers Professor Manos Mavrikakis and his collaborators report fundamental discoveries about how water reacts with metal oxides. The paper, "Water clustering on nanostructured iron oxide films," opens doors for greater understanding and control of chemical reactions in fields ranging from catalysis to geochemistry and atmospheric chemistry.

"These metal oxide materials are everywhere, and water is everywhere," Manos says. "It would be nice to see how something so abundant as water interacts with materials that are accelerating chemical reactions."

These reactions play a huge role in the catalysis-driven creation of common chemical platforms such as methanol, which are produced in quantities of millions of tons annually. "Ninety percent of all catalytic processes use metal oxides as a support," Manos says. "Therefore, all of the reactions including water as an impurity or reactant or product would be affected by the insights developed."

Mavrikakis

Chemists understand how water interacts with many non-oxide metals, which are very homogeneous. Metal oxides are trickier: An occasional oxygen atom is missing, causing what Manos calls "oxygen defects." When water meets with one of those defects, it forms two adjacent hydroxyls—a stable compound comprising one oxygen atom and one hydrogen atom.

Manos, with Assistant Scientist Guowen Peng and PhD student Carrie Farberow, along with researchers at Aarhus University in Denmark and Lund University in Sweden, investigated how hydroxyls affect water molecules around them, compared with water molecules contacting a pristine metal oxide surface.

The Aarhus researchers generated data on the reactions using scanning tunneling microscopy (STM). The Wisconsin researchers then subjected the STM images to quantum mechanical analysis that decoded the resulting chemical structures, defining which atom is which. "If you don't have the component of the work that we provided, there is no way that you can tell from STM alone what the atomic-scale structure of the water is, when absorbed on various surfaces," Manos says.

The project yielded two dramatically different pictures of water-metal oxide reactions.

(Continued on back page)

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Increasingly, we are hearing calls for accountability and these calls express a fair question: What do we have to show for the investments that are being made in the institution by taxpayers, students, parents and donors?

As a reader of this newsletter, you know that the answer for this department is: "A lot!" On page 6 of this issue you can read about the research collaboration of Jim Rawlings, Christos Maravelias and their students with Johnson Controls to develop computational algorithms that will enable building managers to harness available data to run HVAC systems more efficiently. The work promises to provide a big boost to a Wisconsin company and major employer of UW-Madison graduates, but more importantly, it moves us all a step closer toward a sustainable and comfortable future.

Manos Mavrikakis and colleagues are collaborating to better understand the atomic-scale role of that ubiquitous substance, water, as it interacts with the metal oxides that are used in 90 percent of catalytic reactions *(see p. 1)*. Present almost universally either as a reactant, product or impurity, water, it turns out, plays outsized and varied roles in these reactions, depending on the presence or absence of defects in the structure of the metal oxide surface. Just what the ramifications of this research will be will depend on years of further study by a large community of researchers, but they are certain to be important to society.

On page 4, we present work by Regina Murphy and colleagues in the UW-Madison School of Pharmacy to develop a promising drug to prevent Alzheimer's disease. The work derives from a serendipitous discovery in an experimental population of mice—serendipitous in the sense that the specific phenomenon wasn't anticipated, but hardly serendipitous in the sense that the researchers had long focused on the problem and were well prepared to recognize the importance of the finding.

Of course, that is just a sampling of departmental research accomplishments, and that still leaves the educational accomplishments! Perhaps the best measure here is to look at the work of our alumni. This fall, our department honored the professional contributions of Henry Theisen (BS '75), a career employee of the Bemis Company, headquartered in Neenah, Wisconsin *(see p. 7)*, and also indirectly honored his late father, Henry N. Theisen (BS '50, MS '51). Under Henry's leadership, Bemis has grown and evolved to be a major industry in Wisconsin and worldwide, hiring a large number of UW CBE graduates and contributing to the state's economy. Also on page 7 you can read about the long and distinguished career of Don Baldovin (BS '57) with Standard Oil/Amoco. Don has been a particularly generous donor to the department and college. His contributions to scholarship and fellowship funds give him a vested interest in the education of our current students—extremely talented and promising students like BP America Scholarship recipient Sage Bladow, whose story you can read on page 5.

To ensure that the University of Wisconsin-Madison maintains its place as a top-tier university, we are preparing to launch our fourth—and largest—comprehensive fund-raising campaign. Private support is more important than ever to the future of our department, college and university. At a time when the degrees we grant have never been more valuable and the research we do has never been more important, traditional funding mechanisms have become less reliable.

The planning phase of the campaign has already begun with the chancellor, deans and campus leaders charting a new course for the university by identifying those areas of investment that have the most significant impact on the university's future.

Emerging campaign priorities include:

- Faculty excellence
- Student support
- Enhancing the educational experience
- Pushing the boundaries of knowledge

In addition to financial goals, the campaign provides an excellent platform for new and enhanced efforts to reach and engage more alumni and friends to join in support of UW-Madison's mission to help shape and define the university's future impact on the world. The anticipated public launch of the campaign is in 2015. And as a major kickoff to that campaign—and the largest-single contribution ever from individual donors—UW-Madison alumni John and Tashia Morgridge have given a $100 million matching gift for professorships, chairs and distinguished chairs. Their aim is to help UW-Madison continue to recruit and retain world-class faculty and to inspire support for this great university.

I hope that you, too, will consider participating in the campaign, as well as a year-end investment in our highly productive department. Thanks for all that you do.

Tom

CBE programs rank highly

The UW-Madison Department of Chemical and Biological Engineering undergraduate program has been ranked the fifth-best chemical engineering undergrad program in the United States in the most recent rankings issued by *U.S. News & World Report*. The 2015 rankings for graduate chemical engineering programs rated UW-Madison eighth overall.

The CBE undergraduate program's ranking is a highlight in an overall strong year for UW-Madison: The 2015 rankings place UW-Madison 13th among public institutions and 47th overall, and the College of Engineering ranked seventh among public doctoral-granting institutions and 14th overall.

Student inventors get boost to commercialize color 3D printing

Charles Haider and Cédric Kovacs-Johnson with their prototype of Spectrom, a device that incorporates seamless, on-demand color into 3D printing.

Taking something good and making it better is one proven route to entrepreneurial success. Henry Ford took the handmade automobile and built it faster and cheaper on an assembly line. Steve Jobs redesigned the personal computer to make it usable by "the rest of us." Both built substantial businesses based on the logic of improvement.

Applying a similar approach to the 3D printer, a group of UW-Madison 2014 graduates is commercializing a device that adds color to a printer that now dominates the market. Their business idea was one of two student projects to receive an Igniter grant from the university's Discovery to Product (D2P) office. Most recently, the Spectrom team won first place in the undergraduate category of the Collegiate Inventors Competition.

The 15 D2P grants announced in summer 2014, including a $200,000 grant for the printer project, support innovations from food and biomedical engineering to medicine, and are funded with a $2.4 million Wisconsin Economic Development Incentive Grant. John Biondi, director of D2P, says the grants are intended to support campus innovators with proven technologies that have the potential to advance quickly to market, but have yet to form companies.

3D printers have the uncanny ability to transform software code into a three-dimensional object. These printers lay down, or extrude, layers of plastic to build objects that cannot be made in any other way.

The color printer's originators, 2014 chemical engineering graduates Cédric Kovacs-Johnson and Chase Haider, invented a patent-pending technology to obtain a wide range of colors from a single extruder. "They knew 3D was cool," says Taylor Fahey, a computer science major who directs software development for the group, "but if you wanted to switch color, you needed multiple extruders, and the colors could not be blended."

Instead of making entire printers, the strategy is to sell an add-on for the most popular 3D printer; the beta version of the device is to be offered in a couple of months to an initial market of hobbyists.

"3D printing is pretty much a monochromatic industry right now, so you can only print in one color at a time," says Haider. "What people have done are workaround solutions that don't solve the true problem at hand."

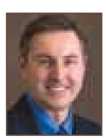
The core technology to color is there, and it works, says Kovacs-Johnson. "We'd like to show that color is not just a feature—it enables you to do so much more," he says. "Our next steps are about determining what people actually want to make in color, and how we can provide the tools for them to do so."

Bioproducts *(Continued from front page)*

chemicals that are otherwise petroleum-derived, as well as developing efficient processes that can be scaled up in order to make bio-based production more competitive with petroleum refining.

"This is about developing new process technology," George says. "We have some ideas about how to make these products, and really it's about moving to the technology-readiness level. It's about prototyping and demonstrating our ideas on a larger scale and getting this exciting technology a step closer to being commercially practical."

George points out that bioenergy researchers at UW-Madison have a history of breakthroughs both in basic science and in the



Banholzer

Dumesic

Huber

Maravelias

business side of bioproducts, from performing economically minded analyses to starting their own spinoff companies in the field.

"This shows the value of supporting basic research at universities and how basic research can translate to high-tech, high-paying jobs," George says. "It's important that Wisconsin doesn't lose its expertise in terms of developing novel technology. I really think the University of Wisconsin is the leading university internationally in biomass-conversion to fuels and chemicals."

Compound advances Alzheimer's prevention efforts

What began as an unplanned response in lab mice has led UW-Madison researchers to craft a trial compound that could guard brain cells against the destructive force of Alzheimer's disease. Smith-Bascom Professor Regina Murphy and Pharmacy Professor Jeffrey Johnson are leading a research effort that has focused on how a protein called transthyretin appears to reduce the toxicity of beta amyloid, another protein that many believe causes Alzheimer's.

Transthyretin serves a number of functions in the body, but the researchers didn't see it as a weapon against Alzheimer's until a group of mice engineered to produce high levels of beta amyloid ended up suddenly producing more transthyretin, which seemed to protect them against the onset of neural decay. Unfortunately, there's not much evidence of humans fending off Alzheimer's with an organic transthyretin surge. "If transthyretin is normally protective and we all make it, why does it stop working?" Regina asks.

But what the researchers do know about transthyretin is that it carries out other roles in the body, and that simply pumping in more of the protein could interfere with its other functions.

Since Regina's lab published its work with the Alzheimer's-resistant mice back in 2002, she has been working to engineer a compound that emulates transthyretin's ability to bind with beta amyloid and reduce the latter's toxicity—yet doesn't do anything else transthyretin does. Regina and Jeff are now patenting an initial version of the compound through the Wisconsin Alumni Research Foundation (WARF). The compound isn't quite as powerful as actual transthyretin at preventing toxicity, but, Regina says, "I think we have the basic idea and structure of what we want it to be."

As she looks ahead to creating a more effective version of the compound, Jeff is thinking about how to develop a therapy based on the engineered substance. That means asking how to most effectively deliver the compound to the brain cells it's intended to protect. Does it need to cross cell membranes? Should it be delivered across the blood-brain barrier? Through food or intravenously?

Just as important is the question of when to administer such a therapy. Alzheimer's is irreversible once it begins, so the treatment would need to be used preventatively, and the age of onset can be unpredictable. And while certain genetic factors make some people more likely to get the disease, even people without those genetic indicators can develop Alzheimer's. In other words, there is currently no way to predict Alzheimer's with certainty in every patient who may develop it.

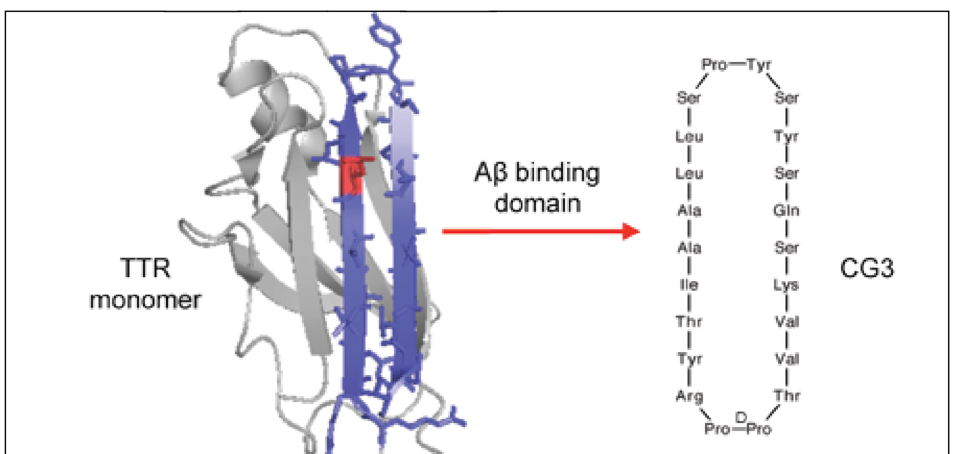
Regina suggests that makes for a bit of a catch-22 in testing a preventative measure—if you can't prove how likely a given person is to get the disease, how do you prove you are preventing it?

That said, Jeff is optimistic that the Alzheimer's research community is getting better at identifying people who are likely to get the disease.

"If people are positive for certain genetic mutations, they will get Alzheimer's disease," he says. "What the AD community has done in the past five years now is identify these high-risk patient populations that will progress into AD."

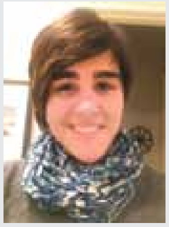
Combining a chemical engineer's understanding of protein and processes with a pharmacist's expertise in drug delivery, Regina and Jeff say there is still a great deal of experimentation ahead, but they are confident in the foundation the new compound provides.

"A lot of things can happen in a test tube that, when you get to real cells, they completely fall apart and don't translate," Jeff says. "We've been very fortunate in that the data that Regina's been generating have translated, actually, to the cells and cell culture systems that we use."



Transthyretin momomer (left) and a peptide that Regina Murphy is deriving from it to create a potential Alzheimer's-blocking compound.

SCHOLARSHIP PROFILE: *Sage Bladow*



Even while balancing research work and what is surely one of the more unusual double majors on campus, sophomore Sage Bladow shows a great deal of focus. Sage draws on her love of math and science, and her family's history of producing engineers of many stripes, in earning a bachelor's degree in chemical and biological engineering. She's also majoring in vocal performance, inspired by her love of musical theater.

Her work as a research assistant with Chemistry Professor Song Jin adds more diversity to the picture, giving Sage hands-on experience at the intersection of chemistry and materials science.

"Now I'm getting to the point where the grad student says, 'OK, run this reaction today,' and kind of leaves it up to me," Sage says. "I really like that I get to decide what happens and that I feel like I'm the one who's really in charge of the experiment. In your lab classes, you have such a well-planned-out lab that you know what the result is supposed to be, and I kind of like the mystery that comes into research."

In her role as a student leader in Tripp Hall, she takes part in the hall's sustainability initiatives and helps to plan the residence hall's busy schedule of events. She's involved in the UW-Madison student chapters of the Society of Women Engineers and American Institute of Chemical Engineers—not to mention honing her technical skills as a vocalist in UW-Madison student ensembles.

Sage recently received a $4,000 BP America Scholarship, which provides a bit of extra security in a career that's already a lot of work to balance. "This makes an unbelievable dent, and takes so much stress off of me and my family financially," she says.

While one could see Sage's undergraduate pursuits pulling her in any number of directions, she's already exploring specific ideas about her post-graduation path as a chemical engineer. In summer 2015, she will be interning at the pharmaceutical research and development company AbbVie. "Right now I'm really interested in learning more about the pharmaceutical industry, but I'm also interested in the food-science sector," Sage says. "I'm trying to explore as many different options as I can."

New award named for Bird, Stewart and Lightfoot

The Institution of Chemical Engineers (IChemE) has created a new award named in honor of Professor Emeritus Byron Bird, Hilldale Professor Emeritus Edwin Lightfoot, and the late McFarland-Bascom Professor Emeritus Warren Earl Stewart. Starting in either 2015 or 2016, the Bird, Stewart and Lightfoot Medal for Exceptional Research in Transport Phenomena will be awarded biennially to researchers who have made outstanding contributions in the field of transport phenomena. IChemE decided to name the award after Bird, Stewart and Lightfoot on the recommendation of a panel of experts assembled to pick recipients for the medal.

The three researchers' legacy in chemical engineering dates back to the 1950s, when they worked together to develop undergraduate courses and a textbook on transport phenomena. The textbook, *Transport Phenomena,* was first published in 1960. The book, in its second edition, remains in print today and has made a lasting impact on chemical engineering research and education. Bird, Stewart and Lightfoot individually and as a group contributed greatly to advancing the chemical engineering field in the post-World War II era, and to growing UW-Madison's widely recognized strength in the field.

Mavrikakis earns Wilhelm Award from AIChE

Paul A. Elfers Professor Manos Mavrikakis has been named the recipient of the 2014 R.H. Wilhelm Award in Chemical Reaction Engineering from the American Institute of Chemical Engineers. The award recognizes a researcher who has demonstrated overall excellence in the field of reaction engineering and catalysis, and is one of the highest honors a researcher can receive in that area. Sponsored by ExxonMobil Research and Engineering company, the award includes a $3,000 prize. Manos received the award at the AIChE annual meeting on November 17 in Atlanta.

Root shares in EPA green chemistry award

Professor Thatcher Root is part of a research team that has received a Presidential Green Chemistry Challenge Award from the U.S. Environmental Protection Agency in recognition of their work using oxygen from the air in chemical reactions. The project is headed up by UW-Madison Professor of Chemistry Shannon Stahl.

In the late 1990s, Shannon launched his investigation into so-called aerobic oxidations, which harness oxygen to synthesize chemicals in a way that minimizes the amount of waste created in the process. In 2007, Shannon's team began a two-year partnership with researchers at Eli Lilly and Company to test their methods in an industrial setting. Soon after, the group began working with Thatcher to develop tools for adapting chemistry and engineering methods to industrial pharmaceutical settings. The two labs later expanded their collaboration to include a consortium of pharmaceutical companies, including Eli Lilly, Merck & Co. and Pfizer.

Shannon's research has created a methodological foundation for pharmaceutical companies to incorporate aerobic oxidations into production processes—and he's also brought that innovation back to the classroom. In 2013 Shannon, former postdoctoral fellow Jessica Hoover and organic chemistry lab director Nicholas Hill created a laboratory module for undergraduate organic chemistry students. Each year, the module exposes more than a thousand students to catalysis by using aerobic oxidations. In the process, students learn techniques used by professional pharmaceutical chemists.

Controlling energy use and costs in commercial buildings

The field of systems control has seen more than a few advances since Warren Johnson founded Johnson Controls in 1885 to market his newly invented thermostat.

Today, as the Milwaukee-based controls company seeks to develop better HVAC control systems for its clients in large commercial buildings, it's collaborating with Paul A. Elfers Professor and W. Harmon Ray Professor Jim Rawlings, Professor Christos Maravelias, and their students.

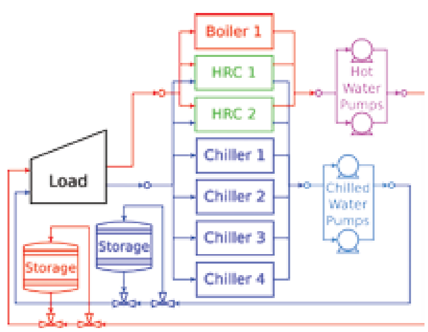
Rawlings

The collaboration will provide to the HVAC world the benefit of tools that chemical engineers have understood for decades. Jim, Christos, and their PhD students Michael Risbeck and Nisith Patel are developing algorithms that will enable building managers to harness a broad range of data to run their HVAC systems more efficiently. Michael has also spent time interning at Johnson Controls, working with staff in the company's main office in Milwaukee. The UW-Madison researchers use a process control method called model predictive control, which involves forecasting the future behavior of a system and taking those forecasts into account to make real-time adjustments.

"In the chemical industry, optimization has been a much more important part in the operation of chemical plants because that's your profitability, that's the goal of the business," Jim says. "So what the HVAC industry is able to do now is take advantage of all that development over the last 20 or 30 years in the chemical industry and bring it right over to buildings."

The reason this didn't happen earlier, Jim says, is that building managers haven't always had much data on which to draw in making decisions about heating and cooling. But in recent years, it's been easier to acquire good data for which chemical-engineering-bred control processes are ideally suited: energy pricing, weather forecasts, the hours when workers tend to enter and leave a building, the impacts of other potential heat sources in a building. Software that harnesses these data can in turn help an operator get the most out of a given building's system of boilers and chillers. And the impact goes far beyond a building owner's power bills.

"Twenty percent of total U.S. energy consumption is in commercial buildings," Jim says. "I had no idea it would be that high. And half of that is education and office space."



In his time working on implementing the algorithms as a Johnson Controls intern, Michael learned that the greatest challenge is creating something that suits the incredibly varied configurations of heating and cooling equipment in different commercial buildings. There's no standard way to put together an HVAC system for a large building, and even within one building, that system might comprise many disparate pieces of equipment and several different software systems controlling them.

To analyze and control such a system as a whole—or even to optimize heating and cooling across an entire campus of buildings—the control framework has to be agnostic to the size and makeup of the system. Clients don't hire Johnson Controls to tell them to buy more efficient heating and cooling equipment—but rather, to make the best of what they already have.

"You're going to be constrained by the choices people have made in the past," Michael says. "It's a difficult optimization because you have to make continuous decisions as well as discrete on-off decisions for these big pieces of equipment."

The researchers and Johnson Controls see the current project—which is being tested at sites including the Johnson Controls building in Milwaukee and buildings on the Stanford University campus—as a foundation for advancing HVAC control systems in general. "It's an infusion of high-tech into a low-tech space," says Dr. Robert Turney, a Johnson Controls engineer and technical lead on the project. "To date we don't really have optimization and control at the enterprise layer. They do control at the layer of the building, but not above that."

Turney says these efforts are driven by cost savings and by the new opportunities that arise as companies harness more data through the cloud. But he and other Johnson staff also find themselves speaking more often with newly appointed sustainability directors at client institutions, especially universities and airports, with lofty goals for improving energy efficiency.

Typically there's a customer-driven aspect where the director of sustainability is asking for better control," Turney says. "There's really a vacuum in the solution space now."

Jim points out that the opportunities and uses for model predictive control systems in commercial buildings are only expanding as engineers access better and better data. "You know how the building is running and you can look at how it ran a year ago, two years ago, 10 years ago, and you can detect things like equipment that is degrading, and you can find out what the use patterns are," he says. "You can find out that over time, energy use in this building is rising or dropping, and you can start to ask what-if questions."

As the optimization algorithms pass through different revisions and iterations, control researchers like Jim and his group gain an increasingly nuanced understanding of the real-world contexts in which their ideas are used. "From an academic standpoint, the examples you find in literature are all small, simplified systems," Michael says. "When I was at Johnson Controls and actually trying to implement a version of this for a multi-million-dollar plant, there's just a lot more difficulty on the back end."

While Johnson Controls provides that crucial dose of reality, Robert Turney credits UW-Madison researchers with helping the controls industry seize on new possibilities.

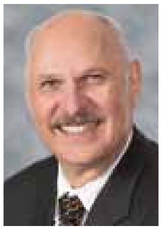
"I count on the university to be the pioneer in solving HVAC problems in new and innovative ways," Turney says.

Henry Theisen honored at ENGINEERS' DAY 2014

Henry Theisen received a Distinguished Achievement Award during the 2014 ENGINEERS' DAY celebration on October 24 on the UW-Madison campus.

A second-generation UW-Madison chemical engineer, Henry Theisen has drawn on his background to make an impact in the packaging industry, both as an engineer and as a leader.

After earning his BS in chemical engineering from UW-Madison in 1975, Henry joined the Bemis Company, headquartered in Neenah, Wisconsin. Bemis is a global supplier of packaging and pressure-sensitive materials, and creates packaging for consumer products ranging from food to pharmaceuticals. The company uses materials science to address a range of issues that come to bear on packaging, from keeping a product fresh to guarding food safety. Henry's work, in a variety of executive positions and management roles in marketing and research and development, has yielded an array of packaging advances that make the material used in the industry more effective, efficient and environmentally sound.



Theisen

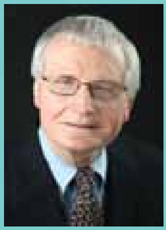
He became president of Bemis in 2007, CEO in 2008, and was named chairman of the board in 2013. In August 2014, the company appointed a new president and CEO, and Henry became executive chairman of the board. But he says the proudest moment in his career came in 1983, when he was awarded a U.S. patent for a unique flexible wrapping material he developed for the company. Intended for food products, the material is impervious to liquids and gases and efficiently provides grease resistance. "This development put Bemis in the leading position in the packaging of natural cheeses, which it maintains to this day," Henry notes.

Henry's UW-Madison ties begin with his late father, Henry Nicholas Theisen, who earned a bachelor's degree in chemical engineering in 1950 and a master's degree in chemical engineering in 1951. The elder Theisen worked for Standard Oil of California, Stauffer Chemical, and Sterling Drug, and ultimately became a division manager for ITT-Rayonier, a pulp and paper company.

Today, the younger Theisen employs about 110 UW-Madison alumni and remains engaged with UW-Madison through such efforts as the UW E-Business Consortium. And, as he's moved through a variety of leadership roles at Bemis, Henry has consistently experienced the value of his chemical engineering education, whether working as an engineer or as an executive.

"Engineering provided a thought process to analyze problems and develop solutions that I used in all aspects of my career, whether in R&D, marketing, finance or management," he says.

Henry lives in Neenah with his wife, Kim. In his free time he enjoys the Wisconsin outdoors.



Giving back with a global view

Don Baldovin has experienced firsthand the value of a Wisconsin chemical engineering degree. "The market for chemical engineers in 1957 was fantastic," Don says, referring to the year he earned his bachelor's degree from the UW. "I had 20 job offers all over the country."

The job he took was with Standard Oil (now Amoco), a company he stayed with for 41 years. Now retired, Don hasn't forgotten what it was like to be a high-school student with high grades but few financial resources."The only way I was able to get to the UW was because I received one of the Knapp Scholarships, which at that time in the 1950s was the highest-value scholarship in the state," he says.

That's a big part of what has motivated Don to support UW-Madison and the College of Engineering through several gifts, including undergraduate scholarships and graduate fellowships. He founded the Angelo and Rose Baldovin Scholarship Fund, named in honor of his parents, which is open to UW-Madison undergraduates in any discipline, as well as CBE-specific undergraduate fund and graduate fellowship in his own name. Both of the undergraduate scholarships target undergrads who show financial need and excellent academic performance in high school. He also has made a large gift to support the construction of the Engineering Centers Building.

Another big inspiration for giving back, Don says, was the experience he gained as he traveled around the world doing financial evaluations of projects for an international energy company. This included stints in the Middle East, Europe and South America. "I found it very enlightening to experience other cultures and see how other people do things," he says.

That's one reason why recipients of his CBE graduate fellowships are required to have an international component to their work. He's also been pleased to see the department look toward international experiences in general.

"I think most people in the United States have a very U.S.-centric view of everything that happens here, and of course we do have the summer lab in CBE that allows options to take that lab abroad," Don says.

Don has found the students who benefit from the scholarships and fellowship to be very appreciative and diligent. He has even worked personally with some of them to help them find internships. In a broader way, he hopes his scholarship will help CBE better fill the needs of American society.

"This country is in crying need of anyone in the STEM curriculum," he says. "And there are still people in this day and age who need financial assistance and do very well in high school."

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Water behavior

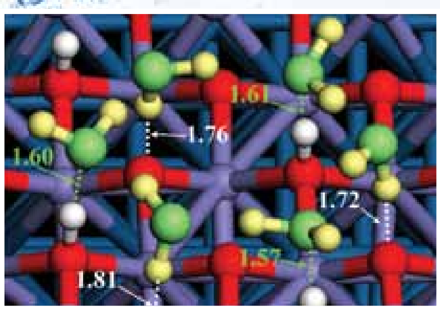
(Continued from front page)

"On a smooth surface, you form amorphous networks of water molecules, whereas on a hydroxylated surface, there are much more structured, well-ordered domains of water molecules," Mavrikakis says.

In the latter case, the researchers realized that hydroxyl behaves as a sort of anchor, setting the template for a tidy hexameric ring of water molecules attracted to the metal's surface.

Manos's next step is to examine how these differing structures react with other molecules, and to use the research to improve catalysis. Manos sees lots of possibilities outside his own field.

"Maybe others might be inspired and look at the geochemistry and/or atmospheric chemistry implications, such as how these water cluster structures on atmospheric dust nanoparticles could affect cloud formation, rain, and acid rain," Manos says.



Computer analyses show the atomic structures that form when water reacts with "oxygen defects" on metal oxide surfaces.

Other researchers might look at whether other molecules exhibit similar behavior when they come into contact with metal oxides, he adds.

"It opens the doors to using hydrogen bonds to make surfaces hydrophilic or attracted to water, and to templating these surfaces for the selective absorption of other molecules possessing fundamental similarities to water," Manos says. "Because catalysis is at the heart of engineering chemical reactions, this is also fundamental for atomic-scale chemical reaction engineering."

The research owes a great deal to state-of-the-art technology. "The size and nature of the calculations we had to do probably was not feasible until maybe four or five years ago, and the spatial and temporal resolution of scanning tunneling microscopy was not there," Manos says. "So it's advances in the methods that allow for this new information to be born."

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