FALL 2017

# CBEUPDATE

## Cong Trinh Takes Aim at Diseases

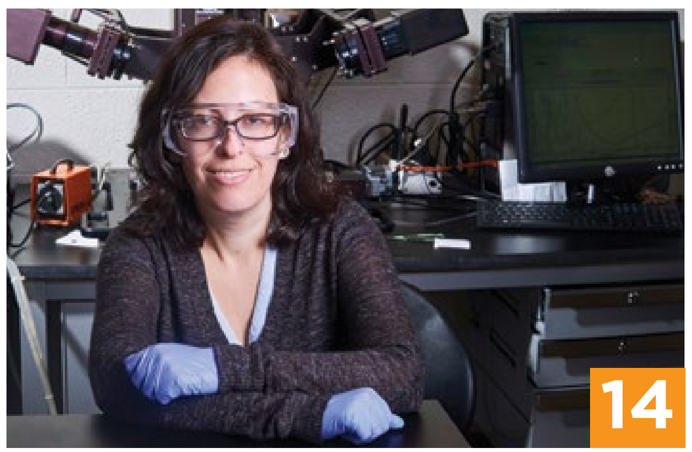
US Department of Defense named Trinh a DARPA Young Faculty award winner for 2017

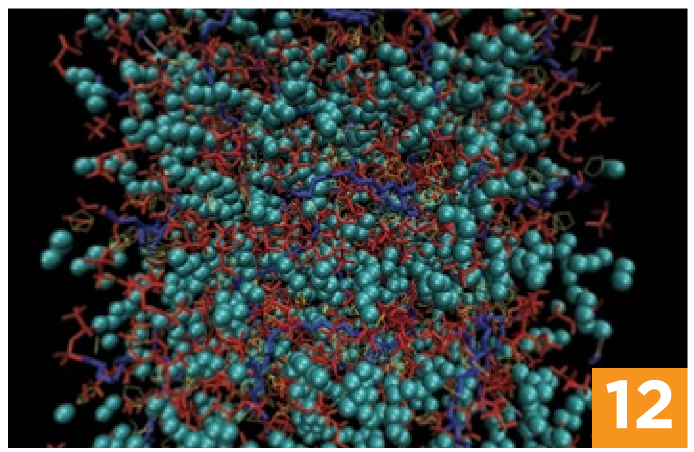
CHEMICAL & BIOMOLECULAR ENGINEERING

CBEUPDATE

# In this issue






## FEATURES



## DEPARTMENTS



**On the Cover:** Cong Trinh, Ferguson Faculty Fellow in Chemical Engineering. *Photography by Jack Parker*


**Department Head,** Bamin Khomami • **Academic Coordinator I,** Rita Gray • **TCE Director of Communications,** Christie Kennedy
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## A MESSAGE FROM THE DEPARTMENT HEAD

The Department of Chemical and Biomolecular Engineering (CBE) at the University of Tennessee, Knoxville, has never been stronger. With approximately 70 full-time doctoral students and 425 undergraduate students, we have the largest student body in the history of the department. With 19 instructional and research faculty, we have the largest number of respected scientists and educators housed within the department since the split with the Department of Materials Science and Engineering in the 1980s. Research expenditures and productivity are near all-time highs, and the reputations of our students and faculty are growing stronger each month.

In spring of 2017, CBE added two new members to its Hall of Fame. Joining Professor John Prados, our inaugural 2016 inductee, are Michael T. Harris (PhD, '92) and James B. Porter Jr. (BS, '65). We are proud to add such exemplary figures and alumni into our Hall of Fame.

This year the department created the CBE Student Service Hall of Fame. We are proud to have Mary McBride (BS, '17) as our inaugural inductee in recognition of her unprecedented impact on our program and students. McBride served as chair of the AIChE Southern Regional Conference planning committee. Her tireless effort leading the organization of this conference, hosted by our AIChE Student Chapter, resulted in an outstanding event that showed the best qualities of our program and college to hundreds of students and faculty from across the Southeastern states.

Our faculty continue to achieve research milestones and garner major national awards. Associate Professor Cong Trinh won a prestigious NSF CAREER award this past year and was also named the 2017 ASEE SE Researcher of the Year as well as the 2017 DARPA Young Faculty award recipient. He received the 2016 Tickle College of Engineering Professional Promise in Research Award and was named the Ferguson Faculty Fellow in Chemical Engineering in 2017. Professor Emeritus Charlie Moore was inducted into *Control* magazine's Process Automation Hall of Fame, and Gibson Chair Stephen Paddison was appointed as a fellow of the Royal Society of Chemistry. Furthermore, UT-ORNL Governor's Chair for Biorefining Art Ragauskas received AIChE's 2017 Professional Achievement Award for Innovations in Green Process Engineering.

Lastly and most importantly, our outstanding body of graduate and undergraduate students have also been recognized for their hard work and dedication. Among the many national and university-wide awards achieved, junior Christopher Neal was named a 2017-2018 Goldwater Scholar, and undergraduates Beini Chen and Michele Christy were awarded the Extraordinary Academic Achievement citation. The Chancellor's Citation for Extraordinary Professional Promise was awarded to undergraduate students Marti Bell and Michelle Lehmann as well as doctoral students Thomas Gaetjens, Hadi Nafar Sefiddashti, and Hanieh Niroomand. A record number of seven CBE students achieved chancellor's citations, tops among all UT academic departments.

I sincerely thank all of our alumni, private donors, and corporate sponsors who have continuously supported our department over the past years which have enabled the tremendous growth we have recently experienced. We are grateful for your support, and we feel truly fortunate to have such a talented, generous, and dedicated group of supporters. With your help, we have built great momentum moving forward in recent years. I believe that our best days are still ahead in terms of teaching, research, and impact. Thank you for your support.

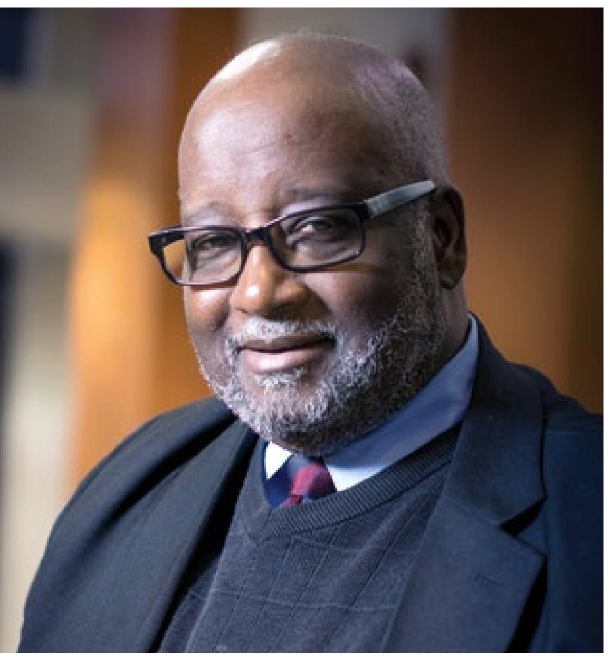
**Bamin Khomami**

*Granger and Beaman Distinguished University Professor*
*Head, Department of Chemical and Biomolecular Engineering*

### Department Inducts New Members to

# Hall of Fame

**The department welcomes alumni Michael Harris and James Porter Jr. as Hall of Fame inductees for 2017. The Hall of Fame award is given to accomplished individuals with significant relationships to our department who have greatly contributed to the profession of chemical and biomolecular engineering.**



*Michael Harris*

*James Porter Jr.*

**Harris** was the first African American student to receive a PhD in chemical engineering at UT, which he earned in 1992. During his studies, he worked full-time as a development engineer at Oak Ridge National Laboratory in areas of control technology, colloids, interfacial phenomena, and the application of finite element and boundary element numerical methods.

He now serves as the associate dean for engagement and undergraduate education at Purdue University, where he is the Robert B. and Virginia V. Covalt Professor of Chemical Engineering.

Harris is the author of 97 peer-reviewed publications and 11 patents. He was a Purdue University Faculty Scholar from 2002 to 2007, served as the programming chair and chair of the ASEE Minority Division from 2011 until 2014, and was named a fellow of AIChE in 2009. Harris won the AIChE Grimes Award for Excellence in Chemical Engineering in 2005 and the AIChE Minority Affairs Distinguished Service Award in 2009.

**Porter** is the founder and president of Sustainable Operations Solutions LLC. He received his bachelor's degree from UT in 1965. He went to work for DuPont in 1966 and remained with the company—aside from a stint in the US Army— for more than 42 years. He held numerous technical and management positions, retiring in 2008 as the chief engineer and vice president of engineering and operations.

Porter served as chair of the Tickle College of Engineering Board of Advisors for several years and was the 2015 recipient of the Nathan W. Dougherty Award. He is a fellow of AIChE and has served on the institute's board.

He is a member of the National Academy of Construction and has served on the boards of FIATECH, the Mascaro Sustainability Initiative, Argonne National Laboratory, and the Fieldbus Foundation as well as on the advisory board for AIChE's Center for Chemical Process Safety.

Porter earned leadership awards from the Construction Industry Institute and FIATECH for his volunteer work in improving the business effectiveness of capital project management and construction practices and systems earned.

Porter's strong support of diversity in engineering was recognized by the Society of Women Engineer's Rodney D. Chipp Memorial Award. He also served as chair of the United Negro College Fund of Delaware.



# Chemical and Biomolecular Engineering Awards Banquet

*CBE Student Award Winners*

## 2017 Department Awards

**Second Place Undergraduate Research Poster Award**
Marti Bell

**First Place Undergraduate Research Poster Award**
Annabel Large

**AIChE Service Award**
Samira Ibrahim

**Dow Outstanding Junior Award**
Amany Alshibli and Ruby Millican

**Professor Jack S. Watson Graduate Award for Excellence in Separation Research**
Thomas Gaetjens

**Professor Jack S. Watson Undergraduate Award for Excellence in Separation Research**
Natasha Ghezawi and Michelle Lehmann

**Kenneth M. Elliott Outstanding Senior Award**
Garrett Smith

**Jim and Sändra McKinley Outstanding Graduate Student Award**
Mohammad Hadi Nafar Sefiddashti

**Exceptional Progress Award for Outstanding Third-Year Graduate Student**
Brian Mendoza

**Most Exceptional Student Award**
Michele Christy

## Student Awards from Outside the Department

**Alpha Chi Sigma Albert H. Cooper Memorial Scholarship Award**
Beini Chen

**American Chemical Society Outstanding Senior Award**
Kelci Bryson

**AIChE Outstanding Student Award**
James Adams

**AIChE Outstanding Baccalaureate Award**
Brandon Wilbanks

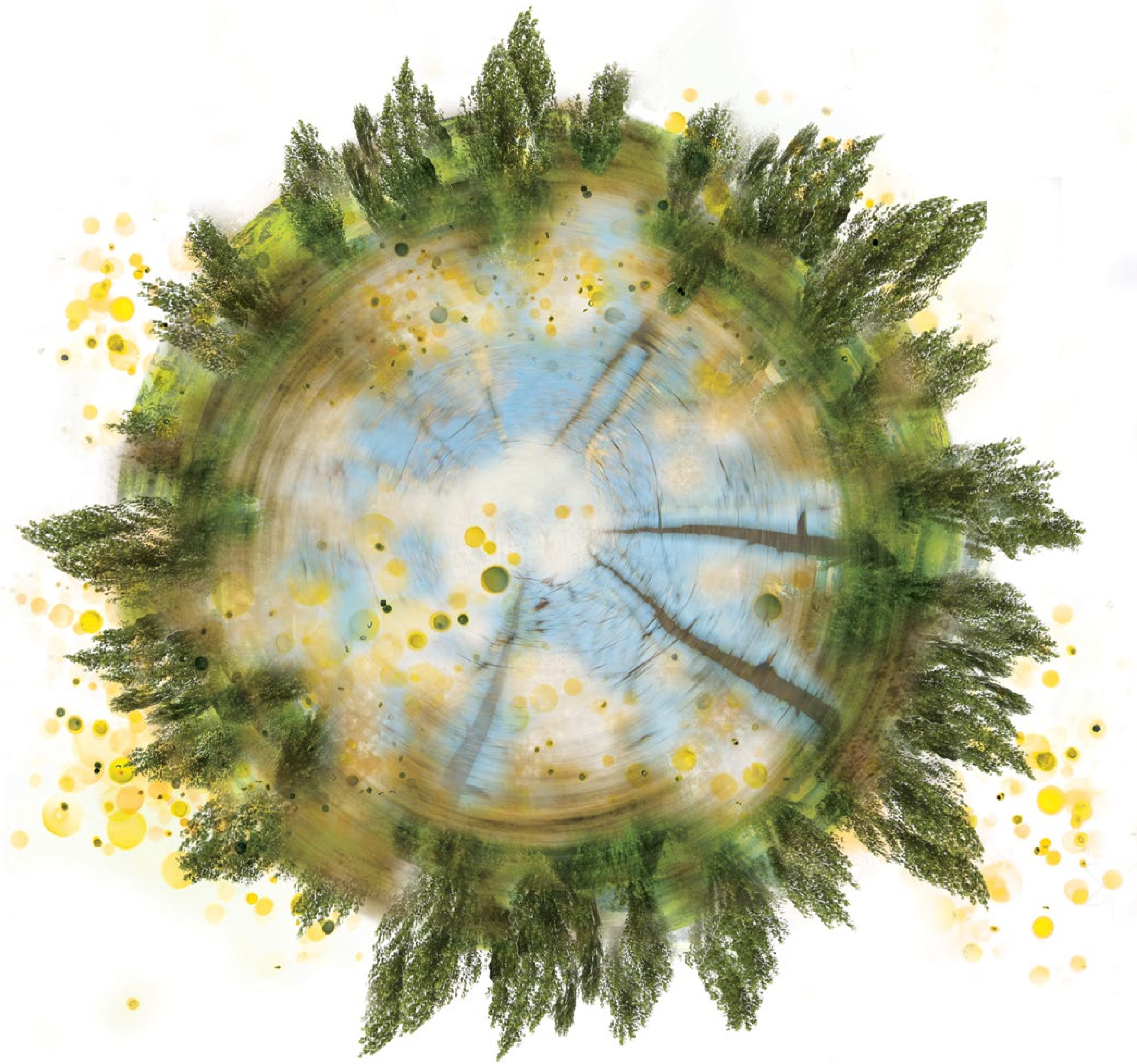
## Faculty and Staff Awards

**Outstanding Staff Member Award**
Lindsi Whitaker

**Outstanding Teacher Award**
Cong Trinh

**Outstanding Faculty Mentor Award**
Michael Kilbey

**Tom and Ruth Clark Chemical Engineering Excellence Award in Teaching**
Michael Kilbey



# SPINNING BIOMASS INTO GOLD

By David Brill

## There's a century-old adage coined by the paper industry that claims "you can make anything from lignin except a profit."

Art Ragauskas has heard this maxim countless times during his career, and it gets him a little riled up every time he hears it. As the UT-ORNL Governor's Chair for Biorefining in the Department of Chemical and Biomolecular Engineering, Ragauskas is channeling that ire into proving that the old saying's time has come and gone.

Lignin and its companion sibling  cellulose reside side by side in the cell walls of poplar trees, switchgrass, and the residues of harvested crops—materials known as biomass.

Cellulose, the fairer of the two, is a sugar-based polymer. It can be deconstructed and fermented into bioethanol, a renewable and carbon-neutral transportation fuel. But where you find cellulose, you also find its clingy and historically less useful cellmate, lignin.

Understanding the structure of lignin and devising profitable uses for it are top priorities for Ragauskas and his multidisciplinary research team.

## Tear Down the Wall

According to the US Department of Energy, the nation's farms and forests can produce more than 1.3 billion tons of biomass annually—enough to meet future demand for bio-based fuels without relying on food grains.

Producing ethanol from corn is relatively easy. But extracting the sugars from biomass is much more difficult, partly because of the complicated relationship with lignin.

Unfortunately, the same properties that make lignin valuable to the plant—structural strength, water repellence, and resistance to decay—also hinder efforts to crack the cell walls and release sugars.

Biorefineries currently use a combination of chemicals and heat to minimize the resistance of cellulose. "But the process is far from perfect," Ragauskas commented. "The pretreatment phase can alter lignin's structure, and the remaining chemicals and sugar degradation products become contaminants."

*UT-ORNL Governor's Chair for Biorefining, Art Ragauskas*

"Over the past century, industries that use woody plants have produced some good science," Ragauskas said. "But in recent years, we've made truly significant gains in understanding and controlling the structure of lignin and other plant polymers."

Such contaminants are of little concern for lignin's low-value uses such as dust control on gravel roads or a resource for biopower. But for higher-value applications, these chemicals must be removed and the structure of the lignin tightly controlled.

One potential solution is to extract the lignin early in the process using organic solvents, including ethanol, and milder temperatures. This method can result in nearly pure lignin, but the cost cannot be justified until profitable uses are identified.

## The Right Tools

Efforts to improve biofuel production—including finding new uses for lignin—are engaging scientists and students from multiple disciplines at UT Knoxville, Oak Ridge National Laboratory, and the UT Institute of Agriculture. They represent the vanguard of a relatively new line of research.

Continual advancements in technology are enabling scientists to see and model the inner workings of plant cells. ORNL's Spallation Neutron Source can generate information on the structure of plant cells down to a nanometer. Supercomputers managed by the UT-ORNL Joint Institute for Computational Sciences can use that information to model physical-chemical processes taking place within the cell wall.

Ragauskas is putting these, and a host of other remarkable tools, to good use.

## Long-Awaited Payout

Lower-value uses for lignin have been around for decades. But high-value applications remain elusive, largely because there has been little need or urgency to develop them. That will change rapidly as full-scale biorefineries go on line and stockpiles of lignin begin to grow.

One way to avoid a lignin glut is to reduce its presence inside plants. To this end, Ragauskas and his colleagues at the ORNL-led BioEnergy Science Center have engineered switchgrass with reduced lignin content and an altered cell wall structure that shows a 34 percent increase in sugar yield.

"These improvements can aid in the release of plant sugars and boost the recovery of high-grade lignin," Ragauskas explained.

Diverting lignin from the waste stream is important, but developing profitable co-products from it will provide biorefiners with an entirely new income stream, "just like crude-oil refining produces a range of co-products, including petrochemicals," he said. "Many of these chemicals, like lignin, were once regarded as waste. They have since grown into a multibillion-dollar industry."

With a few years of focused research, Ragauskas anticipates that lignin-based products will replace many of the petroleum-based items. As they do, it will help debunk the old adage and prove once and for all that you can make nearly anything out of lignin—including a handsome profit and a cleaner environment.

*Originally published in Quest Magazine.*

## Adding Value

Efforts to develop profit-generating uses for lignin have long been frustrated by its complex structure and chemistry. Researchers at UT and ORNL are exploring ways to generate a profit from what is now regarded as waste. Here are some of the more promising ideas:

- Biodegradable grocery bags and food containers
- Feedstock for low-cost carbon fiber
- Green adhesives for wood-composite furniture
- Green industrial chemicals like solvents, lubricants, and detergents
- Natural and nonflammable furniture foams
- Replacement for graphite in lithium-ion batteries
- Resin for 3-D printers
- Sunscreens (lignin absorbs ultraviolet radiation)
- Synthetic fuels

SUPERCHARGED

## Zawodzinski Group

# Building a Better Battery

By David Goddard

One of the biggest drawbacks of the industrial age is the pollution produced by the machines that power society. What, then, might it mean to be able to operate everything from vehicles to houses by a device whose only output beyond the energy it makes is water and heat?

Fuel cells hold such promise. The growth and development of fuel cell technology is one of the big waves in science right now, with UT positioned as a leader of the armada of institutions pushing its boundaries.

Led by UT-ORNL Governor's Chair for Electrical Energy Conversion and Storage Tom Zawodzinski, the Zawodzinski Group in CBE has made several advancements in fuel cell design, particularly in polymer electrolytes, electrodes, and catalysts.

Much like a battery, fuel cells have an anode and a cathode and a membrane that both separates and facilitates the reaction between the two, producing power. Where they differ from a battery is that, as their name implies, they use fuel and air to complete the reaction, and in fuel cells the anode is negative and the cathode positive.

Any improvement in a few key components could have groundbreaking effects on the technology's adaptation as a whole.

"Currently, about one-fourth of the power generated is lost during the reaction," Zawodzinski said. "The materials and techniques we are working on should help us eliminate that to a large degree, which will make the cells more efficient and cost-effective."

Hydrogen is pumped into the anode side, while oxygen from air is introduced into the cathode side. Their reaction produces electricity, water, and heat, making them ideal in a number of ways.

Cars, for instance, could be powered in such a way that the only exhaust was water. Houses could use them to provide all three necessities, something of particular interest given recent recovery efforts following hurricanes. In such cases, having fuel cells at the ready could provide help, especially power and water, weeks or even months before such services might otherwise be restored.

"In many ways, fuel cells are like engines, only you aren't burning anything to make the process work, so it's much smoother, much more efficient, and has no harmful exhaust," Zawodzinski said. "The technology for basic fuel cells has been around for years. NASA used them on the Apollo missions, for example. The key is to make that next great leap forward, technologically speaking."

At the heart of fuel cells lies the proton exchange membrane, or PEM, which allows only positively charged ions to pass from the anode to the cathode. Electrons, separated from the fuel at the anode, take an alternate path to the cathode, which completes the circuit and produces energy.

Currently, PEM fuel cells utilize platinum to varying degrees in their design, especially at the cathode where the oxygen reacts slowly, but Zawodzinski's group is developing a new type of cathode built with less expensive yet more efficient materials.

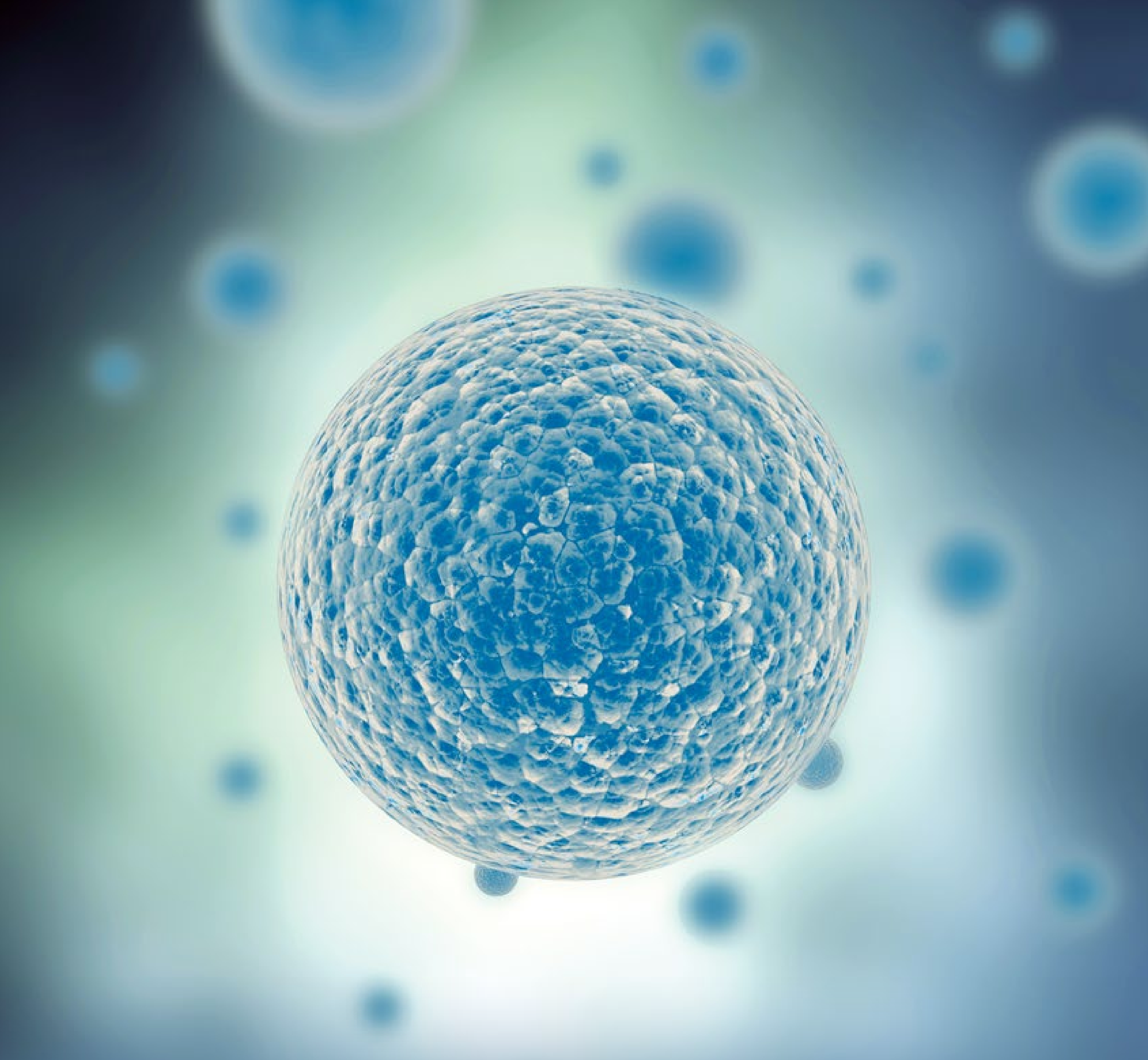
While the ability to provide basic needs for a house is one eventual target, the tweaks the group is making at the PEM level will have a major impact all its own. Each PEM test cell is about the size of a dime, while a real world single cell might have an area the size of a place mat.

"This is a game-changer for both us and the technology itself," Zawodzinski said. "The idea we have could improve output anywhere from 30 to 50 percent. At that point, the idea really becomes practical in an everyday consumer sense."

Some challenges still remain, however. While fuel cells can be filled up the same way one might currently fill a gas tank, Zawodzinski said that in the US only California has really committed itself to establishing a "corridor" of hydrogen filling stations in place for vehicles. To get other states on board might require the next big advancement in fuel cells.

Zawodzinski and his team have a message for those yet to get on board: challenge accepted.

"This is a game-changer for both us and the technology itself. The idea we have could improve output anywhere from 30 to 50 percent. At that point, the idea really becomes practical in an everyday consumer sense." —Zawodzinski



# Cong Trinh Takes Aim at Diseases

By David Goddard

The ability to rapidly identify diseases and begin counteractive measures is key when cities or even countries are faced with a possible epidemic or the use of biological weapons.

Cong Trinh, Ferguson Faculty Fellow in Chemical Engineering, is developing a method to greatly improve the time involved in both identification and removal of such pathogens through the concept of a Virulent Pathogen Resistance program, or ViPaRe.



"In an age when pathogens can be a weapon, having a rapid response is absolutely vital," Trinh said. "Our goal is to be able to identify and target such threats within weeks rather than years, while at the same time not harming the host."

Through ViPaRe, devices are being designed using a blend of statistics, computer science, mathematics, chemistry, and biology. That broad mix is required since the machines must be capable of taking samples, identifying which pathogens are present, and attacking them at their genetic core.

Supercomputers, with their ability to make calculations and break down data millions of times faster than human researchers, make the concept possible, according to Trinh.

"It currently takes a long time to analyze small molecules, which is unacceptable if you're talking about facing an epidemic," he said. "We are developing specialized software and using 'smart' machines to dramatically reduce diagnosis and response times."

Taking such a targeted, specialized approach to fighting pathogens has other benefits, such as curtailing the rise of antibiotic-resistant microbes, since Trinh's method attacks them genetically instead of via medicine.

ViPaRe would also allow treatment to change as diseases mutate, eliminating potentially hazardous new outbreaks of old illnesses. For example, while flu outbreaks occur every year the severity of those outbreaks differs because variations in the strain make it time-consuming for officials to figure out exactly which strain they are facing and produce the correct vaccine.

Using Trinh's idea, medical personnel would be able to take blood samples, identify the particular strain, and eliminate it within weeks rather than over the course of months.

In recognition of his work on ViPaRe, the US Department of Defense named Trinh a Defense Advanced Research Projects Agency Young Faculty award winner for 2017. This award program provides funding, mentoring, and industry and DOD contacts to awardees early in their careers in order to develop research ideas in the context of DOD needs.

Trinh also earned the 2017 American Society for Engineering Educators Southeast New Researcher award, which recognizes a faculty member who has less than six years of teaching and research experience but has demonstrated excellence in both.

# It's a Soft Materials World

By Whitney Heins

Soft materials intersect our daily lives at about every turn. These are materials that can be easily deformed by thermal stresses or thermal fluctuations at around room temperature. Whether it's a dying cell phone battery or a broken refrigerator, most people know there's room for improvement.

CBE faculty members are making great strides to do this. Take, for example, the cutting-edge investigations into polymeric liquids being done by Bamin Khomami, Beaman and Granger Distinguished University Professor and department head, and Brian Edwards, professor and associate department head.

These bizarre materials can display physical properties of both solids and liquids and, thus, are the basis of production for a myriad of consumer products such as plastic containers, clothing, packaging materials, structural components, furniture, building products, and more.

Using the power of some of the world's fastest supercomputers, Edwards conducts simulations to understand how these materials behave in their molten state during industrial processing. A better understanding of this can lead to more efficient industrial processes—and thus better products for you and me.

"New and improved models of polymeric flow behavior will result in the industrial production of new and improved products that will benefit everyone," he said of his NSF-funded research.

For example, products can become stronger, miniaturized, and functionalized.

*"Imagine a thin plastic wire the thickness of a hair that is stronger than steel and could conduct electricity."*

—Brian Edwards

Work by other CBE researchers also promises to improve the products we use in our daily lives.

Associate Professor Manolis Doxastakis is looking to unlock the potential of elastomers, or rubbers. Using computational methods, he examines their molecular level structure and then predicts their macroscopic behavior. Specifically, he tries to answer "what if" questions by modifying the coupling of polymers and particles to change the material's behavior. He also uses computational modeling to try to improve semiconductors by examining how small molecules move through a thin polymer film that's undergoing a chemical reaction.

His findings could lead to better everyday products from tires to computers.

*"We are aiming to improve performance, lower cost, and preserve the environment."*

—Manolis Doxastakis

Assistant Professor Joshua Sangoro's work is also aiming to make soft materials better but he's looking at something different—ionic liquid, or liquid salt. His work holds promise to improve almost every corner of our technological world.

*"I'm of the opinion that there are ionic liquids suitable for nearly every technology. The task is to find the optimal one."*

—Joshua Sangoro

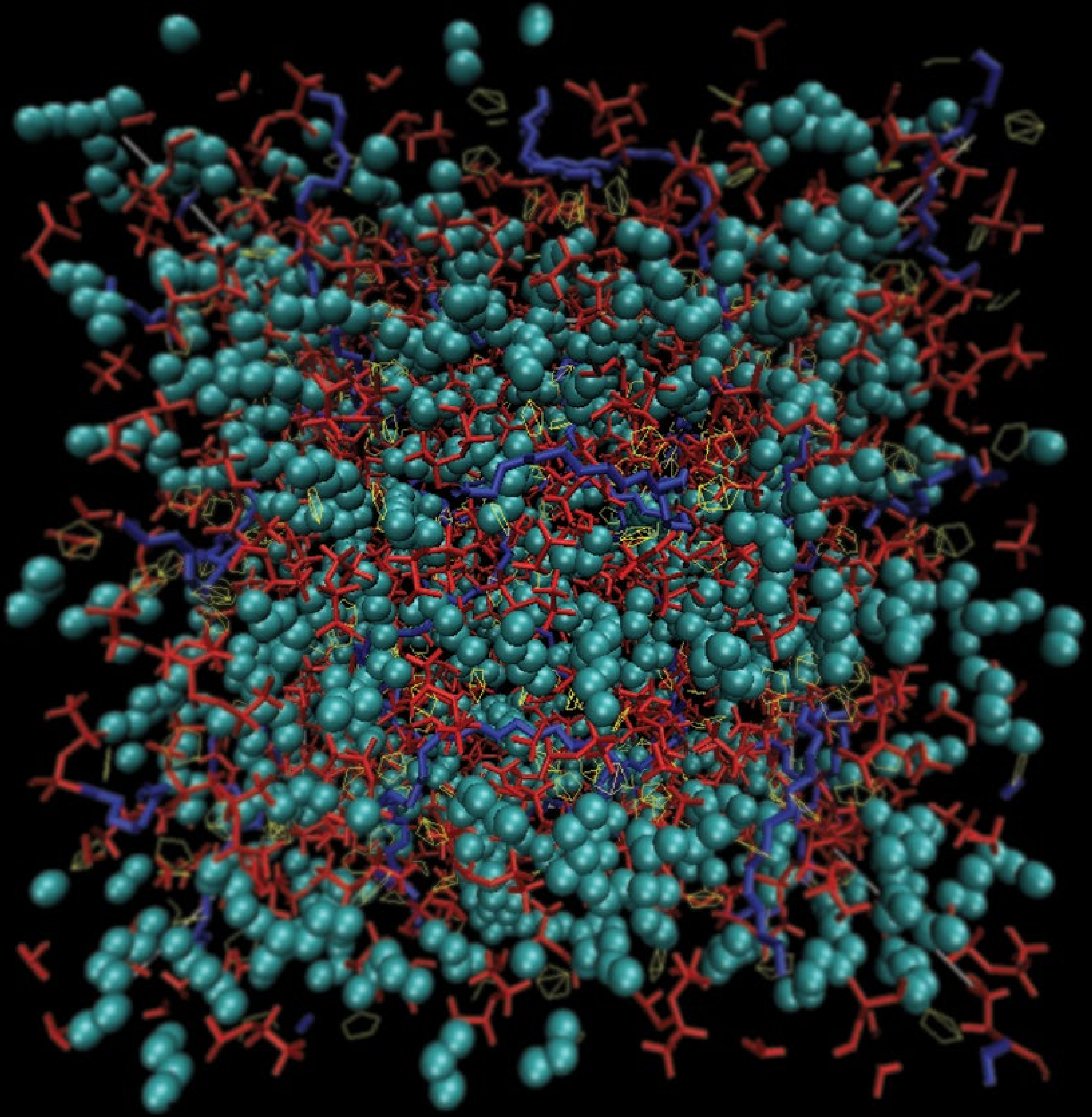
But, the task is almost akin to finding a needle in a haystack. Ionic liquids have a large variety of potentially available cations and anions, which means they hold the possibility of creating trillions of chemically distinct materials, each with different properties and uses.

"This vast number of chemical structures require scientific design criteria based on understanding the correlation between structure and desired properties," Sangoro explained.

He leverages the power of an experimental technique called broadband dielectric spectroscopy to understand the relationship between the ionic liquid's chemical structures and the resulting properties. This method is only being used by a handful of researchers in the country and uniquely probes the response of materials to electric fields through a wide range of timescales. Timescales determine the dynamics and hence, they determine many physical properties of materials, including the extent to which a material can conduct and store electrical energy.

Sangoro's work, supported by research grants from the National Science Foundation and the US Army Research Office, will lay the scientific groundwork for new materials used in batteries that need less time to charge but hold much more energy.

And that's good news for those who use cell phones or computers, or, well, pretty much anyone.



*A representative configuration snapshot of imidazolium-based polymerized ionic liquid from atomistic molecular simulation. Anions are denoted as red bonds, cationic side alkyl chains as cyan spheres, cationic imidazolium rings as yellow lines, cationic backbones as blue bonds, and all H atoms are omitted for clarity.*


# Little Things Matter

By David Goddard

Lithography has been around since the 16th century, making it one of humanity's oldest techniques for duplication. The basic idea of being able to quickly 'imprint' images on a target remains the same, but researchers like Prados Associate Professor Gila Stein have helped take it to a modern level.

Originally, images were transferred by pressing a plate prepared with a variety of substances into a 'target' plate coated with fats. The prepared plate would then etch the image into the transfer plate, allowing mass production of images or text.

Now, light is projected through a series of optics on to thin films of photo-sensitive polymers atop a silicon wafer, producing silicon chips.

"Light triggers a chemical reaction, which is the first step towards forming patterns," said Stein. "Our goal is to understand how the properties of thin polymer films control the progression of these chemical reactions so we can predict how new materials will perform."

It's all part of a broader field of research into the understanding and design of functional polymer films for electronics, energy, membranes, and coatings.

Stein's research group also works with materials called block copolymers that can form patterns and arrays on their own at the nano-level. Gaining an understanding of how these systems self-organize in thin films—two-dimensional layers of polymers—holds endless possibilities. The films can complement lithography in the manufacture of next-generation electronics and can be adapted for controlled use in electronics and sensors.

"Polymer systems have the potential to impact a number of different fields," Stein said, "but they are also pretty complex. We use techniques like X-ray scattering, infrared spectroscopy, and microscopy to examine structure across multiple length scales, from individual molecules to millimeters."

Stein noted that faculty and researchers within the department and at ORNL can help build off one another to improve such research.

"We work with faculty in the department to model chemical reactions in thin films, and to study self-assembling polymers that could be used in batteries," said Stein. "We also collaborate with research groups at Rice University and Oak Ridge to study the surface properties of branched polymers, which are useful in the design of responsive surfaces."

Just another way that Stein and her research group are proving that small things can make a big difference.

## FACULTY NEWS

Research by UT-ORNL Governor's Chair Professor for Biorefining **Art Ragauskas** was spotlighted in a special feature on lignin in the March 2017 edition of *TAPPI* Journal. Ragauskas co-authored the article, titled "Lignin Carbon Fiber: The Path for Quality," along with postdoctoral researcher Qiang Li and Associate Professor Joshua Yuan, both of Texas A&M University. Ragauskas also received the 2017 AIChE Program Committee's Professional Achievement Award for Innovations in Green Process Engineering. He was cited for advancing green process engineering and his distinguished contributions as an educator.

**Charles Moore**, professor emeritus and former department head, was named to Control's Process Hall of Fame in April. Inductees have shown a willingness to share, promote, and disseminate their knowledge and ability to the benefit of others in the profession, to the next generation, and to society as a whole. Moore lists his contributions in four areas: principles of plant-wide control, integration of statistical process control with the more traditional engineering process control, monitoring batch processes, and chemical engineering education.

Senior Research Associate **Gabriel Goenaga** received the 2017 TLSAMP Champion award. He works with Zawodzinski's Electrochemical Energy Research Group and advises and mentors graduate and undergraduate engineering students. He is also the UT Chem-E-Car team faculty advisor, guiding the design and testing process leading up to the team's participation in AIChE's Chem-E-Car Competition at both the regional and national levels. For the past three summers, Goenaga has volunteered in the eVOL10 program, which gives rising tenth graders the opportunity to learn more about UT, the engineering design process, and safe chemical handling techniques.

# Goldwater Scholar Addresses Global Challenges

Christopher Neal kept busy in 2017. In April, he was one of only three UT students to receive a 2017-18 Goldwater Scholarship, one of the nation's most selective awards for undergraduates. He followed that up in July with a presentation at the Global Grand Challenges Summit at George Washington University.

"Earning the Goldwater Scholarship is perhaps the greatest honor I have ever received," he said, adding that it is likely to open doors for him. "This scholarship has afforded me the opportunity to realize my full potential in research and academic excellence."

Neal, a chemical engineering senior from Murfreesboro, Tennessee, is a member of UT's Chancellor's Honors program, the Tau Beta Pi engineering honors society, and the college's Cook Grand Challenge Scholars program.

At the summit, Neal presented "Characterization of Membranes for All-Vanadium Redox Flow Batteries." 900 students came to the event from 115 different universities in the US, Great Britain, and China. Neal was one of four UT engineering students present. The aim of the summit is to inspire the next generation of engineers, policymakers, and the public to address critically important engineering challenges and opportunities facing humanity.

Neal takes on the challenges through research with Thomas Zawodzinski, the UT-ORNL Governor's Chair for Electrical Energy Conversion and Storage, and Senior Research Associate Gabriel Goenaga. Neal has worked with ORNL and numerous international companies. A member of the Chem-E-Car team, he has served as the team's captain for the past year. He is also a resident assistant in the new Stokely Hall.

Neal's goals are to earn a doctorate in chemical engineering with a focus on electrochemistry. He wants to conduct research on alternative electrical energy storage devices—that is, upcoming battery technologies—and teach at the university level.

### 2017 Chancellor's Award Recipients in CBE:

**Extraordinary Academic Achievement**: Beini Chen, Michele Christy

**Outstanding Scholar Athlete**: Michele Christy

**Top Collegiate Scholar**: Garrett Walker Smith

**Extraordinary Professional Promise**: Marti R. Bell, Thomas K. Gaetjens, Michelle L. Lehmann, Mohammad Hadi Nafar Sefiddashti, Seyedeh Hanieh Niroomand



## Mary McBride Inducted into

# CBE Student Hall of Fame

Mary McBride established a unique legacy with her graduation in spring 2017. She is the inaugural member of the department's Student Service Hall of Fame.

"I now have the opportunity of hopefully inspiring current and future CBE students to give to the department and grow professionally," she said.

The Student Service Hall of Fame highlights students who exemplify service to their community. McBride, now in her first year as a medical student at the UT Health Science Center College of Medicine in Memphis, certainly fits the bill.

While working on her chemical engineering degree with a concentration in biomolecular engineering, the Seymour, Tennessee, native also maintained a position as a Tickle College of Engineering student ambassador and took on a major leadership role as chair for the 2017 Southern Regional AIChE Conference.

"I loved working toward a successful conference to help my community in undergrad," she said. "Planning such a large-scale event was new to me. The greatest challenge was time management. I was focused on doing well in classes my senior year, but also spending every extra moment in Dougherty working on the conference."

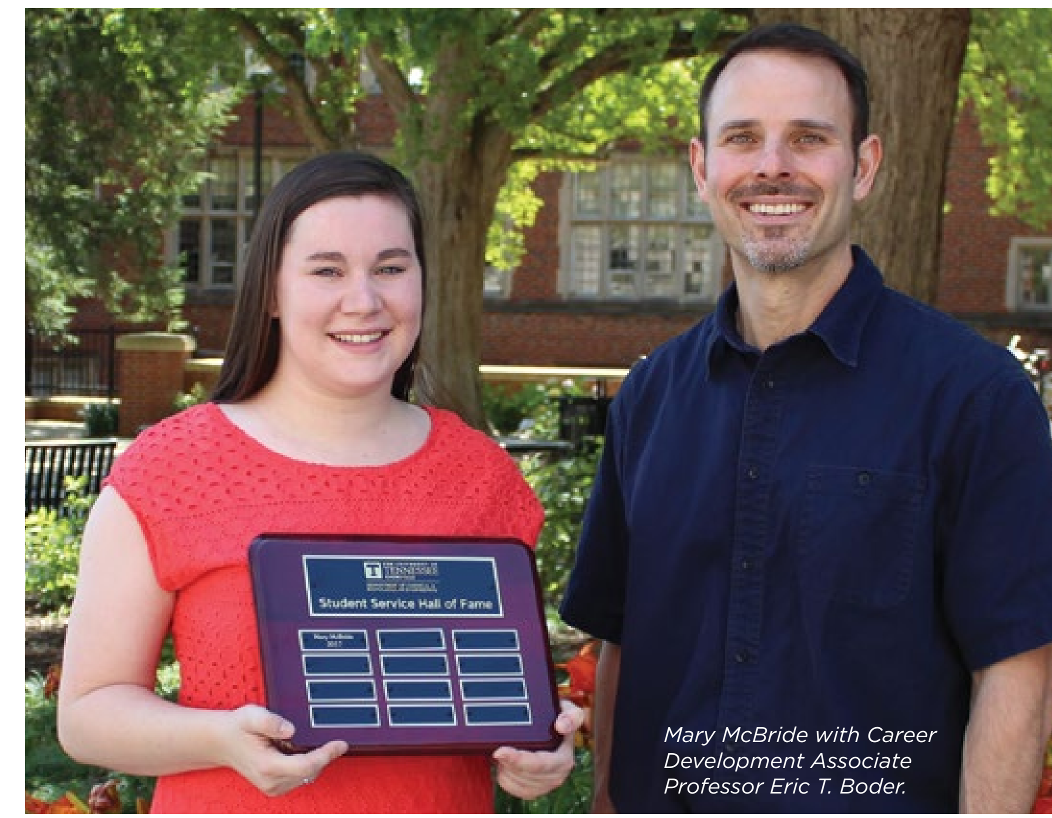
"We invented the Student Service Hall of Fame because we did not feel that we had an award that was commensurate with the effort and impact that Mary made on our department through her work on the conference," said Associate Professor Eric Boder and AIChE Student Chapter advisor. "We had a really great team of students working on our conference planning committee, but every team needs a dedicated and effective leader to function well. Mary worked tirelessly for roughly a year, with a constant smile on her face and positive attitude, making arrangements and planning every detail of the event."

McBride had attended other regional and national AIChE conferences, but many other CBE students had not been able to go.

"Having the conference in Knoxville allowed for our students to get highly involved in the planning process," McBride said. "It was most satisfying to see my peers get involved in AIChE in a more in-depth way than just our local student chapter."

The conference gave UT engineering students the opportunity to network and present research to peers from other universities as well as representatives from industry and graduate schools. McBride looks back on the experience as a definite success.

"Undergraduate students from all over the southeast commented on how smoothly events went and how much fun they had," she said. "I think our successes in organization of Chem-E-Jeopardy, research presentations, tours of ORNL, and the Chem-E-Car competition originated from the care we took in planning each event. We wanted students to feel excited about being in Knoxville and at UT. This made for a great conference, but also numerous opportunities for graduate recruiting for the college."




*Mary McBride with Career Development Associate Professor Eric T. Boder.*

Part of the success could also be attributed to the inclusive sense of community that McBride helped foster, even before the conference got underway.

"In our program book, there was a letter welcoming the students to Knoxville and to UT," she said. "I made it a point in the letter to let visiting students know that, here, they are a part of the Volunteer family."

"The result was an event that showcased our department and our college to hundreds of students and faculty from many states," Boder said. "Within three weeks of the conference, more than a dozen attendees had submitted formal inquiries regarding graduate studies at UT."

## Back to the

# Future of Energy

## 2017 Trotter Distinguished Lecture

Neurock is the Shell Professor of Chemical Engineering and Materials Science at the University of Minnesota (UM). He received his doctorate from the University of Delaware in 1992, worked as a postdoctoral fellow at the Eindhoven University of Technology in the Netherlands from 1992 to 1993, and as a visiting scientist in the Corporate Catalysis Center at DuPont from 1993 to 1994. He joined the chemical engineering faculty at the University of Virginia in 1995 before joining UM in 2014.

Future strategies for energy production will require processes and materials that can efficiently convert sustainable resources into fuels and chemicals. That's according to Matthew Neurock, who spoke at the department's 2017 Troy C. Trotter Distinguished Lecture to a captive audience of students, faculty, and staff members this September.

In his lecture, titled "Engineering Molecular Transformations over Supported Catalysts for Sustainable Energy Conversion," Neurock presented information on recent advances in computational catalysis and the ways these can be applied to engineering molecular transformations for energy conversion and chemical synthesis. He addressed the sites and nanoscale reaction environments necessary to carry out specific bond-making and breaking reactions, plus processes important to the control of the catalytic conversion of biomass to chemicals and the electrocatalytic transformations of fuels to energy.

Neurock has made seminal advances to the development and application of computational methods toward understanding catalytic and electrocatalytic reaction mechanisms and the sites and environments that carry out reactions under working conditions. He has received various awards for his research in computational catalysis and molecular reaction engineering and co-authored over 250 papers, two patents, and two books. He served as an editor for the *Journal of Catalysis* for 10 years and continues to serve on numerous other editorial and advisory boards.

The lecture series was established by the Trotter family to honor alumnus Troy C. Trotter (BS, '47). The lecture provides CBE with the opportunity to invite nationally recognized experts to UT for the benefit of students, faculty, and the local professional community.

Past speakers include David Sholl (Georgia Tech University) in 2014, Juan de Pablo (University of Chicago) in 2011, James C. Liao (UCLA) in 2007, and Arup K. Chakraborty (MIT) in 2004.





## Series Brings Top Chemical Engineers to Campus

Visiting chemical and biomolecular engineers accounted for three of the ten speakers in the 2017 Tickle College of Engineering Distinguished Lecture Series, held in both the spring and fall of the year.

Lecturers presented their topics in person in the Min H. Kao Electrical Engineering and Computer Science Building.

On March 6, Kathleen Stebe presented the first of this year's CBE-related lectures, entitled "Curvature Driven Assembly in Soft Matter." She discussed developments in direct assembly of structures in which one exploits soft matter to develop energy fields related to the geometry of the confinement. Stebe is the Richer and Elizabeth Goodwin Professor of Chemical and Biomolecular Engineering at the University of Pennsylvania.

Gareth McKinley's lecture followed on March 20, titled "Fog, Feathers, and Fluid Friction Reduction using Omniphobic Surfaces: Biomimetic Inspiration and Engineering Realization." In this lecture, he investigated the controlling of the wetting (or non-wetting) properties of fluid and solid interfaces. McKinley is the School of Engineering Professor of Teaching Innovation in the Department of Mechanical Engineering at the Massachusetts Institute of Technology.

In September, Eric Shaqfeh presented "Suspended Particles in Complex Fluids: From Fracking Fluids to Swimming Worms." He outlined breakthroughs in the development of a computational simulation of viscoelastic suspensions with particle-level resolution such that predictions can be made and tested at all volume fraction loadings. He described three foundational problems that have been analyzed using computational methods, including fracking fluid design and swimming in mucous. Shaqfeh is the Lester Levi Carter Professor of Chemical Engineering at Stanford University.

Dean Wayne Davis established the Distinguished Lecture Series with a webcast element to offer worldwide access to these talks on the key topics and research of the day, delivered by top academic and professional minds. To view past lectures, visit ***engr.utk.edu/distinguished-lecture-series***.

Kathleen Stebe

Gareth McKinley


Eric Shaqfeh

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ALUMNI

# Conner celebrates 50 years of service

*Harold Connor (right) with University Professor Emeritus John Prados at the CBE Awards Banquet.*

Chemical engineering alumnus Harold Conner celebrated 50 years of service on US Department of Energy (DOE) and nuclear-related projects in May 2017. He earned his bachelor's and master's degrees in chemical engineering from UT in 1968 and 1978, respectively, before going on to earn his PhD in industrial and systems engineering from the University of Alabama at Huntsville.

Conner, a registered professional engineer in Tennessee and South Carolina, is currently the UCOR manager of nuclear services and engineering. He has broad responsibility for engineering programs, nuclear and criticality safety, work control, fire protection, and other engineering-related functions. His department plays an integral role in maintaining and reinforcing a strong safety culture in UCOR's operations.

Over the years, Conner's career took him to DOE sites across the country, including the Paducah and Portsmouth Gaseous Diffusion Plants, Y-12, the Idaho National Laboratory, the Savannah River Site, and the Lawrence Livermore National Laboratory. He picked up a few awards along the way, including the UT Knoxville Alumni Professional Achievement Award and the Secretary of Energy Award of Achievement.

Conner started work as a co-op student at the former Oak Ridge Gaseous Diffusion Plant while pursuing his chemical engineering degree at UT. His performance earned him a full-time job. He worked for the next 33 years in almost every facility at the East Tennessee Technology Park (ETTP), eventually being named vice president of the Environmental Management and Enrichment Facilities (EMEF) by Lockheed Martin. In that role, he managed 3,000 workers and a $500 million budget for EMEF locations in Oak Ridge, Paducah, and Portsmouth.

"I feel like I have come full circle in my career," Conner said. "It hardly seems any time since that teenage co-op student first set foot on the ETTP site. It's hard to comprehend it's actually been 50 years, and how my roles have changed during that time."

THE UNIVERSITY OF TENNESSEE KNOXVILLE

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# SPINNING BIOMASS INTO GOLD

*Page 4*