FALL 2017

CHEMICAL AND BIOLOGICAL ENGINEERING

UNIVERSITY OF WISCONSIN-MADISON

ALUM STEPHEN SPIEGELBERG RECEIVES DISTINGUISHED ACHIEVEMENT AWARD

CHAIR'S MESSAGE

Manos Mavrikakis

Every fall generates a sense of expectation as we welcome new students to CBE. This semester, we admitted 26 new graduate students and 150 new undergraduates. As we start this academic year, we are excited to share that *U.S. News and World Report* released its rankings for 2018, with our undergraduate program ranked 5th overall and 3rd among all public institutions in the nation.

This fall, we were very saddened by the death of one of the pillars of CBE: Hilldale Professor Emeritus Edwin Lightfoot passed away on Oct. 2 at the age of 92. Ed will be remembered by his students as a great mentor and by the broader chemical engineering community as one of the founders of biological engineering. He will remain a great source of inspiration for current and future generations of CBE faculty. Incidentally, our recent Founders Day lecturer, Brian Kelley (BS '86), who was elected to the National Academy of Engineering last year, specifically acknowledged Ed Lightfoot and Charlie Hill as two of the most influential teachers in his life.

On a more positive note, this has been an exceptional year for CBE in terms of faculty recognition. AIChE honored three of our professors with national awards: the Founders Award was given to Bill Banholzer; the Allan P. Colburn Award to George Huber; and the William H. Walker Award to Jim Rawlings. We also received news that Brian Pfleger will be recognized with the ACS BIOT Young Investigator Award at the spring 2018 meeting of the American Chemical Society.

This year has also been outstanding in terms of CBE grants. Nick Abbott and the entire MRSEC (Materials Research Science and Engineering Center) team successfully renewed the center for another six years, with a total of $15.6 million from the National Science Foundation. MRSEC includes 30 affiliated faculty members from nine departments across campus. Similarly, CBE was selected as a major partner in a new NSF engineering research center for Cell Manufacturing Technologies, with Sean Palecek as its associate director for research. This multi-university center is funded with $20 million and includes several other researchers in the College of Engineering and the UW-Madison School of Medicine and Public Health.

Our undergraduate student Nathan Wang received a very prestigious astronaut scholarship. Among our graduate students, Dongting Zhao, co-advised by George Huber and Ive Hermans, won the 'best poster' award at the spring 2017 meeting of the Chicago Catalysis Club; and Duygu Gerceker, co-advised by Jim Dumesic and me, received the 'best poster' award at the fall 2017 symposium of the American Vacuum Society Prairie Chapter.

The most recent College of Engineering event was Engineers' Day on Oct. 20, when we celebrated the professional accomplishments of our alumni. In particular, we honored Stephen Spiegelberg (BS ChE '88, PhD ChE '93 MIT) with our Distinguished Achievement Award. Stephen is the president and co-founder of the Cambridge Polymer Group and a second-generation chemical engineer. His father Harry also received his degree from CBE (BS '59) and was recognized in 2007 with a Distinguished Alumni Award from the Wisconsin Alumni Association and in 1986 with a Distinguished Service Award from the College of Engineering.

We are always interested in hearing what you are up to. Please email che@che.wisc.edu to share your news.

ON, WISCONSIN!

Manos Mavrikakis
Vilas Distinguished Achievement Professor
and Paul A. Elfers Professor, and Chair
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Former and current CBE department chairs *(back row from left to right)*: Jim Rawlings, Manos Mavrikakis, Michael Graham, Nick Abbott. Bob Bird is shown in front. (Missing from photo: Thomas Kuech)

ALL WAYS FORWARD

Graduate students play an essential role in the Department of Chemical and Biological Engineering—both in our research and educational missions. One of the department's top fund-raising priorities is to raise a minimum of $20 million to provide first-year graduate support for 20 PhD students annually.

To ensure national competitiveness and continue to attract leading scholars to our graduate program, it is essential that we are able to offer named graduate fellowships. First-year graduate fellowships in the Department of Chemical and Biological Engineering will help us attract the best and brightest students by providing full support to each student for the first academic year. By eliminating the need to support new students on research grants, these privately funded fellowships will provide more educational breadth in the early stages of the student's career, producing a better, more rounded graduate. Such fellowships also will allow first-year graduate students to focus on their coursework and broadly explore research areas before settling into a particular specialization for their PhD studies.


Ann Leahy

Our success in recruiting the best and brightest graduate students strengthens our ability to attract outstanding new faculty to pioneer advances in critical research areas such as energy, new and advanced materials, systems and optimization, and biological engineering, while training the next generation of leaders in chemical and biological engineering. Further, these students contribute greatly to the education of our undergraduate students, both by serving as teaching assistants in undergraduate courses and by mentoring them in their first steps with exploring advanced research. Ultimately, these scholars will carry our Wisconsin tradition forward as the academic, scientific, entrepreneurial, and industrial leaders of tomorrow.

You can establish a named graduate fellowship through a minimum endowment of $1 million, or through a multi-year pledge of $45,000 per year. You may also establish a graduate fellowship through an estate gift.

Ann Leahy is the associate vice president and managing director of development for the College of Engineering. She collaborates closely with department chair Manos Mavrikakis and Dean Ian Robertson on raising financial resources to support the department's highest priority initiatives. Contact Ann at ann.leahy@supportuw.org or (608) 316-5874.

PAVING THE WAY FOR LESS EXPENSIVE BIOMASS-DERIVED LIQUID FUELS

The future demand for diesel and jet fuel is expected to increase by at least 30 percent by 2040. To meet this growing demand, energy companies are pursuing technologies for producing these heavy duty liquid fuels from biomass.

In a recently published paper in *Joule*, a team of scientists led by Harvey D. Spangler Professor George Huber reported a new earth-abundant catalyst for one such technology that can be up to 1,000 times less expensive than previously used precious metal catalysts. The simple catalyst consists of titanium dioxide and cobalt and generates fuel precursors with similar performance as those from platinum catalysts.

The project was funded by ExxonMobil. "In our continuing partnership with ExxonMobil, we will build upon these insights to continue to explore technologies for converting readily available biomass into heavy duty liquid fuels," Huber says.

The future demand for diesel and jet fuel is expected to increase by at least 30 percent by 2040.

Read more:
www.engr.wisc.edu/new-research-may-lower-cost-producing-heavy-duty-liquid-fuels-biomass/

From left to right: Stephen's parents, Harry (BSChE '59) and Bonnie (BA '60) Spiegelberg, his wife, Denise Saltojanes (BSChE '95, University of New Hampshire; MBA '07, Babson College), Stephen, Manos Mavrikakis.

MEET STEPHEN SPIEGELBERG: 2017 DISTINGUISHED ACHIEVEMENT AWARD RECIPIENT

We honored Stephen for his foundational developments in polymeric materials design, testing and processing methods that have greatly impacted the biomedical, chemical and food industries.

Harry and Stephen with their Summer Lab photos (https://summerlabphotos.che.wisc.edu). Harry received the Distinguished Achievement Award in 2007.

Stephen Spiegelberg

President and Co-Founder,
Cambridge Polymer Group
BSChE '88 (PhDChE '93, MIT)

Why did you choose UW-Madison and an engineering major?

Most of my family went to UW going all the way back to my grandfather. But the main motivation for choosing chemical engineering was that I needed to pick a science discipline for my undergrad degree before I could move on to a graduate degree in veterinary science. My dad, who was also a chemical engineer, suggested ChE so I'd have other career options if I didn't like veterinary science. And, since Wisconsin had one of the best undergrad ChE programs, it was a pretty easy decision.

Did you have a favorite engineering class?

I really liked the labs. I'm a hands-on person so I liked the classes with labs: polymer labs, chemistry labs, and engineering labs. It's probably the motivation for building a lab at my company. I still work in the lab about once a week if I can, often to the chagrin of my employees.

What was your favorite place to hang out as a student?

Dotty Dumpling's Dowry. At the time, it was over near the stadium and the engineering campus. My roommates and I didn't have much money, but whenever we could scrape something together and had cause to celebrate (usually the completion of a really tough exam) we'd go to Dotty's. They had great burgers there.

Of what professional accomplishment are you most proud?

I say it was starting my company, Cambridge Polymer Group, with two partners. We did it without knowing anything about running a business. I always wonder: Had I actually known more about running a business, would I have actually done it? But we learned a lot over the years—from the successes, but also from the failures. We're not a huge company, but I think we've got a really good reputation because we work really hard and we try to bring a really good product to our customers. And I'm very proud of that.

Who has played the greatest role in your achievements?

I've had an opportunity to interact with some really smart and experienced people throughout my career. I like to think I've learned a little bit from each one of them. I try to see what makes others successful and adapt some of those things. Some of the key mentors I've had would be my three business partners, Gareth McKinley, Gavin Braithwaite and Orhun Muratoglu. Also my father, a chemical engineer who gave me some very good advice throughout the years. And going back to my Wisconsin days, I had two close roommates, John Church and Rob Schumacher. Both of them have gone on to very successful careers, and the two of them really helped me through the last couple years of the chemical engineering program. And in recent years, my wife, Denise, who is also a chemical engineer.

What advice would you give to current engineering students?

Take advantage of the full breadth of scope that the engineering program offers. A lot of technology jobs these days really benefit from a broad range of experience. So, take advantage of the fact that you can take materials courses, transport courses and biology courses all within the framework of your major. Also take some non-engineering courses. Business classes are always beneficial. And take some classes for fun, as well; my favorites were the music classes.

IMPROVING HUMAN HEALTH THROUGH CELL THERAPIES

Photo: Stephanie Precourt

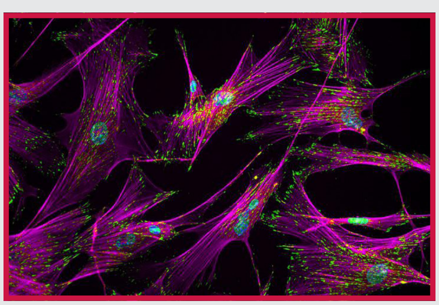
UW-Madison major partner in $20 million research center to expand use of therapies based on living cells.

The National Science Foundation (NSF) has awarded nearly $20 million to a consortium of universities to support a new engineering research center that will develop transformative tools and technologies for the consistent, scalable and low-cost production of high-quality living therapeutic cells. Such cells could be used in a broad range of life-saving medical therapies now emerging from research laboratories.

The new NSF Engineering Research Center for Cell Manufacturing Technologies (CMaT) will be led by the Georgia Institute of Technology. Working closely with industry and clinical partners, it could help revolutionize the treatment of cancer, heart disease, autoimmune diseases and other disorders.

UW-Madison was selected as a major partner for its pioneering efforts in stem cell engineering and a long history of collaboration between the College of Engineering and the School of Medicine and Public Health, says Sean Palecek, the Milton J. and A. Maude Shoemaker Professor who is the project's associate director for research. Additional partners include the University of Georgia and the University of Puerto Rico, Mayagüez campus.

The UW-Madison team includes William Murphy, the Harvey D. Spangler Professor in biomedical engineering; Randolph Ashton and Krishanu Saha, both assistant professors of biomedical engineering; Cardiology Professor Timothy Kamp; Medical History and Bioethics Professor Linda Hogle; and Mary Fitzpatrick, who directs the College of Engineering's diversity research and initiatives.



The UW-Madison researchers will focus on two disease applications: induced pluripotent stem cells for making heart muscle and engineered T cells to combat cancer.

The UW-Madison researchers will focus on two disease applications: induced pluripotent stem cells for making heart muscle and engineered T cells to combat cancer.

In July 2017, the oncological drugs advisory committee of the Food and Drug Administration endorsed the use of T cells, a type of immune cells in the blood, for treating certain types of blood cancer. "Engineering the patient's own T cells to recognize and kill tumor cells is one of the new frontiers in cancer research," says Palecek. "But more work is needed to prevent a massive immune response in the patients who receive these modified T cells and to learn how this type of therapy may eventually be applied to solid tumors as well."

To realize the promise of stem cell-derived heart muscle cells for survivors of a heart attack, who typically lose about 25 percent of their pump's muscle mass, researchers need to go from making millions of cells to billions while ensuring uniformly high quality. "Cell therapy is today where biotechnology was in the 1980s," Palecek says. "It is a field with a ton of promise that we know will be big. But since we don't yet have a cure for anything, we need to make plans for a manufacturing process while we don't exactly know yet the specific cell type we're going to manufacture."

To help with that tall order, CMaT will rely on the combined expertise of the Stem Cell and Regenerative Medicine Center, co-directed by Murphy and Kamp, and the resources of Waisman Biomanufacturing, a cell and gene product development facility at UW-Madison's Waisman Center. "We are one of just a handful of places in the world that has this kind of biomanufacturing capability right here on campus, allowing for a much faster translation of lab research findings to the clinic," Palecek says.

Palecek says building a community of people with different levels of training and career paths, but similar overall interests, is one of the biggest benefits of a large-scale project like CMaT. "The opportunity for collaboration across multiple disciplines and institutions is very exciting," he says. "In addition, our regular interactions with companies that are on the front line of making these cells mean that they may sponsor additional research efforts and offer internships to our students, ensuring that this kind of public-private partnership will truly be a win-win for everybody."

CHEMICAL ENGINEERS ASSESS PROSPECTS FOR NEXT-GENERATION BIOECONOMY

Christos Maravelias

Photo: Matt Wisniewski

As the old saying goes, all roads lead to Rome. And when it comes to converting biomass into liquid fuels, all roads start with deciding whether the raw plant material should be broken down by exposing it to water or to high temperatures.

It takes chemical engineering expertise to thoroughly compare and evaluate these two basic processes and the many details of implementing either of them in a biorefinery that may—years down the road—be cost-competitive with today's petroleum refinery.

In a June 2017 interview with *Advanced Science News*, Christos Maravelias, the Vilas Distinguished Achievement Professor and Paul A. Elfers Professor, and his former postdoctoral fellow Jeffrey Herron, who now works for The Dow Chemical Company, shared their thoughts on designing the kind of biorefinery that may eventually power a next-generation bioeconomy.

The interview was based on a study Maravelias, Herron and their colleagues at the University of Oklahoma recently published in the journal *Energy Technology*. The study focused on one particular chemical process called torrefaction, or thermal fractionation. In this process, pre-treated biomass is exposed to a series of increasing temperatures (300 to 850 degrees Celsius) to decompose it into a wide range of chemicals of smaller molecular weight.

The next stage upgrades these chemicals to the end products of interest using catalysts, which are compounds designed to speed up a reaction of interest while remaining relatively stable themselves. Since each torrefaction stage yields a different set of chemical species, referred to as a "fraction," several independent upgrading strategies are needed. The last stage in the process combusts the leftover biomass char to recover heat energy.

"The goal of our study was to provide previously lacking guidelines on how to best integrate the thermal decomposition stages with the subsequent upgrading of the biomass fractions," Maravelias says. "By identifying the main drivers of this multistage process, future research efforts can focus on improving those stages that are especially complex and expensive."

One of the key questions in any biomass conversion process is when and how to separate its three main components: cellulose, hemicellulose and lignin. Plant cell walls contain a complex mixture of these three chemicals that needs to be disentangled to generate biofuels and other chemicals of interest. But deciding whether or not to separate each biomass component in its own fraction is a tradeoff between cost and efficiency.

"On the one hand, you tend to have better chemical efficiency if you separate everything, but on the other hand, it adds complexity and increases the cost of scaling up the process," Maravelias explains. "That's because building one large reactor is generally cheaper than building two reactors that are half the size of the larger one."

A closer look at this tradeoff produced the study's most surprising result: The authors found that the upgrading steps may actually be more efficient when components from multiple fractions are combined.

The main implication for future work is that the thermal decomposition process should be optimized jointly with, rather than separately from, the catalytic upgrading steps. Doing so, Maravelias says, will require a more detailed techno-economic analysis of the conversion process that goes beyond the high-level roadmap the current study provided.

As part of that follow-up work, researchers will also need to evaluate the ability of thermal decomposition-based strategies to generate more than one end product: biofuel and commodity chemicals, such as precursors of plastics, that can be sold at a higher per-unit price.

This is necessary because of some fundamental differences between a biorefinery and a petroleum refinery: The latter facility is often located right next to an oil field, or is supplied by tankers loaded with large quantities of oil, while biomass may need to be collected from a larger surrounding area, which increases costs. Chemically processing fresh plant material also tends to be more complex.

"Producing commodity chemicals is one way to improve the economics of the process," Maravelias says. "And analyses like ours—whether at the big-picture or more detailed level—help pinpoint exactly where in the process those improvements are needed the most."

MAJOR NSF-SPONSORED MATERIALS RESEARCH COLLABORATION RECEIVES $15.6M GRANT

Chemical engineering PhD student Yingxin Guan conducts research with a plasma focused ion beam microscope (pictured in background). The microscope is used for high-speed nanomachining to create test samples for transmission electron microscopy and other experiments.

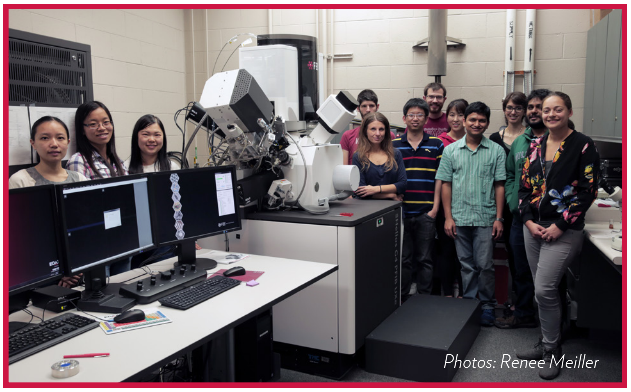
A flagship interdisciplinary research center has received $15.6 million from the National Science Foundation (NSF) to pursue groundbreaking research on materials. The grant will provide six more years of funding for the Materials Research Science and Engineering Center (MRSEC), which is housed within the College of Engineering, and includes 30 affiliated faculty members from nine UW-Madison departments.

MRSEC is one of 20 NSF-funded centers that conduct fundamental materials research, education and outreach at the nation's leading academic institutions.

The funding marks more than two decades of NSF support for the quest to investigate fundamental, large-scale and complex questions in materials science. These central questions are best explored by interdisciplinary teams, says MRSEC Director Nick Abbott, the John T. and Magdalen L. Sobota Professor and Hilldale Professor. "Only large teams with skills in synthesis and characterization of materials, materials processing, and theory and computation can go after difficult fundamental questions in materials-related areas," Abbott says. "Answering these questions will lead to breakthroughs that will transform our understanding of materials and lead to a new slate of technologies."

It's the high-risk, high-reward nature of the research that makes NSF's broad and flexible funding commitment so important, Abbott says. MRSEC-affiliated researchers enjoy the flexibility to exhaustively pursue fundamental problems—a painstaking process that may come to its natural conclusion without an elusive "eureka!" moment of discovery.

But this flexibility and long-term commitment has also produced pioneering breakthroughs, such as liquid crystals for portable sensors of toxic gases; semiconductor synthesis from new materials with broad implications for electronics; and carbon nanotubes as a potential material for next-generation solar energy harvesting.



Photos: Renee Meiller

Graduate students from the MRSEC interdisciplinary research groups are pictured in the Materials Science Center with the plasma focused ion beam microscope. This particular microscope was the first next-generation instrument of this type installed in the United States.

A major thrust of MRSEC research today concerns glass, which is much more than the brittle and transparent material we know from windowpanes, storage containers and smartphone screens. A new fundamental understanding of glassy materials may eventually extend the life of machine tools, enable advances in quantum computing, and produce even better cell phone displays.

Another MRSEC area centers on complex oxides: oxygen-containing materials that often have unusual crystal structures and exhibit surprising electronic, magnetic and optical properties when they are formed into thin films. "We work on new ways of creating 2D and 3D structures from complex oxides that will have remarkable properties," says Tom Kuech, the Milton J. and A. Maude Shoemaker and Beckwith-Bascom Professor.

Along with cutting-edge research, MRSEC funds internationally recognized educational and outreach programs that have helped thousands of high school teachers convey basic materials science concepts with research-inspired educational kits and activities. Continuing this legacy, the new funding will also support the development of educational digital games to engage an even greater number of people around the world.

Last but not least, MRSEC also provides scientific equipment for use by industry and academic researchers at and beyond UW-Madison, as well as professional development opportunities as part of the Advanced Materials Industrial Consortium.

FLIPPED CLASSROOM PUTS STUDENTS IN DRIVER'S SEAT

Learning is most effective when students engage with the material they are taught—but getting to that point is easier said than done. Some educators have made the case that a new style of teaching called "the flipped classroom" is one way to boost student engagement. Instead of spending class time on listening to a lecturing professor, students view online video lectures on their own time at home and work on problems in class, with support from the instructor.

Associate Professor Jennifer Reed is one of several instructors who have been exploring the pros and cons of traditional and flipped classrooms for several years—in Reed's case, since summer 2014.

"I have found that the flipped format gives students more time to digest the material and come up with questions to ask me," Reed says. "They typically watch the video lectures for my course, CBE 255: *Introduction to Chemical Process Modeling*, the day before class and have time to think about what they heard before we meet."

Much of the course—designed for sophomores majoring in CBE—involves learning how to program with the software MATLAB. For this kind of material, Reed appreciates more time to work with students on computer coding problems, either one-on-one or in a small group, when she teaches the flipped version of the course in the summer.

She has also noticed that a substantially higher proportion of those summer students take advantage of office hours—perhaps because they have already come to appreciate the value of interacting with the instructor, although the generally smaller class size may play a role as well.

Reed's colleague, Smith-Bascom Professor Regina Murphy, first explored the flipped format in summer 2013, a year before Reed did, for CBE 250: *Process Synthesis*. She is now combining the best of both worlds when she teaches her larger class during the school year: traditional lecturing, optional lecture watching at home, and required online quiz taking. She notes that those quizzes are "low-stakes" since the scores don't have a big impact on the final grade.

"I think the students do well with the optional video lectures because they can review material or get additional practice when they need it," Murphy says. "Students in a later class may even go back and review those earlier lectures if they feel a little shaky on that topic, which is a really nice use of the online format."

The biggest advantage of that format may be that it allows students to learn at their own pace: They get to decide when they have mastered the material. In contrast, a traditional lecture exposes all students to new concepts for the exact same amount of time, regardless of their ability to process the information.

Associate Professor Jennifer Reed

Another benefit of tackling hands-on computer programming problems during class is that students can compare their own solutions with others. Reed says this is extremely effective in illustrating how different versions of computer code all arrive at the same final answer, but with different efficiencies: Some programs are much shorter than others.

For Reed and Murphy, the flipped classroom is here to stay. "I think it's more interesting for students to be actively working on problems during class time, with the teacher serving as a coach, compared to passively listening to a lecture," Reed says. "And I would agree that this teaching style puts students in the driver's seat for their learning experience and increases their overall engagement."

Photos: Stephanie Precourt

OPHELIA VENTURELLI STUDIES THE SECOND GENOME IN OUR GUT

Photo: Stephanie Precourt

Genetically speaking, we are more bacterial than human: Our "second genome" of microbial genes outnumbers our human genome more than 100-fold, containing more than three million bacterial genes in the gut alone.

The importance of this gut microbiome for human health has now been established. Deviations from its balanced state have been associated with conditions ranging from neurological and immune disorders to cancer.

But understanding the complexity of the communities in which these microbes coexist is still a challenge—one that Ophelia Venturelli, an assistant professor of biochemistry, spends much of her time tackling.

Venturelli, who has affiliate appointments with CBE and the Department of Bacteriology, is researching a variety of ways to manipulate a dysfunctional microbiome in order to restore or improve human health. Her goal of purposefully editing an entire microbiome is a tall order, given that we have only recently discovered the technology for editing single molecules of human DNA.

To accomplish this formidable task, Venturelli draws upon her background and training in multiple disciplines: biochemistry, biophysics, control and dynamical systems theory, and bioengineering.

"My lab uses both computational and experimental methods to understand how interactions between the gut microbiota influence a variety of community-level tasks," Venturelli explains. "This collective behavior then impacts the host's energy balance, immune response and other important functions."

By exposing gut microbiota to environmental perturbations, Venturelli also hopes to learn more about their response to external influences, such as changes in our diet or medication, and to internal processes, such as aging. This helps her design targeted interventions that steer gut microbiota toward desired states.

Working at the intersection of computational modeling and biochemical experiments at a systems level, rather than a detailed molecular level, was a career goal that Venturelli began to pursue when she realized—in her sophomore year at Stanford University—that biology alone did not satisfy her desire to conduct quantitative research.

"During a summer internship in a research lab, I discovered my fascination with applying computational tools to dissect and predict biological systems, and then test and re-test those predictions in experiments," she explains.

A few years later—after earning her PhD in biochemistry and biophysics from the California Institute of Technology in 2013—she identified the microbiome as a rich area of application for this kind of interdisciplinary science.

During a three-year postdoctoral stint in Adam Arkin's lab at the University of California, Berkeley, she secured microbiome research funds from the U.S. Department of Defense. The results of that postdoctoral project became critical preliminary data for the grant applications she submitted after joining the UW-Madison faculty in July 2016.

And thanks, in part, to her first junior faculty year being free of teaching commitments, she was extremely successful in growing her lab's people power with these grant applications.

Since July 2016, she has received the Shaw Scientist Award from the Greater Milwaukee Foundation; a MIRA grant (maximizing investigators' research award) from the National Institutes of Health; a young investigator award from the U.S. Army Research Office; and one of 13 multi-investigator grants from UW-Madison's Microbiome Initiative.

While the gut microbiome is the common thread that connects all of these grants, each project represents a unique and distinct approach to its investigation or manipulation. Given the complexity of the system, Venturelli supervises a diverse group of graduate students from chemical engineering, microbiology and biophysics. She also has two postdocs who received their chemical engineering PhD at UW-Madison.

"The engineering students tend to be goal-oriented and bring strong quantitative skills, while the science students tend to have more lab experience and a deep interest in fundamental scientific questions," Venturelli says. "I really enjoy the diversity of perspectives they bring to their daily work because it enhances the lab culture and nurtures everybody's creativity."

With that creativity, the students often pursue a twofold goal: developing genetic tools to manipulate specific bacterial species in the gut microbiome (the engineering aspect) and deciphering microbial interactions that shape collective functions (the basic science question).

"Right now, we don't understand how individual cells process information from the environment and how that processing affects the overall population dynamics," Venturelli says. "Since I believe this relationship is crucial for microbiome stability and function, my long-term research goal is to connect these two scales."

IVE HERMANS BUILDS BRIDGES BETWEEN DISCIPLINES, PROFESSIONS AND CONTINENTS

Between growing up in Belgium, a trilingual country with multiple ethnic communities, receiving dual training in chemistry and chemical engineering, and holding faculty positions in both Europe and the United States, Ive Hermans is used to straddling two (or more) worlds. That helps him relate to the distinct mindsets of students who major in either of his own two disciplines.

"Most chemical engineering students are very good at performing an experiment, which may include writing programming code to extract information, or simulating chemical reactions," says Hermans, the John and Dorothy Vozza Professor of chemistry. "But chemistry students may be better at interpreting the experimental data on the molecular level."

Ive Hermans

Hermans enjoys bringing together these different skills and perspectives in a research team charged with doing something new and creative—which is why many of his papers include students and faculty members from two academic homes: CBE and the Department of Chemistry.

Hermans himself was a joint hire by these two departments. He moved to Madison in January 2014 and continues to divide research and teaching responsibilities evenly between his two departments.

He also tries to bridge the worlds of industry and academia, and is perhaps uniquely qualified to do so, having earned a postgraduate business degree "on the side" while working on his PhD. A prime example is a class for budding chemists and engineers called *Industrial Chemistry and Business Fundamentals*, which he co-teaches with Bill Banholzer, a former CTO of the Dow Chemical Company who is now a CBE research professor.

"Students may join a chemical company with a PhD in polymer engineering, but they don't know how to make a garbage bag," Hermans says. "The practical knowledge of how stuff is made is often lost in academia, but if you want to devise a new way of making something, you need to know the benchmark you have to exceed."

> **"In the U.S., people are more open-minded and enthusiastic about trying new things—even though that sometimes means pursuing an unrealistic goal."**

Much of Hermans's research—for which he received UW-Madison's Vilas Faculty Mid-Career Investigator Award in June 2017—involves designing more sustainable chemical reactions that generate less waste, consume less energy, or produce fewer greenhouse gas emissions, while still meeting consumer demands for the everyday products that rely on these reactions.

A perfect example is a February 2017 paper published in *Green Chemistry* that described how a basic building block for many kinds of plastics can be produced from cellulosic biomass with an easier process than from petroleum, today's starting material. In this case, the simpler way was also more sustainable.

Hermans used another trick from the green chemist's toolbox in a December 2016 paper published in *Science*: This time, his group discovered a new catalyst, a chemical designed to speed up a reaction of interest with minimal changes to its own structure.

For Hermans, both papers illustrate the benefits of being affiliated with more than one department: access to a greater number of students and the opportunity to collaborate with other world-class faculty who contribute a wide range of expertise to joint research projects.

During the more than three years Hermans has lived in the United States, he has noticed a fundamental difference in how his colleagues react to new ideas. "In Europe, people will often focus on why a new idea will not work," he says. "In the U.S., people are more open-minded and enthusiastic about trying new things—even though that sometimes means pursuing an unrealistic goal."

Being open-minded is one of the values Hermans hopes to instill in his students. Others include the ability to speak more than one scientific language—that of chemistry and chemical engineering—and to approach a complex problem that may initially seem unmanageable with confidence. He says most big problems can be broken down into smaller sub-problems, each of which can then be solved with the scientific method. If that is unsuccessful, it is just as important to recognize the right time to leave a project as it is to identify a new one.

But his most important advice for students, especially those who are just beginning their research careers, is this: Don't be afraid of failure.

"Students with a perfect GPA may not have learned yet how to recover from disappointment, so they are sometimes afraid to highlight whatever aspect of an experiment did not work as expected," he notes. "But chemical experiments are almost never perfect. The unexpected results you observe along the path of systematic inquiry are often the much more interesting observations that merit deeper investigation."

ASTRONAUT SCHOLARSHIP REWARDS EARLY ACADEMIC SUCCESS

Nathan Wang likes to stay busy. During his four high school years in Madison, he was in after school clubs virtually every day: volunteering in the community, practicing his public speaking skills, or writing and editing articles for the student newspaper. He also tutored younger students one-on-one in math and Spanish.

Nathan Wang receiving his award.

Summer didn't slow him down, either. He began his first research internship at UW-Madison the summer after his high school junior year, and before he had even completed his college freshman year in spring 2016, he was on his third lab rotation with Sean Palecek, the Milton J. and A. Maude Shoemaker Professor.

Between these early research experiences and the advanced and honors courses in chemistry, mathematics and physics he excelled in, the professors who nominated him for a prestigious astronaut scholarship may have been less surprised than Wang himself when he learned in summer 2017 that he would travel to Washington, D.C. in the fall to receive the award.

"I was traveling in Europe with my two older sisters and had just arrived in Vienna when I found out that I had been selected," Wang says. "It certainly made our trip even more memorable!"

Originally established more than 30 years ago by the six surviving astronauts of NASA's Mercury Seven mission, the Astronaut Scholarship Foundation awards merit-based scholarships to the best and brightest university students in science, technology, engineering and mathematics (STEM) programs.

Wang credits both family and high school teachers with nurturing his early interest in STEM fields. His dad earned a physics PhD from UW-Madison and met his mom, now an oncology nurse at St. Mary's Hospital, while both were in graduate school; his middle sister just started medical school and his oldest sister is a graduate student at Columbia University.

Wang says his freshman chemistry class was the first time he encountered challenging science topics at James Madison Memorial High School because his teacher went well beyond the standard curriculum, even for advanced students. Similarly, his math teachers insisted on manual calculations for solving definite integrals in calculus classes.

That extra labor paid off in Wang's computer programming classes at UW-Madison, where he also found himself (more than once) writing code at 4 a.m. in Engineering Hall. Combining his passion for dry lab programming with the study of chemical processes in living organisms that fascinates him in the wet lab, he double-majored in chemical engineering and biochemistry, with a certificate in computer sciences.

"I chose chemical engineering because I love its focus on chemistry applications in the real world," Wang says. Palecek's lab turned out to be a perfect fit for his emerging interest in studying biological systems with both computational and experimental methods.

He currently analyzes antimicrobial peptides, a group of compounds whose first member was discovered in the skin of an Australian frog and turned out to have anti-cancer activities. Understanding exactly what it is that gives this group of chemicals this and other appealing medical properties is the kind of challenge Wang enjoys tackling.

"I have never had an undergraduate propose a new, independent research idea before," Palecek wrote in his letter of recommendation for the astronaut scholarship. "Nathan has an excellent grasp of the important questions and techniques and is very creative and innovative, with a level of maturity I have never seen in a student at this stage."

Wang's long-term plans aren't set in stone yet, but a career that includes research is a strong possibility. "I like that chemical engineering gives me multiple career options in both industry and academia since I'm not sure yet what kind of job I want to pursue," he says. "But I really enjoy the kind of research I do in Professor Palecek's lab and definitely plan to go to graduate school next."

Photo: Stephanie Precourt

LEED SCHOLARS CHOOSE INSPIRING MENTORS


Eric Codner


Amy Seymour


Alex Sanchez


Thatcher Root

Two members of CBE were recently honored as exceptional mentors to undergraduates within the department.

Undergraduate lab manager Eric Codner and Professor Thatcher Root were both named “inspiring mentors.” Recent graduating seniors Amy Seymour and Alex Sanchez, respectively, nominated them.

Both Sanchez and Seymour were LEED (Leaders in Engineering Excellence and Diversity) Scholars throughout their undergraduate careers. Their experiences as students and LEED Scholars made the two keenly aware of the personal qualities that can help produce a positive learning environment for all students, and they recognized those qualities in Codner and Root.

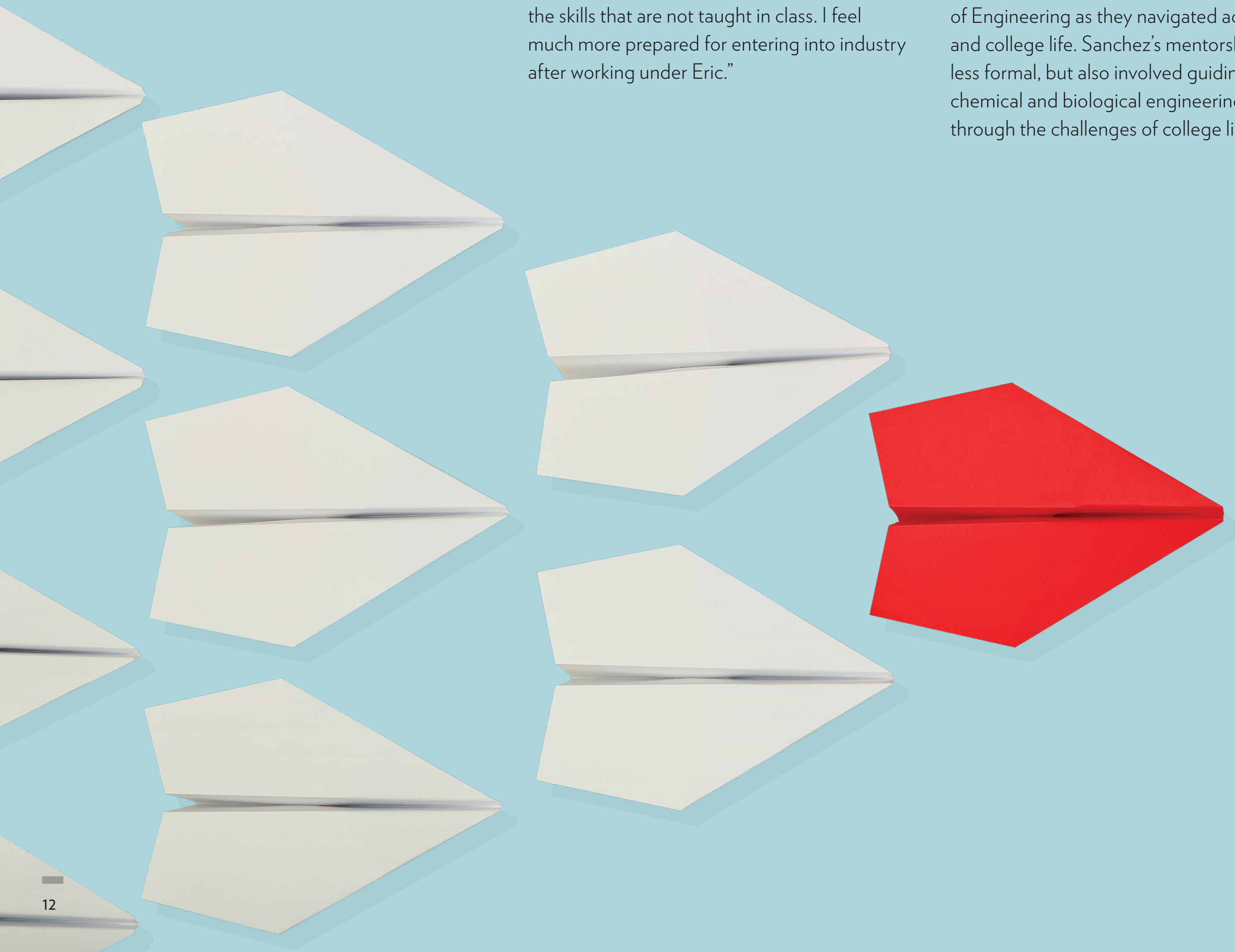
Sanchez and Seymour both noted the preparation they received from Codner and Root for the real world awaiting beyond their degree.

“I took classes with Professor Root and found them very engaging because they discussed real-world issues,” Sanchez says. “He got me to think about how I can use engineering in everyday life.”

Seymour’s experiences working in the lab with Codner offered her a similar perspective.

“I worked closely under Eric Codner, and that was probably the best decision I made while in college,” Seymour says. “I learned so much about practical engineering and learned the skills that are not taught in class. I feel much more prepared for entering into industry after working under Eric.”

As LEED Scholars, Sanchez and Seymour are no strangers to providing mentorship themselves, which helped inform their selections of Codner and Root. Seymour was a student assistant for the college’s introduction to engineering course for five semesters, where she assisted freshmen in the College of Engineering as they navigated academics and college life. Sanchez’s mentorship was less formal, but also involved guiding younger chemical and biological engineering students through the challenges of college life.



EVENT KINDLES HISPANIC HIGH SCHOOL STUDENTS' INTEREST IN ENGINEERING

Students participate in a lab tour led by Ryan Clark, a recent PhD graduate whose advisors were Brian Pfleger and Thatcher Root.

The population of Latinos in the United States is on the rise—yet of all the people who work in science, technology, engineering and math (STEM) careers, less than 10 percent are Hispanic.

The student chapter of the Society for Hispanic Professional Engineers (SHPE-UW) hopes to change that.

In April 2017, SHPE-UW spearheaded an annual event called Latinos Exploring Engineering Professions (LEEP) that brought students from Madison- and Milwaukee-area high schools to the College of Engineering to learn more about careers in engineering.

"The goal is to encourage students who typically wouldn't see themselves pursuing engineering and show them the possibilities," say Jose Renteria, SHPE-UW's outreach coordinator.

Students from Carmen High School of Science and Technology, Alexander Hamilton High School, Riverside University High School, Madison East High School and Madison West High School attended the event. And, although all students were welcome, most of the students who attended the event were Hispanic, including second-generation United States citizens and first-generation college students.

Students of West Madison High School brainstorm ideas for constructing a short bridge—an activity meant to demonstrate the collaborative and challenging tasks of engineering.

During the full-day event, attendees interacted with engineering students and faculty, participated in a hands-on bridge building workshop, and toured various engineering laboratories, including the Abbott lab, Huber lab, Pfleger lab, the Traffic Operations and Safety Lab and the Simulation Based Engineering Lab.

While Latinos Exploring Engineering Professions aimed to excite Hispanic high school students about engineering, it also attempted to show them that success in STEM is possible. In his keynote speech at the event, Victor Zavala, the Richard H. Soit assistant professor, tried to dispel misconceptions that commonly deter underrepresented students from pursuing careers in engineering.

One of those is that math is hard and scary. "The moment you tell prospective students that engineering is math-based, they get afraid," says Zavala.

To diffuse math phobias, Zavala tried to show students how they already solve complicated mathematical problems every day without realizing it.

For example, when we schedule things, our brain naturally intuits the goals, constraints and logic that underlie our schedules. "When you arrange meetings and commitments, like puzzle pieces, you are implementing a scheduling algorithm—it's complicated math," says Zavala.

Such mathematical thinking is natural, and Zavala hopes to encourage more underrepresented students to pursue an

> **"The goal is to encourage students who typically wouldn't see themselves pursuing engineering and show them the possibilities."**

engineering education by helping them to embrace math and by highlighting the breadth of the discipline. He says students often only think of bridges or vehicles without realizing that polymers, solar energy, logistics and machine learning are all part of engineering as well.

In his keynote speech, Zavala also highlighted how engineers from different fields interact to solve global issues such as energy and agricultural sustainability, and how students can get involved to make a difference. As the day progressed, students became more engaged and asked many questions.

"I think we definitely kindled curiosity in students and also inspired those who already had some desire to enter the STEM field," says Renteria.

BUILDING CBE'S FUTURE WITH A CHARITABLE TRUST

Manos Mavrikakis and Alum Kurt Wulff.

Kurt Wulff (BS '63) has regularly contributed appreciated securities for the past 15 years to a trust for the future benefit of CBE.

The CBE share of the trust principal has surpassed $1 million—and continues to grow with positive economic conditions. Wulff and his wife, Louise, are lifetime income beneficiaries, and the principal will be distributed after they both pass away. Their planned gift is an unrestricted gift—meaning that the department can apply it to current needs, whether it be for undergraduate scholarships, graduate research, faculty recruiting or another critical designation.

Building a legacy for future generations was far from Wulff's mind as a student under the guidance of great CBE professors such as Ragatz, Lightfoot, Crosby and DiBenedetto, among others. Favorable recommendations from them, combined with his degree from a top chemical engineering program, helped Wulff land a job as a design engineer with Chevron in San Francisco. He met and married Louise soon after his arrival in California. Within a few years, his perceptive young wife recommended that Kurt apply to Harvard Business School for an MBA.

Combining chemical engineering, oil industry experience and his business education, Wulff then worked with a Cambridge, Massachusetts, firm in energy consulting for four years. In 1971, he joined Donaldson, Lufkin & Jenrette (DLJ) on Wall Street as an oil and gas investment analyst. "The 1970s was a great decade to be an oil analyst, as most recommendations made money with the price of oil increasing more than tenfold," he says.

The 1980s were a challenge as oil price and stock prices declined. Drawing on an unconventional approach for the times, Wulff doggedly pursued the idea that most of the integrated oil companies would have a much higher stock price if production operations were separated from downstream refining and chemicals. Those companies that resisted "restructuring," as he called it, became takeover targets.

However, Wulff advised activists Boone Pickens, Carl Icahn, Gordon Getty and Richard Rainwater, who then drove the transformation of the oil industry toward fewer integrated companies and stronger independents. Over the next two decades, the new entrepreneurial independent producers also developed the fracking technology that transformed the United States from an importer of high-price oil and natural gas to an exporter of low-price oil and gas.

Wulff then restructured himself to become an independent analyst with McDep Associates, a company he created in 1987 and named after the analytical ratio for valuing oil and gas stocks. Clients paid McDep in "soft dollars" by directing securities commissions to a subsidiary of DLJ newly formed to facilitate compensation for independent research.

The 2000s presented a second-in-a-lifetime oil opportunity coincident with new demand for independent research. Rising oil prices sparked interest among investors who could now find McDep on the internet. At the same time, McDep was uniquely qualified to provide independent research to Wall Street brokerage houses who were required to buy outside research in settlement of conflict of interest issues.

Now the 2010s, like the 1980s, are a decade of lower oil prices. Yet, U.S. oil and gas producers have more positive volume growth prospects today than in the past. As a result, Wulff continues to be active, combining the technical understanding he learned as a chemical engineer with business experience to help investors make money. "A further goal is to share financial rewards with succeeding generations," he says, of his commitment to giving back to the department that is the foundation for his career success.

> **Wulff helped restructure America's larger oil conglomerates into today's more efficient production and exploration companies.**

ENGINEERING EDUCATION A JOHNSON FAMILY TRADITION


Ken and Karl Johnson

The Johnson family has many traditions—among them: annual tailgates, ice fishing, caroling expeditions—and engineering education at UW-Madison.

The latter tradition began with Urban Johnson. Urban graduated from high school in Monroe, Wisconsin, in 1942 and enrolled at UW-Madison in fall 1943. After one semester, he enlisted in the Merchant Marines and was assigned to active duty in the European and Pacific Theaters of World War II, where he specialized in steam and diesel engine mechanics. After the war, Urban returned to UW-Madison and completed his degree in mechanical engineering in 1950.

Next came Urban's sons Ken and Karl Johnson, who both earned degrees in chemical engineering—Ken in 1974 and Karl in 1981. Upon graduating, both Ken and Karl took positions at Universal Oil Products.

"UW-Madison gave me a broad background that facilitated my future success," says Karl, who went on to enjoy a long career at Universal Oil Products. He started as a field service engineer and gradually took on various company roles ranging from product development to project management. While at Universal Oil Products, Karl earned a master's certificate in project management from UW-Madison, which contributed to his success as a project manager.

Ken's professional trajectory was more winding. In the 1990s, after a stint at Universal Oil Products, Ken returned to Madison to work for the Wisconsin Alumni Research Foundation (WARF), where he encouraged the creation of UW-Madison startups. At WARF, Ken networked, learned about technology transfer, and developed skills that eventually translated to a career in Wisconsin venture capital. "The association with businesses and other alumni was a huge asset," says Ken.


Jenica McHugh

All the while, Ken's enthusiasm for UW-Madison was wearing off on his daughter Jenica, who eventually followed in the footsteps of her UW alumni family members. "I was very excited to continue in the family tradition," says Jenica.

It wasn't so much the pressure to do so; rather, she was drawn to the energy of innovation and opportunity that UW-Madison offers.

Jenica graduated in 2005 with bachelor's degrees in chemical engineering and computer science. Now, she works in business strategy management at Accenture, a professional services company. She applies the strong work ethic instilled through her UW-Madison engineering education to her work at Accenture.

"I always look for Madison grads when I'm staffing projects because I know they'll have the right attitude," says Jenica.

It's this attitude that connects the Johnsons to UW-Madison and will continue to do so.

UW-Madison provides educational rigor, top-tier sports and an energetic atmosphere unlike other universities, they say. And their shared engineering education has taught them how to think and work together to solve problems. "When we need to organize on an issue, like how we are going to feed 40 people at our Christmas family dinner, we all have common ground on how to approach the problem," says Jenica.

Ken is now working on recruiting his granddaughter, Jenica's 14-year-old step-daughter, to the UW-Madison engineering program. He has already toured the campus with her. In addition, he's introduced her to the high energy of a football game day. "I've got a game plan going," says Ken. "It's a full-court press."

IN VARIED CAREER PATH, ALUMNA THERESA GOOD MAKES HER MARK ON SCIENCE AND SCIENCE POLICY

Theresa Good (PhD '96) has lived in many places and explored a few career paths, but some things have never changed: a passion for science, a deep appreciation of mentoring, and the love of sailing she first discovered on Lake Mendota, as a graduate student at UW-Madison.

Born as the fourth of six children to parents who started their family at the tender age of 17 in a suburb of Rochester, New York, Good says she never really knew there was anything but science as a career choice. Her father was a chemist; her oldest brother followed in his footsteps; two of her other brothers are engineers; and her sister teaches computer science. Her mother was a role model for persistence by completing her bachelor's degree in finance at the age of 50.

Exactly what kind of science career Good herself wanted to pursue was a bit more challenging to figure out, though. At Bucknell University in Lewisburg, Pennsylvania, she thought a bachelor's degree in chemical engineering was all she would need for the kind of job she had in mind. Encouraged by her professors to consider graduate school, however, she applied for the chemical engineering PhD program at Cornell University—and was accepted as the only woman that year.

But the lack of a female role model likely contributed to her questioning the pursuit of a PhD degree while at Cornell. In the end, she decided to leave earlier than planned—though not without a master's degree in hand—to join the Peace Corps. For the next two years, she taught biology and chemistry (in French) in a remote village of the Democratic Republic of the Congo.

Upon her return to the United States, she worked for a pharmaceutical company before returning to academia as a biomedical lab scientist at the University of Illinois at Chicago. "That's when I realized that I wanted to work on my own research, rather than somebody else's," Good says. "So I was pretty sure I would go back to graduate school and pick up where I had left off."

But before she put that plan into action, there was one more opportunity she could not pass up: going abroad for another year to Cairo, Egypt, to teach biology and math (in English this time) at an international school attended primarily by diplomats' children. From Cairo, she applied for the chemical engineering PhD program at UW-Madison to study the basic mechanisms of neurotoxicity in Alzheimer's disease in Regina Murphy's lab.

"I was very lucky that Regina had room for me in her lab, and I felt that I had the best research project that anyone could possibly have," says Good. "I loved Madison and spent a wonderful four years of my life there."

Those four years included sailing with the Wisconsin Hoofers Sailing Club, many runs through the UW Arboretum to train for marathons, regular bike rides between home and campus, and frequent visits to the Farmer's Market on the Capitol Square.

"I worked hard and played hard," Good recalls. "I was an early riser, so I got my experiments started in the morning, went sailing while the reactions were coming to equilibrium, and then finished up at the lab late in the day."

Good was especially inspired by two of her CBE professors: Charlie Hill who taught kinetics (her favorite class of all), and Juan de Pablo for whom she was a teaching assistant.

"Watching how Professor de Pablo convinced the students that they knew nothing at the beginning of the semester and then laid out everything they had accomplished by the end of it was pretty amazing," she says. "Seeing this circle of knowledge was empowering for them, and they adored him for it."

Upon graduation, Good began her faculty career at Texas A&M University and then moved to the University of Maryland, Baltimore County. In 2010, her career path took another unexpected turn when she was recruited by the National Science Foundation to become a program director.

After exploring science administration for two years in a temporary role, she accepted a permanent position with NSF's Division of Molecular and Cellular Biosciences in 2013 and was soon asked to serve as its deputy director, overseeing a research budget of $130 million a year—an appointment she continues to hold today.

"I decided that I could have a bigger impact on the direction of science at NSF than I could running my own lab at the university," Good says.

She credits several mentors with her professional success: Michael Shuler at Cornell University, who was very supportive when she felt unsure about pursuing a PhD degree the first time around; Regina Murphy, the best PhD advisor she could have asked for; and Parag Chitnis at NSF, who guided her on science policy and helped shape her vision for the division she now directs.

Having been on both the receiving and giving end of mentoring, Good is especially proud of a mentoring award she received from the Graduate Student Association at the University of Maryland, Baltimore County, in 2007. She is also a fellow of the American Institute for Medical and Biological Engineering and received the Distinguished Service Award in Chemical Engineering from the Food, Pharmaceutical and Bioengineering Division of the American Institute of Chemical Engineers in 2015.

Today, Good continues to sail, bike and run (though no longer marathons) near her home in Pasadena, Maryland, and still has a passion for science. Reflecting upon her own career, she shares some advice with current engineering students: "Be curious, learn as many different things as you can before you finish your degree, and collaborate with people who are smarter than you."

FROM AN UNLIKELY START TO A GLOBE-SPANNING CAREER AS A CHEMICAL ENGINEER

Madeleine Wilson

Unlike thousands of high school seniors today, Madeleine Wilson (BS '82) did not have to obsess over college application essays to attend the top-ranked University of Wisconsin-Madison.

As a matter of fact, she didn't even have to obtain a high school diploma—thanks to slow mail, hard work and some measure of good luck.

Back in the 1970s, as a high school junior in San German, Puerto Rico, Wilson (née Molini) stumbled upon an advertisement for the minority engineering summer program at UW-Madison and decided to apply on a whim, thinking she would only take one chemistry class a day and otherwise enjoy her summer by the Madison lakes. Little did she know she would end up in class from 8 a.m. to 5 p.m. every day for eight weeks straight, and—halfway through the program—be offered early admission that fall, as one of only a handful of high school juniors.

She may have been better prepared if the paperwork about her summer program had been sent from UW-Madison to Puerto Rico via airmail, rather than ground/ocean mail, giving her a chance to review some of its details—including the possibility of early admission—before she left home.

But 40 years after that eventful summer of 1977, Wilson says she would happily do it all over again since her chemical engineering degree resulted in a successful 35-year (and counting) career at Abbott, a global manufacturer of pharmaceuticals, medical devices, diagnostics and nutrition products.

"With over 94,000 employees in more than 150 countries worldwide, the company offers such a diversity of positions that there has never been any reason to leave," Wilson says.

Her time in Madison four decades ago spanned the whole range of today's student experience: from favorite memories (orange custard chocolate chip ice cream from Babcock Dairy and Badger football games) and favorite class (thermodynamics by Professor Charlie Hill) to getting used to winter ("pretty tough for someone coming from the Caribbean") and suffering from bouts of anxiety.

That anxiety was due to feeling a great deal of pressure to succeed, given her financial dependence on a scholarship and the fact that she started college at age 17 without a high school diploma in hand. "But every time I thought about quitting chemical engineering and going into something else, I couldn't think of any other job I wanted to do," Wilson says. "So I just decided to buckle down and finish it and was grateful for the many times my parents told me not to give up because I had a bad day or two."

At Abbott, her current position as the director of global contract manufacturing for pharmaceuticals involves a great deal of travel around the world, close relationships with the company's legal team, and a detailed knowledge of the differences between the U.S. Food and Drug Administration and its counterparts in other countries.

"Chemical experiments and process/project engineering disappeared from my job description long ago, but I use my knowledge of the basic foundations of chemistry and chemical engineering every day," Wilson says.

And there is another reason that Madison is never far from her mind: football games.

With over 94,000 employees in more than 150 countries worldwide, the company offers such a diversity of positions that there has never been any reason to leave.

Like many fellow alumni, Wilson credits Summer Lab, a special tradition for chemical engineering undergraduates, with much more than learning how to analyze the experimental data the students generated in the basement lab of Engineering Hall.

"We had to write many reports which were graded very critically, so it was really the department's way of preparing us for industry and other careers," Wilson says. "As exhausting as it was at the time, when I looked back on it later, I realized that it was excellent in that regard."

Even when she attended parents' weekend at Purdue University, she enjoyed being a red-clad Wisconsin fan at the Boilermakers game vs. the Northwestern Wildcats.

"My son was wearing his Boilermakers gear, my husband his Wildcats sweatshirt, and I showed off my Badger pride, so when people looked at us funny, I said we were a Big Ten family," Wilson laughs. "Once a Badger, always a Badger—some things just stick with you for life!"

Madeleine (Molini) Wilson with her 1981 summer lab group. She is pictured sixth from the left in the front row.

RENOWNED BIOCHEMICAL ENGINEER EDWIN N. LIGHTFOOT PASSES AWAY

Hilldale Professor Emeritus Edwin Lightfoot passed away Monday, Oct. 2, 2017, at age 92.

Lightfoot was a brilliant researcher known for his ability to clearly convey complex topics in the classroom and instill a love of learning—and of chemical engineering—in his students. He was energetic, kind and, particularly in his role as a mentor, generous with his time and support. “There were very few topics on which he wasn’t extremely well-informed, and willingly shared his opinions,” says former student Abraham Lenhoff (PhD ’84), the Allan P. Colburn professor in chemical engineering at the University of Delaware.

Following World War II, as the field of chemical engineering matured and challenges became more complex, Lightfoot and colleagues R. Byron (Bob) Bird and Warren Stewart (who passed away at age 81 in 2006) recognized a growing need to provide students unifying principles in a variety of transport phenomena.

In the 1950s, the trio developed an undergraduate course in the area and, in 1960, published the seminal textbook, *Transport Phenomena*. That original text remained in print 41 years and saw five translations; its second edition appeared in 2001 and a simplified version, *Introductory Transport Phenomena*, which added co-author Daniel Klingenberg, was published in 2015.

In 1974, Lightfoot wrote *Transport Phenomena and Living Systems: Biomedical Aspects of Momentum and Mass Transport*. In fact, he conducted groundbreaking research in biochemical engineering, focusing specifically on separation processes and controlling the dynamics of biological systems—interests intended to advance biotechnology.

By nature, his research was interdisciplinary. Throughout a career at UW-Madison that spanned more than 50 years, Lightfoot collaborated on research with colleagues in disciplines ranging from medicine to environmental engineering. Later in his career, he studied the parallels between biological processes and systems in the chemical industry.

His legacy, says Lenhoff, is in his books and research papers—many of which have transformed the diverse scientific fields to which he contributed. “He was especially adept at analyzing complex technical systems into more easily tractable problems, which is why he was a pioneer in biological engineering,” he says.

Lightfoot was born in Milwaukee County in 1925 and attended Cornell University, earning both his bachelor’s and PhD degrees in 1947 and 1950, respectively. After working as a research engineer for the Charles Pfizer Co. in Brooklyn, New York (where he developed a patented commercial process for recovering and purifying vitamin B12), he joined the UW-Madison chemical engineering faculty in 1953. Then-department chair Olaf A. Hougen charged Lightfoot to develop the biochemical research and education program within the department. During his time on the faculty, he supervised 49 PhD students, many of whom today are professors at leading universities and researchers in industrial biochemical and biomedical laboratories. Along the way, Lightfoot also received numerous prestigious national and international honors. He retired in 1996.

Lightfoot was married to his wife, Lila, for 67 years. He believed Lila’s influence was not only the key to his personal happiness but also his professional success. Together, they warmly opened their home to many students and they became part of the extended Lightfoot family. Lila passed away in November 2016. Lightfoot is survived by daughters Theodora (Enrique), Edwin J. (Sue), Nancy (Nick), Robert (Karin), and David (Barry); and his granddaughter Kate.

A few of Edwin Lightfoot’s graduate students gather for a photo with him in honor of his 90th birthday.

ALUMNI NEWS

Roger Harrison (MS '69, PhD '75) was inducted into the Oklahoma Higher Education Hall of Fame at a ceremony held at the University of Central Oklahoma, recognizing his achievement and leadership in scholarship, teaching, research, administration, staff support, outreach and public service. Roger worked in the chemical industry before becoming a professor of chemical, biological and materials engineering at the University of Oklahoma, where his research has focused on developing new types of proteins for cancer chemotherapy.

Christopher Jewell (PhD '08) was promoted to associate professor with tenure at the University of Maryland effective July 1, 2017. Since Chris joined the Fischell Department of Bioengineering in August 2012, his research has focused on biomaterials that generate immune responses with specific tunable characteristics, an idea known as immunomodulation. Chris was advised by David Lynn.

William G. Pitt (PhD '87) was elected a Fellow of the American Institute of Chemical Engineers (AIChE) in 2016. Bill is a professor of chemical engineering at Brigham Young University, where he teaches courses on transport phenomena, polymers and biomedical engineering. He is noted for research in polymeric biomedical materials and drug delivery, with a recent emphasis on ultrasonic enhanced drug delivery, which has the potential to deliver chemotherapeutic drugs to tumor sites without affecting the rest of the body.

Michael Solomon (BS ChE, Economics '90; PhD '96 University of California, Berkeley) was elected a Fellow of the American Physical Society (APS) for experimentally elucidating the self-assembly and rheology of colloidal soft matter. As a professor of chemical engineering at the University of Michigan, his research program includes complex fluids, nanocolloidal assembly, colloidal gelation and the biomechanics of bacterial biofilms. Mike was also named Interim Dean of the Rackham Graduate School at the University of Michigan.

FACULTY NEWS

ExxonMobil and a team led by Professor **George Huber** renewed a two-year agreement to research the fundamental chemistry of converting biomass into transportation fuels. The research is part of a broad effort to identify scalable and commercially viable solutions to help meet increasing global energy demand with a renewable resource.

At the fall 2017 meeting in Milwaukee, the American Vacuum Society (AVS) recognized Professor **Manos Mavrikakis** with the Prairie Chapter Outstanding Researcher Award for his cumulative work in the computational chemistry of catalysis and his contributions to the AVS, a professional society dedicated to advancing the science of vacuum, materials, surfaces, interfaces, thin films, and plasmas.

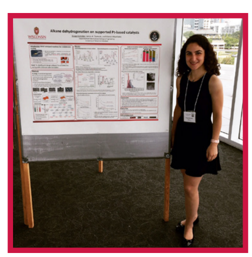
Jay and Cynthia Ihlenfeld Professor **Brian Pfleger** won the American Chemical Society's Division of Biochemical Technology (ACS BIOT) Young Investigator Award. The award honors an outstanding young contributor to the field of biochemical technology. Pfleger was recognized for his work in developing synthetic biology tools and deploying them in microbes to implement metabolic engineering strategies for sustainable chemical production.

Pfleger's research focuses on methods to close the carbon cycle by making chemical products from renewable resources, such as biomass, and by harnessing solar energy to power the conversion of carbon dioxide to chemicals. To develop these methods, he uses the tools of synthetic biology, a subfield of biotechnology that combines elements of engineering, mathematics, chemistry, and biology to synthesize novel systems from known biological components. One example is the genetic engineering of cyanobacteria, some of the oldest organisms on Earth, to create fuels and chemicals directly through photosynthesis without the need for agricultural land or potable water.

Pfleger will receive the ACS BIOT Young Investigator Award at the BIOT annual meeting in New Orleans in March 2018.

STUDENT NEWS

Graduate student **Dongting Zhao** won the best poster award for her poster, "Butene oligomerization over cobalt catalysts: Effect of ammoniation temperature," which she presented at the Catalysis Club of Chicago's spring 2017 meeting. Zhao is co-advised by George Huber and Ive Hermans.



Graduate student **Duygu Gerceker** won the best poster award for her poster, "Alkane dehydrogenation on supported Pt-based catalysts." She presented her work at the fall 2017 meeting of the American Vacuum Society's Prairie Chapter meeting in Milwaukee. Gerceker is co-advised by Jim Dumesic and Manos Mavrikakis.

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THREE CHEMICAL ENGINEERS RECEIVE NATIONAL AWARDS

Bill Banholzer, George Huber, Jim Rawlings and Manos Mavrikakis

In July 2017, three faculty members learned they were selected for national awards from the American Institute of Chemical Engineers (AIChE). AIChE is the world's leading professional organization for chemical engineers, with more than 50,000 members from more than 100 countries.

Harvey D. Spangler Professor **George Huber** received the 2017 Allan P. Colburn Award for Excellence in Publications. This award is presented to a younger member of AIChE, who received their highest academic degree within the last 12 years, and honors significant contributions to chemical engineering through research publications.

Research professor **William (Bill) Banholzer**, who joined UW-Madison in 2013 after a 30-year career in the chemical industry, received the 2017 Founders Award for Outstanding Contributions to the Field of Chemical Engineering. The award recognizes Banholzer's broad impact on chemical engineering and his long and distinguished record of service to the profession, including both technical and professional activities.

Steenbock Professor and W. Harmon Ray Professor **James (Jim) Rawlings** received the 2017 William Walker Award for Excellence in Contributions to Chemical Engineering Literature. The award recognizes Rawlings' seminal contributions in the areas of control theory and applications and chemical reaction engineering.

The three received their awards at a ceremony in Minneapolis on Oct. 29, 2017, as part of the annual AIChE meeting.