MASS Transfer

News from Chemical and Biomolecular Engineering at Illinois

Spring/Summer 2017

ILLINOIS 150 1867-2017

MASS Transfer

Department of Chemical and Biomolecular Engineering

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Contents

About cover:
The title of the cover image is *Feathers of Autumn*. Needles, spherulites, and dendrites are observed in this image of ellipticine, a pharmaceutical used to treat cancer, grown by solution shearing on a polymer substrate. The multitude of crystal morphologies resembles the diversity in color and shape of feathers in autumn. The image coloring was slightly enhanced. Image by Elizabeth Horstman (PhD '17, Kenis) and Yifu Zhang, an undergraduate student in Dr. Ying Diao's group. They won first prize in the School of Chemical Sciences' annual Science Image Challenge.

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From the Department Head's Desk

Dear Alumni and Friends,

As I write this letter, a fairly quiet spring semester is coming to an end. The university continues to grapple with a tight budget and uncertainty with respect to the state budget. On the positive side, this situation is leading to reform in the way the campus handles budget allocations. Given our large undergraduate program in combination with our excellence in research, we expect that the proposed budget models will benefit the department compared to the current model.

This May, 139 seniors graduated with a bachelor's degree in Chemical Engineering, four received their master's and five received their doctoral degrees. Many of them joined us at our convocation with alumnus **Dr. Elmer Dougherty** (PHD '55) as the featured speaker. A Kansas native, Dr. Dougherty earned his bachelor's degree from the University of Kansas in 1950 and his MS and PhD degrees from the University of Illinois in 1951 and 1955, all in Chemical Engineering. Here at Illinois he worked with the legendary Professor Harry Drickamer. Dougherty was a pioneer in developing computer applications for the oil and gas industry and at 87 years old he is still involved with the consulting company he formed in 1979. We were pleased to have him join us and share his insights with our graduates.

Another highlight from the spring was our Undergraduate Awards Ceremony when we recognize the many scholarship recipients and outstanding undergraduate researchers in the department. This year we had the privilege of welcoming back **Jim Grant** (BS '69) and his wife Pamela, who presented the James K. Grant Scholarship to its first recipient. Thanks as always to alumni who returned to campus as judges of the Undergraduate Research Symposium: **John Schnake** (BS '89), who is corporate director of process analyzers at Endress+Hauser Group; **Corey Correnti** (BS '85), retired executive from BP and currently consultant to energy companies; and **John Bassett** (BS '72), also retired, having worked in petroleum refining and the mining industry, most recently as Vice President of Operations for Molycorp and president of Seadrift Coke.

We have plenty of good news to share in this issue. For example, Assistant Professor **Charles Sing** was awarded a 2017 National Science Foundation CAREER Award for his proposal, "Developing the design rules of charge sequence to inform polymer self-assembly." And Professor **Hyunjoon Kong** was elected to the College of Fellows of the American Institute for Medical and Biological Engineering (AIMBE) for his outstanding contributions to the fields of biomaterials, bioimaging contrast agents and tissue engineering. Also, **Dr. Charles Schroeder** has been promoted to full professor. In this newsletter we are also catching up with Professor **Tony McHugh**, now at Lehigh, who spent 23 years on the faculty at Illinois, graduating 40 MS and PhD students. Personally I am still grateful to Tony for setting a fantastic example in my first semester at Illinois when I team-taught fluid mechanics and heat transfer with him.

This summer we will say goodbye to Lecturer **Dr. Troy Vogel**, who will be joining Notre Dame as an Associate Teaching Professor and the Director of Undergraduate Studies in their Chemical and Biomolecular Engineering Department. Since he joined the department in 2011, Troy has taught capstone design as well as a few other courses. He has been instrumental in connecting with corporate partners (often alumni) to support specific design projects. We expect to hire a new lecturer this summer. Speaking of hiring, we were not able to recruit a new faculty member this spring, but we hope to do so the coming year. Our goal remains to grow the department to 20 tenure-track faculty, from 18 currently.

Looking ahead, we hope you will be able to join us for one of several special events being planned for this fall. As you may have already heard, we will celebrate the rededication of the freshly renovated Chemistry Annex building on October 6-7 as part of the School of Chemical Sciences' sesquicentennial celebration. Later that month, as part of Homecoming weekend, our department will host an event to honor the legacy of **Thomas Hanratty**, who passed away in 2016, as well as our customary alumni tailgate. Please be on the lookout for an invitation or visit our website, chbe.illinois.edu, for further information.

Last but not least, I would like to recognize all our alumni and friends who continue to give back to the department. These gifts, both big and small, many times make a big difference, be it for our students in pursuing their undergraduate or graduate degrees, or for our faculty in pursuing their research. Thank you for your continued support!

I wish you all an enjoyable summer, and hope to see many of you back on campus this fall!

Paul J. A. Kenis
William H. and Janet G. Lycan Professor and Department Head

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Save The Dates:
Homecoming and Hanratty events

As part of Homecoming weekend on Oct. 27-28, 2017, the department will host an event honoring the late **Dr. Thomas J. Hanratty**. The weekend will include talks by former students and colleagues of Dr. Hanratty, tours, and other activities.

We plan to welcome former students and colleagues of Dr. Hanratty's with an informal lunch on Friday, Oct. 27, followed by discussions with guest speakers and an evening reception that will be held in the Chemistry Library. On Saturday, Oct. 28, we will host an alumni tailgate outside Memorial Stadium before the football game. The Fighting Illini will take on the Wisconsin Badgers for the Homecoming football game at 11 a.m. On Saturday evening there will be a dinner for Hanratty students and colleagues at the Illini Union. Please be on the lookout for a postcard and email invite. And as always, you can visit chbe.illinois.edu for information.

Celebrating our Sesquicentennial: 1867-2017

In February the University of Illinois kicked off its 15-month celebration of the sesquicentennial at Krannert Center for the Performing Arts. Over the past 150 years, faculty, staff, and students have transformed the social and economic landscape of our world. As a leading institution of higher learning, the university will continue to expand its global presence through supporting public policies that address the grand challenges of a global society, to lead advancements in information and medical technology, and to catalyze economic development. More information on campuswide festivities is available at 150.illinois.edu.

As part of the campus sesquicentennial, the School of Chemical Sciences, the Department of Chemical and Biomolecular Engineering, and the Department of Chemistry are planning a special weekend on campus for alumni and friends Oct. 6-7, 2017. The celebration will include a rededication of the renovated **Chemistry Annex**, a ceremony marking the **Dr. Herb Gutowsky Chemical Landmark Designation**, panel discussions, and more.

More information will be forthcoming at scs.illinois.edu/scs150.

Postdoc named to Forbes 30 Under 30 List

Congratulations to postdoctoral fellow **Lydia Kisley**, who was featured in the Forbes 30 Under 30 List for 2017.

The annual list highlights innovators who are under 30 years old and work in a variety of different industries, from media to manufacturing. Kisley was included on the healthcare list.

Kisley, 28, is a Beckman-Brown Interdisciplinary Postdoctoral Fellow at the University of Illinois. She works with several researchers on campus, including **Deborah Leckband**, Reid T. Milner Professor of Chemical Sciences; **Martin Gruebele**, James R. Eiszner Chair in Chemistry and Chemistry Department Head; and **Paul Braun**, Ivan Racheff Professor of Materials Science and Engineering.

Kisley said she aims to "inspire and design materials and biomaterials in smarter ways by using unique microscopy in order to understand them better."

She received her PhD in Chemistry in 2015 from Rice University. Her bachelor's degree is from Wittenberg University in Ohio.

Since arriving at Illinois in 2015, she has worked with polymers and hydrogels, studying how proteins fold at the surface of a polymer brush (polymer chains grafted to a surface) or within a hydrogel, and observing how stable the proteins are and how they function. Her research has applications in biotechnology, particularly in biosensors, and development of medical devices.

As a graduate student at Rice, she explored ways to purify and separate drug molecules, with the goal of improving efficiency in pharmaceutical manufacturing. She and her fellow researchers also observed blood serum proteins combining with gold nanoparticles, prompting them to aggregate, a finding that has implications for nanoparticle toxicity issues. Gold nanoparticles have been used in some cancer treatments.

In addition to her research, she has been involved in a number of outreach activities with organizations such as the Girl Scouts of Central Illinois and the Houston Museum of Natural Science.

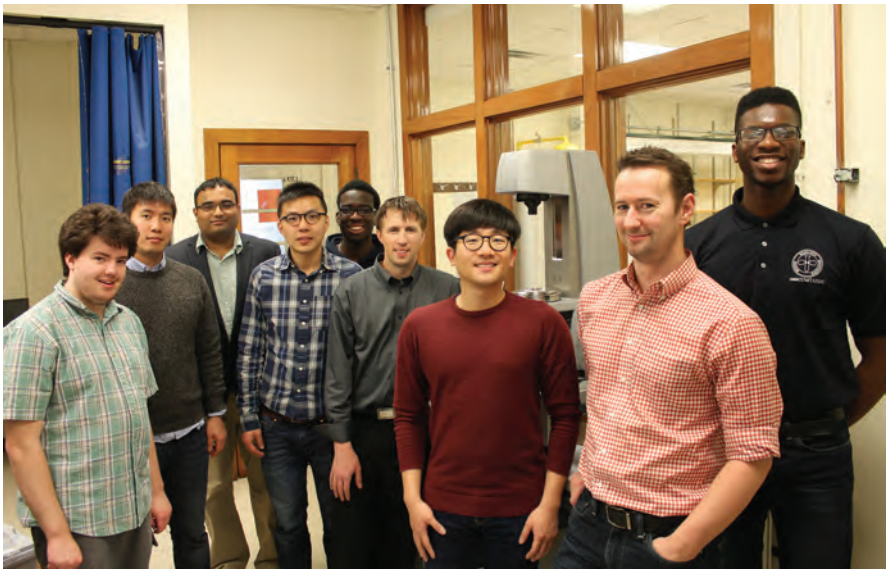
Kisley intends to pursue a career in academia and to establish a research lab at a university where she can combine the skills she is learning at Illinois in understanding protein folding, surfaces and materials with skills she developed while pursuing her PhD, which entailed research at the single molecule level.

Rogers Lab receives NEW INSTRUMENT FOR RHEOLOGY RESEARCH

Anton Paar, a leading laboratory equipment company which makes high end instrumentation for material characterization, has provided state-of-the-art instruments to the Simon Rogers Lab to support their work on advancing fundamental and applied research in the field of rheology.

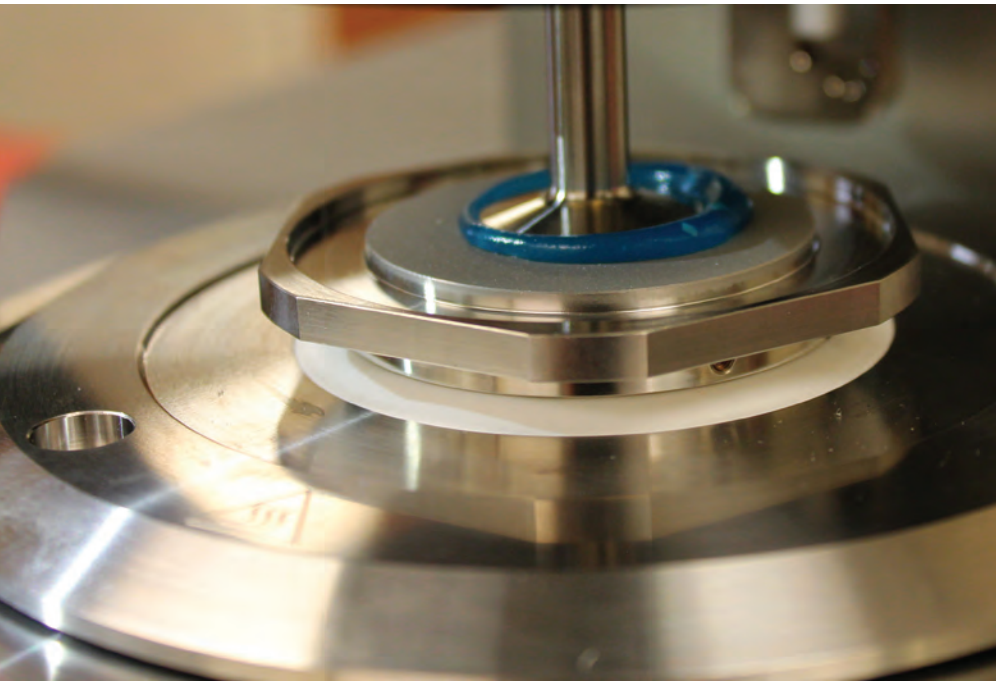
Anton Paar is loaning Illinois researchers Simon Rogers, Assistant Professor of Chemical and Biomolecular Engineering, and Randy Ewoldt, Assistant Professor of Mechanical Science and Engineering, each with a top-of-the-line rheometer which will be fully loaded with accessories to allow maximum flexibility to characterize different types of complex fluids such as polymer solutions, colloidal suspensions, micellar solutions, and surfactant monolayers.

"The Rogers lab is extremely grateful to Anton Paar for the confidence they have expressed in our future with this agreement. We will be pushing rheological research forward, in our own little way, with this instrument and the support from Anton Paar," Rogers said. His research group investigates the fundamental physics behind time dependent phenomena exhibited by soft condensed matter systems under deformation for biomedical, energy, and environment applications.



Simon Rogers, members of his research group and Anton Paar officials gather around the new rheometer.

A celebration to mark the partnership was held April 3 on campus. Anton Paar personnel spent the week installing the rheometers and offering training and demonstrations of the instruments' capabilities.



A close-up of the rheometer

> "The Rogers lab is extremely grateful to Anton Paar for the confidence they have expressed in our future with this agreement. We will be pushing rheological research forward, in our own little way, with this instrument and the support from Anton Paar."
>
> **Dr. Simon A. Rogers, Assistant Professor**

"The new equipment brings incredible capabilities to our lab, which we plan to leverage and build upon with several research projects," said Randy Ewoldt, Assistant Professor of Mechanical Science and Engineering. The Ewoldt group studies rheology, non-Newtonian fluid mechanics, mathematical modeling, and design involving soft materials. His work often involves interdisciplinary collaborations and is a combination of experiment and theory.

Anton Paar, which was established in 1922, develops, produces and distributes laboratory instruments as well as process measuring systems and provides custom-tailored automation and robotics solutions worldwide.

The company was looking to collaborate with researchers who "'think outside the box' for novel new ways to use research rheometers, especially scientists who have a vision for new rheological test method developments which can impact both fundamental and applied research. Both Ewoldt and Rogers are collaborative researchers, and their work in rheology has a number of diverse applications ranging from biomedical, energy, and environmental to designing of soft materials, said Abhi Shetty, Lead Scientist at Anton Paar.

> "We tried to find people in universities who are willing to push the limits of what is measurable."
>
> **Norbert Ponweiser**
> Anton Paar Company

Ewoldt and Rogers' labs will receive MCR 702 TwinDrive rheometers, valued at approximately $600,000 total. This is the most advanced rheometer to date, according to the company. The model boasts several advantages, such as allowing researchers to perform rheological tests with two torque transducers and drive units at once. Operating two Electronically Commutated (or EC) motors at once opens up new possibilities, such as counter-rotation. This mode is an invaluable option for microscopy applications, according to Abhi Shetty, Lead Scientist at Anton Paar. Both researchers will receive the microscopy set-ups.

Rogers said some of his current experiments take a lot of time and effort, and with the new instrument, researchers will be able to "be more productive faster."

"We'll also be able to perform tests that just aren't possible on other instruments," he added.

The equipment will be loaned to the university for three years, with the possibility of extending the term for another two years. As part of the agreement, the researchers will conduct beta testing of new accessories.

Chemical and Biomolecular Engineering Department Head Dr. Paul Kenis, Mechanical Science and Engineering Department Head Dr. Anthony Jacobi, Dr. Randy Ewoldt and Dr. Simon Rogers with members of the Anton Paar team.

CONGRATULATIONS GRADUATES!

On May 14, 2017, 139 seniors graduated with a bachelor's degree in Chemical Engineering, four students received their master's and five received their doctoral degrees. This year's convocation was especially notable because the department invited graduate students to the ceremony. Following tradition, faculty advisors placed doctoral hoods over the heads of graduate students, marking their students' successful completion of the program.

Dr. Elmer Dougherty delivered this year's convocation remarks. A Kansas native, Dr. Dougherty earned his bachelor's degree from the University of Kansas in 1950 and his MS and PhD degrees from the University of Illinois in 1951 and 1955, all in Chemical Engineering. As a graduate student, he studied under the legendary Professor Harry Drickamer. After graduate school, he worked at Esso and Dow (where he wrote his first computer program in 1955), as well as Union Carbide and Chevron. Along the way he also formed two software companies.

In 1971, Dr. Dougherty joined academia and became a Chemical Engineering Professor at the University of Southern California. He retired from USC in 1995. He continues to be involved in his company, Maraco, an oil and gas software development firm that he established in 1979. He has consulted around the globe and he has written over 50 technical papers. A distinguished member of the Society of Petroleum Engineers, he received its prestigious Cedric Ferguson Medal. In 2006, the University of Kansas Chemical Engineering Department inducted him into its Alumni Hall of Fame.

In his address, Dougherty told students that their integrity is a "badge of dependability and trust."

"If you remember nothing else I say today, remember this. If your boss asks you a question and you do not know the answer, do not, I repeat, do not babble gibberish. Say, 'I don't know. But I'll find out. When do you need the answer?'"

Dougherty advised students to continue honing their communication skills and to express ideas simply and concisely. He also told them that every day of their professional life, "a jury of your peers and superiors is judging you."

"Before you act, remember your physics, chemistry, and engineering. Does it compute? If it doesn't, reboot. You only succeed if you get things done, but you must consider the risk," he said.

In his speech Dr. Dougherty also reflected on his time on campus and the excellent teachers he had, including chemical engineering giants James Westwater, Harry Drickamer, and Tom Hanratty.

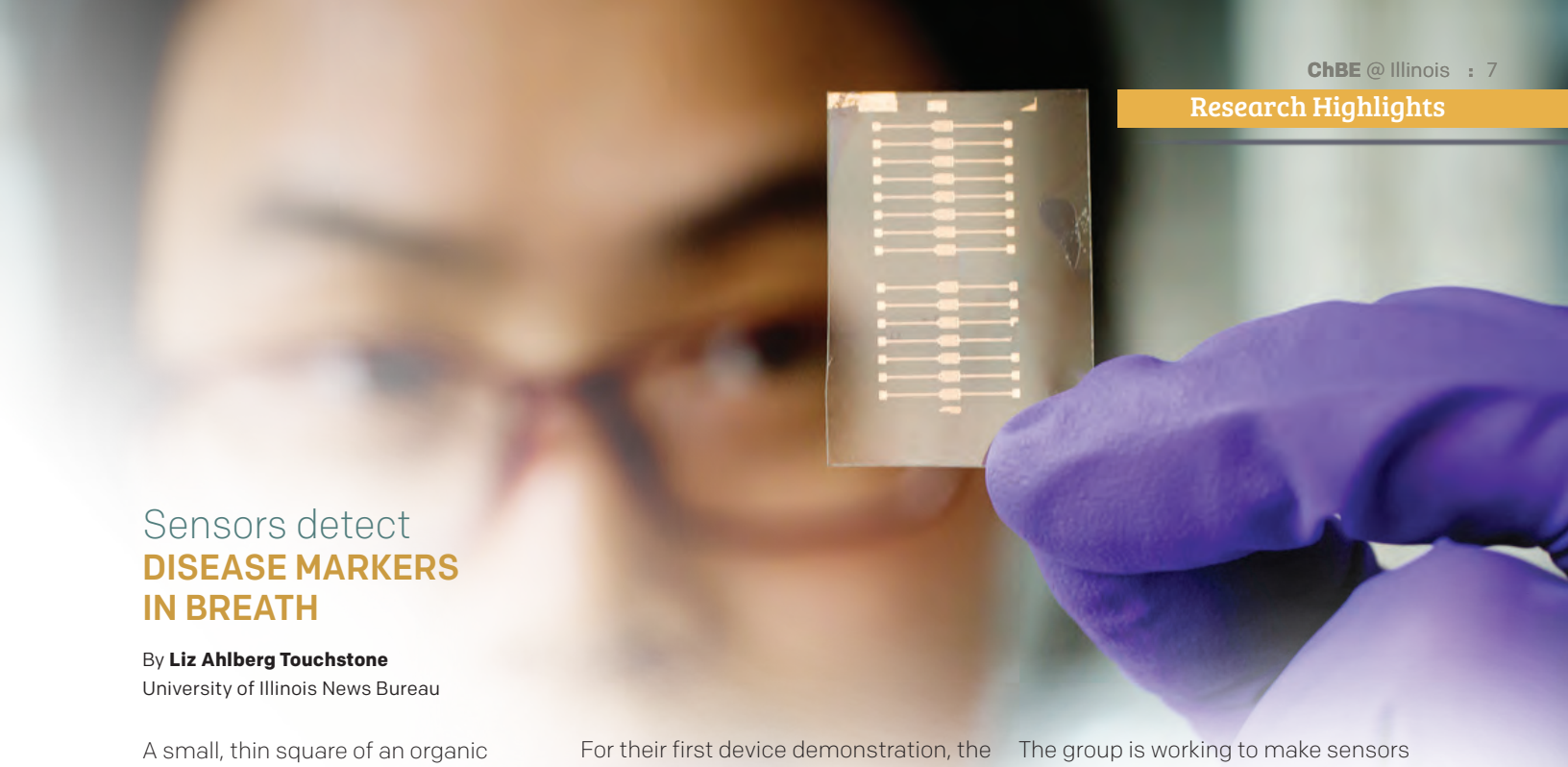
"Go out and make your mentors proud of the results of this slice of their life's work," he advised.

Feng Sheng Hu, dean of the College of Liberal Arts & Sciences, said students should be immensely proud of themselves for having succeeded in one of the most rigorous programs on campus, one with a longstanding record of excellence, home to award-winning teachers and researchers working at the forefront of their disciplines. As members of the College of Liberal Arts and Sciences, they are also joining a community of more than 160,000 alumni around the world, graduates who have distinguished themselves in business, medicine, research, and many other areas.

"Be a force for good and a strong advocate for your alma mater," he said.

Department Head Dr. Paul Kenis said he and fellow faculty and staff wished students success in their pursuits and best of luck in personal and professional lives. He also urged them to stay in touch with the department and he looked forward to hearing news of their accomplishments.

A reception was held in a tent on Centennial Plaza, between Noyes Laboratory and the Chemistry Annex.



Sensors detect **DISEASE MARKERS IN BREATH**

By **Liz Ahlberg Touchstone**
University of Illinois News Bureau

A small, thin square of an organic plastic that can detect disease markers in breath or toxins in a building's air could soon be the basis of portable, disposable sensor devices. By riddling the thin plastic films with pores, University of Illinois researchers made the devices sensitive enough to detect at levels that are far too low to smell, yet are important to human health.

In a new study in the journal *Advanced Functional Materials*, Dr. Ying Diao's research group demonstrated a device that monitors ammonia in breath, a sign of kidney failure.

"In the clinical setting, physicians use bulky instruments, basically the size of a big table, to detect and analyze these compounds. We want to hand out a cheap sensor chip to patients so they can use it and throw it away," said Diao, Assistant Professor of Chemical and Biomolecular Engineering and Dow Chemical Company Faculty Scholar.

Other researchers have tried using organic semiconductors for gas sensing, but the materials were not sensitive enough to detect trace levels of disease markers in breath. Diao's group realized that the reactive sites were not on the surface of the plastic film, but buried inside it.

"We developed this method to directly print tiny pores into the device itself so we can expose these highly reactive sites," Diao said. "By doing so, we increased the reactivity by ten times and can sense down to one part per billion."

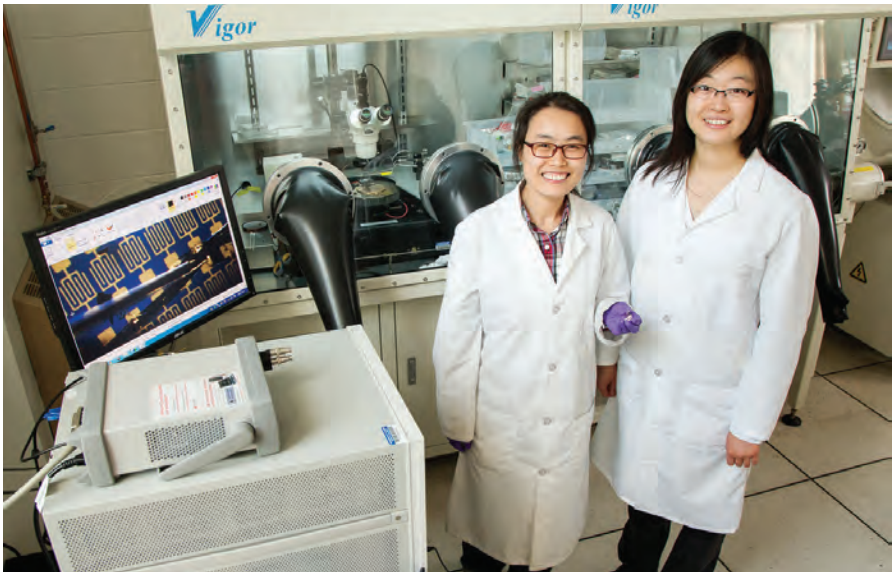
For their first device demonstration, the researchers focused on ammonia as a marker for kidney failure. Monitoring the change in ammonia concentration could give a patient an early warning sign to call their doctor for a kidney function test, Diao said.

The material they chose is highly reactive to ammonia but not to other compounds in breath, Diao said. But by changing the composition of the sensor, they could create devices that are tuned to other compounds. For example, the researchers have created an ultrasensitive environmental monitor for formaldehyde, a common indoor pollutant in new or refurbished buildings.

The group is working to make sensors with multiple functions to get a more complete picture of a patient's health.

"We would like to be able to detect multiple compounds at once, like a chemical fingerprint," Diao said. "It's useful because in disease conditions, multiple markers will usually change concentration at once. By mapping out the chemical fingerprints and how they change, we can more accurately point to signs of potential health issues."

Diao's group collaborated with Purdue University professor Jianguo Mei on this work.



Postdoctoral researcher Fengjiao Zhang and Dr. Ying Diao, Assistant Professor of Chemical and Biomolecular Engineering, developed devices for sensing disease markers in breath. *Photo by L. Brian Stauffer.*

Researchers develop new capabilities for GENOME-WIDE ENGINEERING OF YEAST

By **Claudia Lutz**, Carl R. Woese Institute for Genomic Biology

One of humankind's oldest industrial partners is yeast, a familiar microbe that enabled early societies to brew beer and leaven bread and empowers modern ones to synthesize biofuels and conduct key biomedical research. Yeast remains a vital biological agent, yet our ability to explore and influence its genomic activity has lagged.

In a new article in Nature Communications, University of Illinois researchers describe how their successful integration of several cutting-edge technologies—creation of standardized genetic components, implementation of customizable genome editing tools, and large-scale automation of molecular biology laboratory tasks—will enhance our ability to work with yeast. The results of their new method demonstrate its potential to produce valuable novel strains of yeast for industrial use, as well as to reveal a more sophisticated understanding of the yeast genome.

"The goal of the work was really to develop a genome-scale engineering tool for yeast . . . traditional metabolic engineering focused on just a few genes and the few existing genome-scale engineering tools are only applicable to bacteria, not eukaryotic organisms like yeast," said Steven L. Miller Chair of Chemical and Biomolecular Engineering Huimin Zhao, who led the study. "A second innovation is the use of synthetic biology concepts, the modularization of the parts, and integration with a robotic system, so we can do it in high-throughput."

The team focused on yeast in part because of its important modern-day applications; yeasts are used to convert the sugars of biomass feedstocks into biofuels such as ethanol and industrial chemicals such as lactic acid, or to break down organic pollutants. Because yeast and other fungi, like humans, are eukaryotes, organisms with a compartmentalized cellular structure and complex mechanisms for control of their gene activity, study of yeast genome function is also a key component of biomedical research.

"In basic science, a lot of fundamental eukaryotic biology is studied in yeast," said Tong Si, a Carl R. Woese Institute for Genomic Biology Research Fellow. "People have a limited understanding of these complicated systems. Although there are approximately 6,000 genes in yeast, people probably know less than 1,000 by their functions; all the others, people do not know."

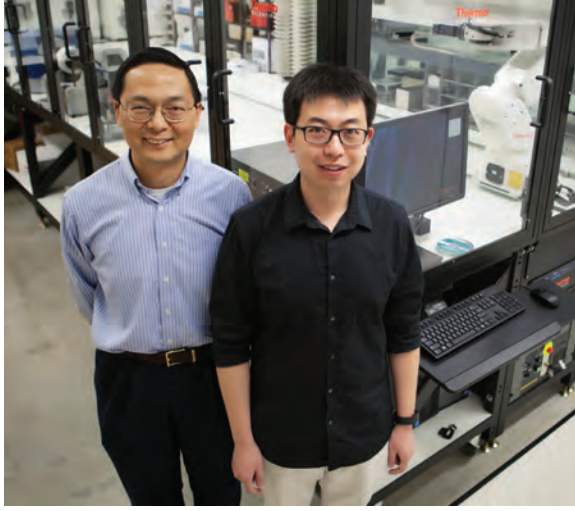
The group took the first step toward their goal of a novel engineering strategy for yeast by creating what is known as a cDNA library: a collection of over 90% of the genes from the genome of baker's yeast (Saccharomyces cerevisiae), arranged within a custom segment of DNA so that each gene will be, in one version, overactive within a yeast cell, and in a second version, reduced in activity.

Zhao and colleagues examined the ability of the CRISPR-Cas system, a set of molecules borrowed from a form of immune system in bacteria (CRISPR stands for clustered regularly interspaced short palindromic repeats, describing a feature of this system in bacterial genomes). This system allowed Zhao to make precise cuts in the yeast genome, into which the standardized genetic parts from their library could insert themselves.

"The first time we did this, in 2013, there was no CRISPR . . . the best we could get was 1% of the cells modified in one run," said Si. "We struggled a little on that, and when CRISPR came out, that worked. We got it to 70% [cells modified], so that was very important."

With gene activity-modulating parts integrating into the genome with such high efficiency, the researchers were able to randomly generate many different strains of yeast, each with its own unique set of modifications. These strains were subjected to artificial selection processes to identify those that had desirable traits, such as the ability to survive exposure to reagents used in the biofuel production process.

This selection process was greatly aided by the Illinois Biological Foundry for Advanced Biomanufacturing



Huimin Zhao, Steven L. Miller Chair of Chemical and Biomolecular Engineering, and Tong Si, Carl R. Woese Institute for Genomic Biology Research Fellow. *Photo by Kathryn Faith.*

(iBioFAB), a robotic system that performs most of the laboratory work described above in an automated way, including selection of promising yeast strains. Use of iBioFAB greatly accelerated the work, enabling simultaneous creation and testing of many unique strains. The iBioFAB was conceived and developed by the Biosystems Design research theme at the Carl R. Woese Institute for Genomic Biology (IGB), which is led by Zhao.

With support from the High Performance Biological Computing Group at Illinois, Zhao, Si and their colleagues analyzed the modified genomes of their most promising yeast strains. They identified combinations of genes whose altered activities contributed to desirable traits; the functions of some of these genes were previously unknown, demonstrating the technique's ability to generate new biological knowledge.

"I think the key difference between this method and the other existing metabolic engineering strategies in yeast is really the scale," said Zhao. "The current metabolic engineering strategies are all focused on just a few genes, dozens of genes at most . . . it's very intuitive. With this we can explore all the genes, we can identify a lot of targets that cannot be intuited."

The work, which was funded by the Roy J. Carver Charitable Trust, IGB, Defense Advanced Research Program Agency, and National Academies Keck Futures Initiative on Synthetic Biology, paves the way for similar approaches to broad-scale, automated genome engineering of other eukaryotic species.

Changing the environment
WITHIN BONE MARROW ALTERS BLOOD CELL DEVELOPMENT

By **Sarah Banducci**,
University of Illinois News Bureau Intern

University of Illinois researchers reported earlier this year they can alter blood cell development through the use of biomaterials designed to mimic characteristics of the bone marrow.

The findings, reported in the journal *Science Advances*, are a first step toward developing more effective bone marrow treatments for diseases like leukemia and lymphoma.

Blood cells flow throughout the body delivering life-supporting oxygen and nutrients. As these cells are used and recycled they are regenerated by bone marrow, the soft tissue inside the body's long and hollow bones.

Certain regions of bone marrow contain hematopoietic stem cells, the precursors of all blood and immune cells, said Brendan Harley, Associate Professor of Chemical and Biomolecular Engineering. He led the research with postdoctoral researcher Ji Sun Choi.

"The tissue environment that surrounds these cells in the bone marrow provides a wealth of signals that can alter how these precursor cells behave. This paper looked at the signals provided by the tissue matrix itself," said Harley, who also is affiliated with the Carl R. Woese Institute for Genomic Biology at Illinois.

One of the major tools that oncologists use to treat leukemia and lymphoma involves transplanting HSCs. The donor stem cells must locate marrow cavities and start producing blood and immune cells. However, there is a limited quantity of available donor HSCs and the success rate of transplantation is low.

"We're interested in this problem from an engineering standpoint," Harley said. "The goal is to create better tools to both expand the number of donor HSCs and improve their capacity to repopulate the bone marrow after transplantation."

Like cells throughout the body, HSCs are contained in a three-dimensional tissue environment known as the extracellular matrix. Harley and Choi gathered samples of HSCs from mice and then grew them in the laboratory using biomaterials engineered to mimic some of the extracellular matrix properties of the native bone marrow. Their goal was to examine how these engineered systems could alter the HSCs' capacity to proliferate and differentiate to become blood cells.

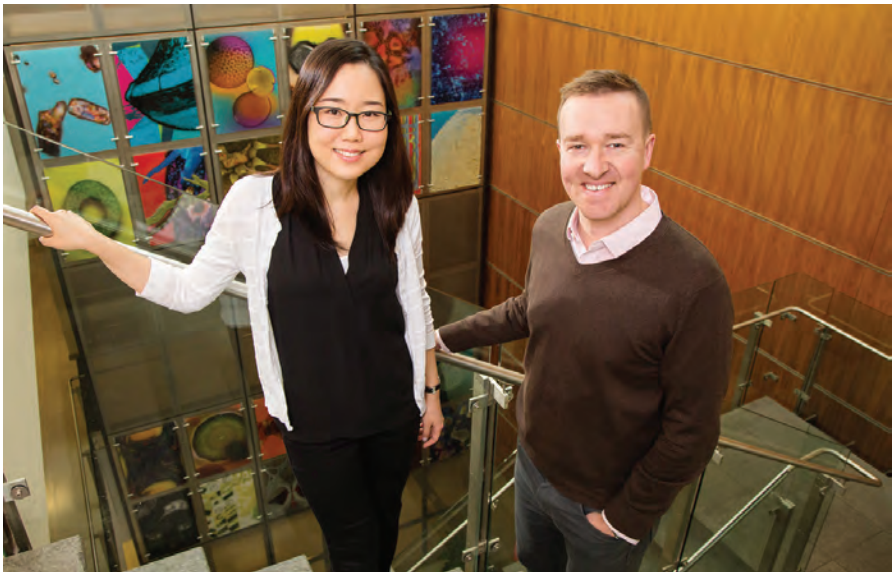
The researchers examined two main elements of the matrix that regularly interact with HSCs: collagen and fibronectin. They found that the HSCs that were exposed to collagen proliferated more rapidly but that they had differentiated, meaning they were no longer stem cells. When exposed to fibronectin, the stem cells proliferated less rapidly, but were able to maintain their stem cell-like nature.

"With the collagen substrates, we got more cells but not useful cells," Harley said. "With the right combination of stiffness in the matrix and the presence of fibronectin, we identified a class of biomaterials that show promise for being able to maintain and eventually expand these stem cells outside of the body. An engineered bone marrow will be of enormous value for treating hematopoietic cancers such as leukemia, but also for understanding the process of bone marrow failure and other hematopoietic diseases."

> "We're interested in this problem from an engineering standpoint. The goal is to create better tools to both expand the number of donor HSCs and improve their capacity to repopulate the bone marrow after transplantation."
>
> **Dr. Brendan A. Harley, Associate Professor**

This project is only the first step in controlling the signals from the matrix that influence HSCs, Harley said. He and other researchers in his lab are currently investigating other features of the matrix that can be manipulated to increase the number of stem cells and make them more effective in transplantation.

The National Science Foundation, National Institutes of Health and the American Cancer Society of Illinois supported this research.



Postdoctoral research associate Ji Sun Choi and Associate Professor of Chemical and Biomolecular Engineering Brendan Harley.
Photo by L. Brian Stauffer.

FACULTY ACHIEVEMENTS


Hyunjoon Kong


Charles Sing


Bill Hammack


Ying Diao


Damien Guironnet


Jonathan Higdon


Diwakar Shukla


Andrew Ferguson


Charles Schroeder


Rohit Bhargava

Kong named AIMBE Fellow, joins med school

The American Institute for Medical and Biological Engineering (AIMBE) has elected **Dr. Hyunjoon Kong**, Professor of Chemical and Biomolecular Engineering, to its College of Fellows for outstanding contributions to the fields of biomaterials, bioimaging contrast agents and tissue engineering.

The College of Fellows is comprised of the top two percent of medical and biological engineers in the country. The most accomplished and distinguished engineering and medical school chairs, research directors, professors, innovators, and successful entrepreneurs, comprise the College of Fellows.

Kong's research focuses on the synthesis, characterization, and processing of nanobiomaterials for diagnostic imaging and molecular/cell therapies of wounds and vascular diseases and regeneration of neuromuscular interface. He joined the Illinois faculty in 2007.

Also earlier this year, Dr. Kong joined the Carle Illinois College of Medicine inaugural faculty as a professor. He also joined the editorial board of the journal *Biofabrication*.

Schroeder promoted to Professor

Dr. Charles M. Schroeder, the Ray and Beverly Mentzer Faculty Scholar, has been promoted to full Professor effective Aug. 16, 2017. Schroeder studies the dynamics of polymers, proteins, and soft materials using single molecule techniques. He joined the department in 2008 and received his PhD from Stanford.

Sing earns NSF CAREER Award

Dr. Charles E. Sing, Assistant Professor of Chemical and Biomolecular Engineering, has received a 2017 National Science Foundation CAREER Award for his proposal, "Developing the design rules of charge sequence to inform polymer self-assembly."

The NSF's Faculty Early Career Development Program's CAREER Awards are prestigious and competitive awards given to junior faculty who exemplify the role of teacher-scholar through outstanding research, excellent education, and the integration of education and research within the context of the mission of their respective organizations. The program will provide five years of support.

"I am incredibly honored by this award. I think it reflects the exciting ideas and hard work of my students, and I am excited to keep working with them to explore this new area of charged, patterned polymers. I hope we can live up to this recognition and push the field forward," he said.

He aims to enable advances in materials that demand structural precision at the nano-level, such as fuel cell membranes, functional coatings and sensors, and drug delivery vehicles.

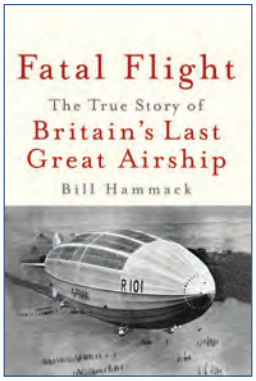
Dr. Sing's research is inspired by the sophisticated precision of biological systems made from large molecules that specifically and exclusively interact using information encoded in patterns of electrostatic charge. He will investigate whether polymers—long chain-like molecules made of joined molecular units called monomers—that self-organize can be made to behave in a similar way. He and his research group will determine how patterns of electrostatically charged monomers along a polymer molecular chain can be designed to guide the self-organization of molecular structures at the nanometer length scale.

The NSF CAREER award will also support outreach efforts. Sing and his graduate and undergraduate students volunteer with the St. Elmo Brady STEM Academy, which aims to boost interest in STEM fields among underrepresented minorities. They teach elementary-age students about issues such as sustainability and the lifecycle of plastics and introduce them to interactive computer simulation activities.

Sing joined the faculty in 2014. He received his B.S.E./M.S. from Case Western Reserve University and his Ph.D. from the Massachusetts Institute of Technology. His postdoctoral work was at Northwestern University's International Institute for Nanotechnology.

New book for Hammack

Professor Bill Hammack has written a new book, *Fatal Flight: The True Story of Britain's Last Great Airship*. The book brings to life the dramatic year of operation of R.101, a luxury liner three and a half times the length of a Boeing 747 jet.



Hammack is the Donald and Dolores Morris Professorial Scholar in the Department of Chemical and Biomolecular Engineering. His narrative follows First Officer Noel Atherstone and his crew from the 1929 test flight to its final flight on Oct. 5, 1930. On that day, during a demonstration flight to India, it crashed in France, killing everybody aboard.

Set against a backdrop of the British Empire at the height of its power in the early 20th Century, Fatal Flight portrays an extraordinary age in technology, fueled by humankind's obsession with flight. The aircraft, with its glass promenade decks, dining room and lounge, was a supremely imaginative human creation, Hammack writes.

The 310-page book includes illustrations, line drawings and appendices with never-before published documents about the air ship's construction. Published by Articulate Noise this June, it's available as hardcover and eBook. A companion video series with archival photos and materials will be broadcast on Hammack's YouTube channel, engineerguy.

More information is available on his website, www.engineerguy.com/airship.

Excellent teachers

Congratulations to ChBE faculty who were included on the list of Teachers Ranked as Excellent by their Students for the Fall 2016 and/or Spring 2017 semesters: **Ying Diao, Damien Guironnet, Jonathan Higdon, Diwakar Shukla, Brendan Harley, Simon Rogers and Ed Seebauer**. The results are based on Instructor and Course Evaluation System (ICES) surveys maintained by the university's Center for Innovation in Teaching and Learning.

Ferguson receives young investigator, college research awards

Andrew Ferguson, Assistant Professor of Materials Science and Engineering and an affiliate in ChBE, was awarded the ComSEF (Computational Molecular Science & Engineering Forum) Young Investigator Award for Modeling and Simulation at the AIChE annual meeting in November 2016. The award recognizes outstanding research in computational molecular science and engineering, encompassing both methods and applications.

This spring Ferguson was also a recipient of the 2017 Dean's Award for Research, which is given out annually by the College of Engineering.

Beckman, Agilent honor Bhargava

Dr. Rohit Bhargava was recently presented with the Agilent Thought Leader Award by Agilent Technologies in recognition of his pioneering work in the development of infrared spectroscopic imaging, and its application to life sciences research.

Dr. Bhargava is Founder Professor of Bioengineering and an affiliate in ChBE.

The Agilent Thought Leader Award, which includes funding and technology from Agilent, will enable Dr. Bhargava to develop new applications and software to facilitate infrared analysis of histological samples, in particular for cancer detection and diagnosis.

Agilent Technologies is a global leader in life sciences, diagnostics and applied chemical markets. The company works with customers in more than 100 countries, providing instruments, software, services and consumables for the entire laboratory workflow.

Bhargava was also the recipient of the Beckman Institute's Vision and Spirit award. The award recognizes a researcher at the Beckman who exemplifies founder Arnold Beckman's vision in establishing the institute, and who, like Beckman and other faculty members, has fostered collaboration in order to mount a bold and risky experiment that meets not only short-term research goals, but inspires future long-term work.

2016-2017
UNDERGRADUATE SCHOLARSHIPS

> “The students who sit among you today come from throughout the U.S. and around the world, from small farm towns to cities of over 8 million. Some are among the first in their families to go to college. Others come from a long line of engineers. During their time at Illinois, they’ve established themselves as outstanding, driven students.”

Dr. Paul Kenis, William H. and Janet G. Lycan Professor and Department Head

Every spring the department awards undergraduates with scholarships funded by generous alumni and friends. This was the first year the department awarded the James K. Grant Scholarship. Jim Grant, who earned his bachelor’s degree in Chemical Engineering in 1969 from Illinois, attended the April 7 ceremony with his wife Pamela Grant, a graduate of the College of Media.

Jim Grant was born and raised in Chicago, the son of a carpenter and a stay-at-home mother. He credits his parents for instilling in him a lifelong desire to learn. After Illinois, he would go on to earn his M.S. in Chemical Engineering from Washington University, his M.S. in Engineering Management from the University of Missouri-Rolla and an M.S. in Chemistry from the University of Missouri-St. Louis. Throughout his career, he has worked with chemists in pharmaceutical process development and managed major environmental remediation and restoration projects at Tyco Healthcare Mallinckrodt. He currently oversees the handling of hazardous material for the Transportation Security Administration of the Department of Homeland Security.

Department Head Dr. Paul Kenis described the scholarship winners as an inspiring group of students and he was confident that they will add to the department’s luster and tradition of excellence.

“The students who sit among you today come from throughout the U.S. and around the world, from small farm towns to cities of over 8 million. Some are among the first in their families to go to college. Others come from a long line of engineers. During their time at Illinois, they’ve established themselves as outstanding, driven students,” he said.

“In addition to excelling in the classroom, many also work in the labs of our faculty members on exciting new research, such as synthesis of electrocatalysts. Several hold leadership positions in student organizations like American Institute of Chemical Engineers (AIChE) and Omega Chi Epsilon (OXE), and the Society of Women Engineers. They volunteer their time tutoring other ChemE students and introducing chemical engineering concepts to high schoolers. They’ve devoted themselves to causes outside the classroom, such as advocating for homeless students. They have dreams of becoming professors, process engineers, doctors and entrepreneurs,” Kenis said.

Congratulations to this year’s winners and thank you to the donors who support these important awards!

Jim and Pamela Grant with scholarship recipient Vivek Vermani outside Roger Adams Laboratory on April 7, 2017.

Scholarship recipients 2016-2017

John Martin Ankenbauer Memorial Scholarship
Isaac N. Strain

Franklin A. Boyle Scholarship
Jacob E. Komenda

Chemical Engineering Alumni Scholarship
Elijah B. Karvelis
Ashley C. May
Omotola O. Okesanjo
Benjamin J. Pedretti
Weikun Zhu

CITGO Scholarship
Pacharapol Charoensuk
Dongkwan Lee

Donald E. Eisele Scholarship
Michael D. Jorgensen

ExxonMobil Scholarship
Seo Woo Choi
Tiernan D. Ebener

Robert S. Frye Scholarship
Atreyo Ghosh

Clarence G. Gerhold Memorial Scholarship
Anthony J. Salazar
Yiling Loh

Dr. Joseph and Donna Glas Scholarship in Memory of Professor James Westwater
June R. Qian

James K. Grant Scholarship
Vivek Vermani

Chester W. Hannum Scholarship
Justin W. Genova
Pimpisa Pechvijitra
Yuying Wu
Zijie Wu
Yijiang Yu
Edwin K. Zen

Edmund D. and Sara J. Heerdt Scholarship
Lauren C. Schmitt
Noah R. Wood

Earp Jennings Chemical Engineering Scholarship
Lucas S. Kreidl

Donald B. Keyes Scholarship
Ethan J. Dukovic

John W. Latchum, Jr. Scholarship
Caleb J. Zmuda

Dr. Ray A. Mentzer Scholarship
Victor Qiao

Omega Chi Epsilon Scholarship
Byeongjin Kang
Alexandra N. Warton

Edward I. Onstott Scholarship
Daniel J. Cordero
Awele Bill Uwagwu
Junli Wu

Raymond M. Pasteris Scholarship
Christian T. Monte

Pathways to Success Scholarship
Austin R. Cepeda
Daniel J. Cordero
Andrew S. Morrice
Liam J. Quinn
Anna R. Welton-Arndt

Phillips 66 Scholarship
Rebecca L. Boehning
Jesus Dominguez
Mikaela R. Dressendorfer

Worth Huff Rodebush Scholarship
Shawn Lu

Thomas R. and Yolanda S. Stein Scholarship
Madeleine M. Chalifoux
Yijung Chen
Sohum K. Patel

Glenn E. and Barbara R. Ullyot Scholarship
Kenan Al-Bardan
Francisco Canales
Scott J. Kieback
Alexander J. Koutsostamatis

R. J. Van Mynen Chemical Engineering Scholarship
Faisal A. Aldukhi
Nicholas Y. Chan

Bruno H. Wojcik Scholarship
Moeen S. Meigooni

Alumnus Jim Grant (BS '69) delivers remarks at the scholarship ceremony while department head Dr. Paul Kenis looks on.

Undergraduate Research Symposium

The Illinois chapter of Omega Chi Epsilon, the national honor society for chemical engineering, celebrated another successful Undergraduate Research Symposium on April 7, 2017.

This year's judges included **John Schnake**, BS '89, who is corporate director of process analyzers at Endress+Hauser Group; **Corey Correnti**, BS '85, retired executive from BP and currently consultant to energy companies; and **John Bassett**, BS '72, also retired, having worked in petroleum refining and the mining industry, most recently as Vice President of Operations for Molycorp and president of Seadrift Coke.

Thirteen undergraduates presented at the symposium.

First place winner was **Edwin Zen** of the Rao Group with his presentation, "Selection for enhanced growth yield strains of Escherichia coli in xylose via emulsion-based encapsulation."

Second place went to **Moeen Meigooni** of the Shukla Group with, "Molecular Perspectives on Agrochemical Control of Drought Resistance."

Third place was a tie. Those winners included the team of **Omotola Okesanjo and Robert Schneider** of the Guironnet Group with "Topology Control of Bottlebrush Polymers" and **Kenan Al-Bardan** of the Yang Group with "High performance oxygen evolution catalysts for water splitting in acidic electrolytes."

In addition to the winners, this year's symposium's participants included the following:

Mikaela Dressendorfer and Kristen Lee (Guironnet Group), Advanced Polymer Architecture Synthesis and Characterization.

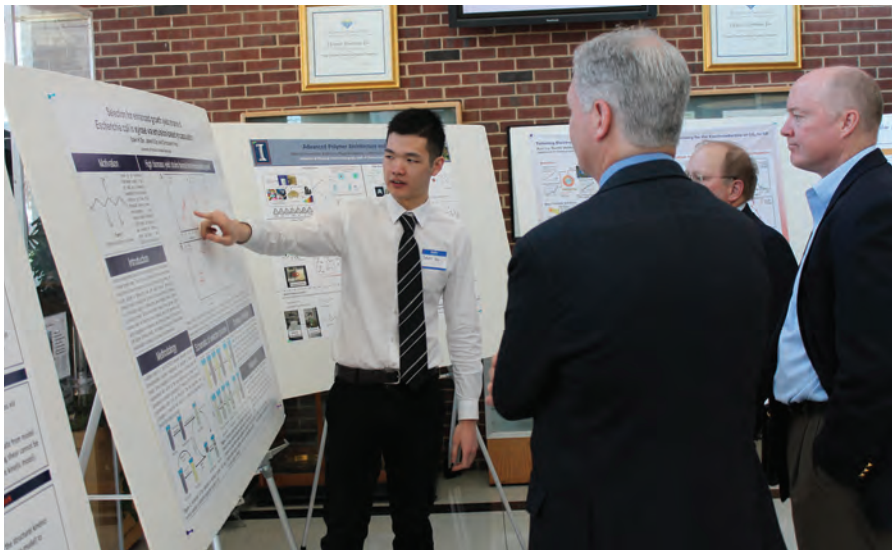
Xun Lu (Kenis), Tailoring Electrolyte Composition to Improve Activity and Energy Efficiency for the Electroreduction of CO_2 to CO.

Ugonna Oduocha (Rogers Group), Fluidization and Aging of Colloidal Gel.

Pimpisa Pechvijitra (Murphy Group), Development of an Aerosol Delivery System for Gold Nanoparticles.

June Qian (Sing Group), Single Chain Dynamics of Ring Polymers in Dilute Solution Under Mixed Flows.

Weikun Zhu (Diao Group), Application of image analysis on the investigation of growth kinetics of C8BTBT.



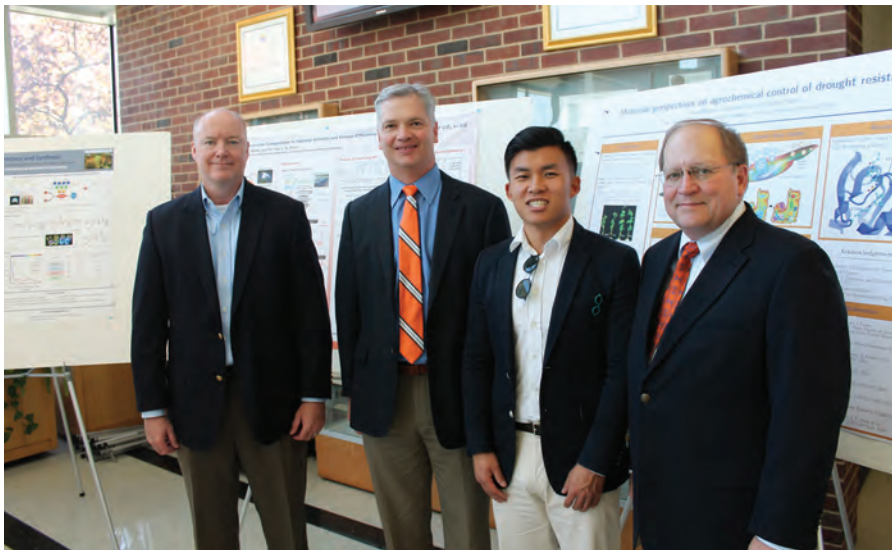


Photo above: First-place winner Edwin Zen discusses his work with the judges.

Photo on left: Omega Chi Epsilon President Byeongjin Kang (second from right) with this year's symposium judges (from left) John Schnake, BS '89; Corey Correnti, BS '85; and John Bassett, BS '72.

ENGINEERING OPEN HOUSE 2017

Curious students, from grade schoolers to high schoolers, packed Loomis Laboratory to learn about a variety of chemical engineering applications as part of the 97th Engineering Open House. They learned about everything from cyclone separators to homemade lip balm and they sampled the always popular liquid nitrogen ice cream.

Engineering Open House was held March 10-11, 2017, with over 250 exhibits and several design competitions. The theme for this year's open house was Illuminate New Horizons.

Congratulations to ChBE students involved in winning exhibits: "Oil Spills and Ferrofluidity," which won third place in the Go Green (Sustainability) category; "Edible Liquids & Photolithography," which won third place in the Best Freshman Exhibit; and "Illuminate Your Mind," which won third place in the Illuminate New Horizons presented by ExxonMobil category.

Photo on top: A lesson on ferrofluids and how they can help clean up oil spills.

Photo in middle: Experiments on treating gastroesophogeal reflux disease.

Photo on bottom: Tim McGregor and Lily Chen, both 2015 graduates, represented ExxonMobil at its corporate booth in Engineering Hall.

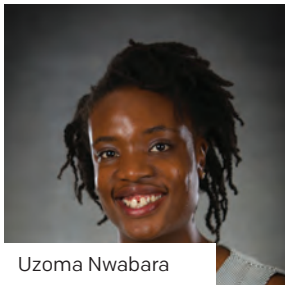
Graduate Student Achievements


Jason Adams

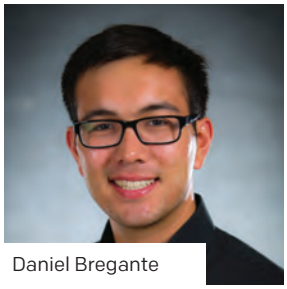

Raul Sun Han Chang


Jason Madinya


Aleczandria Tiffany


Uzoma Nwabara


Katelyn Dahlke


Daniel Bregante

Four receive NSF fellowships

The department is thrilled to announce that four graduate students in Chemical and Biomolecular Engineering have been chosen for National Science Foundation Graduate Research Fellowships for 2017-2018 and one student has received an honorable mention.

Congratulations to fellowship recipients **Jason Adams**, **Raul Sun Han Chang**, **Jason Madinya**, and **Aleczandria Tiffany**. They joined the department in Fall 2016. In addition, **Uzoma Nwabara** received an Honorable Mention. She also joined the program last fall.

For the 2017 competition, the NSF received over 13,000 applications, and made 2,000 award offers. Launched in 1952, the NSF Graduate Research Fellowship program is the nation's oldest and largest fellowship program for graduate students. It is also one of the most prestigious.

Aleczandria Tiffany completed her undergraduate studies at the University of Southern California and is a member of Associate Professor Brendan Harley's research group. Raul Sun Han Chang's bachelor's degree is from Pomona College and he also is a member of Dr. Harley's research group.

Jason Madinya earned his bachelor's degree from Florida State University and is a member of Professor Deborah Leckband's research group and Assistant Professor Charles Sing's group. Jason Adams completed his undergraduate studies at Georgia Tech and is a member of Assistant Professor David Flaherty's lab. Uzoma Nwabara earned her bachelor's degree from the University of Michigan and is a member of Professor Paul Kenis' group.

Future Faculty Fellows

Congratulations to graduate students **Katelyn Dahlke** and **Daniel Bregante**! Both have been chosen to be Mavis Future Faculty Fellows (MF3) for the 2017-2018 academic year.

The College of Engineering program is designed to facilitate training for the next generation of great engineering professors. There are three main components: teaching, research, and service. All fellows will become proficient in these core areas through various activities and events. The activities in each area will be designed to enhance the graduate students' experiences in their departments. In addition, the fellows will complete a capstone experience that will enhance their professional development in a self-directed area.

As a student in Professor David Flaherty's lab, Daniel Bregante is working on catalysts and catalytic systems for the selective epoxidation of olefins and oxidation of hindered sulfides. He completed his undergraduate studies at the University of California, Berkeley in Chemical Engineering with a minor in Chemistry.

Katelyn Dahlke is a student in Dr. Charles Sing's lab where she does theory and computation of polymer physics. Specifically, she studies the cooperative behavior of DNA and protein interactions specific to prokaryotic cells, and eventually would like to use the methods she develops to simulate an entire nucleoid. She received her undergraduate degree in Chemical Engineering from Iowa State University.


Megan Witzke


Thao Ngo


Maggie Bridgewater


Evan Lloyd


Shekar Mishra


Zahra Shamsi

Witzke awarded TechnipFMC fellowship

Graduate student **Megan Witzke** has been selected to receive the TechnipFMC Fellowship for 2017-2018. Witzke is a member of Assistant Professor David Flaherty's lab. Her research aims to improve the catalytic conversion of biomass derivatives to higher value chemicals by determining the reaction mechanism and underlying factors that control catalyst selectivity. She entered the ChBE graduate program in Fall 2013 after earning a B.S. in Chemical Engineering from Case Western Reserve University.

The fund was originally created by Bert A. Gayman, a mechanical engineering graduate of the University of Illinois with a gift of shares of Chicago-based Link-Belt Company, later acquired by FMC Corporation. FMC recently merged with Technip to create TechnipFMC, a global leader in subsea, onshore/offshore and surface projects. The fund supports scholarships, fellowships, and research.

Ngo chosen for Lindau meeting

Graduate student **Thao Ngo** was invited to participate in the 67th Lindau Nobel Laureate Meeting this summer. She is a graduate student in the lab of Dr. Hong Yang, the Richard C. Alkire Professor of Chemical Engineering. Her research focuses on studying the growth and dissolution of Pt-based nano catalysts using in situ electron microscopy and x-ray based techniques.

Ngo is a National Science Foundation Graduate Research Fellow who received her B.S. in Chemical Engineering from Arizona State University in 2013. She joined the department in Fall 2013.

The 67th Lindau Meeting will focus on chemistry and take place in June 2017. Ngo is the only awardee from the University of Illinois to be invited to the scientific conference this year. Since they began in 1951, the meetings have become an international forum for scientific exchange, bringing together Nobel Laureates and the next generation of leading scientists, including post-doctoral researchers and graduate and undergraduate students.

Excellent TAs

Congratulations to ChBE graduate students who, as Teaching Assistants, were included on the list of Teachers Ranked as Excellent by their Students for the Fall 2016 and/or Spring 2017 semesters: **Maggie Bridgewater**, **Evan Lloyd**, **Shekar Mishra, Zahra Shamsi**, **William Balance**, **Andrew Kuhn**, and **Carl Schultz**. The results are based on Instructor and Course Evaluation System (ICES) surveys maintained by the university's Center for Innovation in Teaching and Learning.

Undergrads recognize outstanding TA

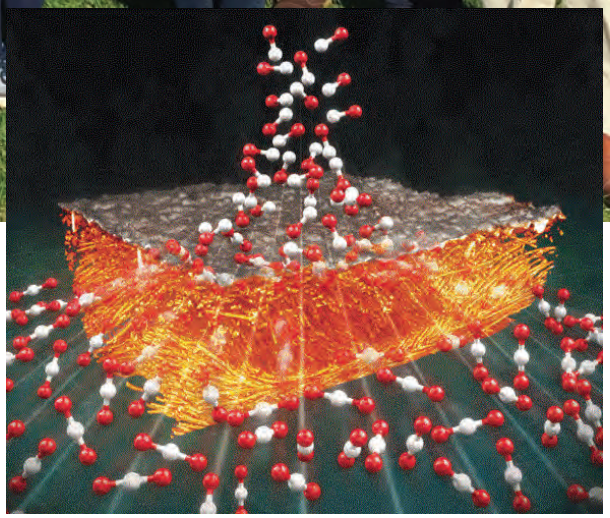
Chemical and Biomolecular Engineering's Undergraduate Advisory Board has begun an effort to recognize the department's outstanding teaching assistants. The first recipient is ChBE graduate student **Maggie Bridgewater**.

This is the first semester the undergraduate group has presented awards to TAs. Members hope to continue the practice every semester, said Palak Patel, a member of the department's Undergraduate Advisory Board.

The undergraduate group solicited nominations from students and Bridgewater was chosen "because of her incredible dedication to teaching. Teaching is not a graduate student's main focus, so it is impressive that she's able to do both (research and teach)," Patel said.

Bridgewater was most recently a TA for CHBE 422: Mass Transfer Operations.

PAUL KENIS:
At the crossroads of engineering and the sciences



From his early work in supramolecular chemistry to new advances in carbon dioxide reduction, most of Dr. Paul Kenis' research has had a common theme: applying chemical engineering principles to address challenges in energy and biology.

Kenis, the William H. and Janet G. Lycan Professor and head of the Department of Chemical and Biomolecular Engineering, oversees a diverse research portfolio. His initiatives have often involved Illinois colleagues from a variety of fields, such as biology and chemistry. His projects have spanned the globe and included peers from Singapore, France, and the International Institute for Carbon-Neutral Energy Research (I^2CNER) at Kyushu University in Japan. His work also often involves collaborations with companies such as Dow Chemical and AbbVie.

"I like to do research that has a somewhat direct impact on society. There are a few exceptions, but most of our efforts are applied in nature or focus on unravelling disease-related biology," he said.

Kenis joined the University of Illinois Department of Chemical and Biomolecular Engineering in 2000 and became head of the department in 2011. Since landing at Illinois, he has received a number of accolades, including being appointed a University Scholar and a Beckman Fellow. He has received teaching and advising awards from the School of Chemical Sciences and the College of Engineering.

In recent years he and his research group have become known around the world for their scholarship and research in **electrochemical reduction of carbon dioxide** to valuable intermediates such as carbon monoxide and ethylene for the production of synthetic fuels or other chemicals. They have published results in journals such as *Nature Communications* and written often-cited review articles on the current

> "I like to do research that has a somewhat direct impact on society. There are a few exceptions, but most of our efforts are applied in nature or focus on unravelling disease-related biology."
>
> **Dr. Paul Kenis, William H. and Janet G. Lycan Professor and Department Head**

status and remaining challenges of CO_2 utilization research.

In addition to being a leader in electrochemical CO_2 reduction, he is active in three other areas: (1) **Microfluidic Crystallization** such as crystallization of proteins and subsequent on-chip X-ray data collection, or to identify suitable solid forms of candidate drugs; (2) **Microreactor Technologies** for efficient synthesis of radiopharmaceuticals or anisotropic nanoparticles for lighting applications; and (3) **Biological Study Platforms** to investigate antibiotic susceptibilities of bacteria, to study tumor cell behavior in low-oxygen environments, and to study protein folding related to Alzheimer's and other diseases.

From the Netherlands to the United States

Kenis' scholarly interests and research pursuits have always been diverse, spanning biology to materials and mechanical engineering. As a child growing up in the Netherlands, he enjoyed taking apart devices like coffee machines and radios. In high school he gravitated toward physics and chemistry and when it came time to choose a university, he decided to pursue chemistry at Radboud University in Nijmegen. As an undergraduate he conducted a year of research on supramolecular model systems for metalloproteins with Professor Roeland Nolte. While at Radboud, he discovered his love of research and decided to pursue his PhD degree in Chemical Engineering with Professor David Reinhoudt at the University of Twente. There he studied supramolecular materials for optical data storage applications.

"We studied thin films of so-called molecular materials and applied all kinds of spectroscopy, imaging, and other characterization techniques to unravel structure-property relationships. I learned a lot about these different techniques as well as how to synthesize these molecules and polymers," he said.

After obtaining his PhD, Kenis received a postdoctoral fellowship from the Netherlands Organisation for Scientific Research to join the lab of Professor George Whitesides, a leader in supramolecular chemistry, at Harvard University. At Harvard, instead of diving further into supramolecular chemistry, he transitioned into microfluidics.

"At that time, the field of microfluidics was in its infancy, so everything we did was fascinating, unexpected and new!" he said.

Kenis' work there led to several publications in high-impact journals, including one in *Science* in which he reported the ability to fabricate microscale structures inside sub-millimeter capillaries, which was akin to building a ship in a bottle. As a result of this success, his intended one-year postdoc lasted almost three years.

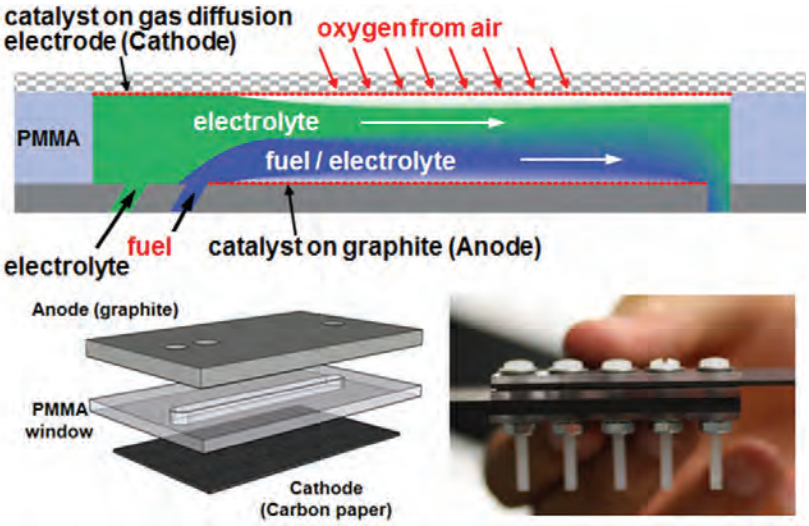
"Nolte, Reinhoudt, and especially Whitesides taught me to think outside of the box, and how to choose which problems to solve by asking questions like, 'Who will care?' The interdisciplinary and exploratory nature of those three labs provided the critical basis for my success at Illinois."

Early collaborations at Illinois

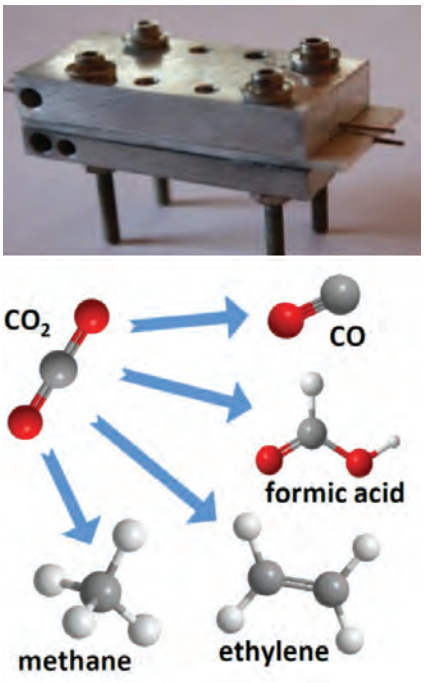
Kenis joined the Illinois faculty in 2000 as an assistant professor; he was recruited by then-department head Chip Zukoski. What stood out to him at Illinois was its culture of collaborative, interdisciplinary research occurring among faculty of different departments.

Together with two Illinois colleagues—retired ChBE Professor Rich Masel and late Mechanical Science and Engineering Professor Mark Shannon—Kenis started to pursue all kinds of microchemical systems type of research. One project looked at microfuel cells and another focused on microreactors for hydrogen generation.

In his first five years at Illinois, he also developed membrane-less fuel cells, that instead of a membrane use laminar flow to keep the anode and cathode compartments separated.



Early Illinois work: Membrane-less fuel cells.



Electrolyzer flow cell for and schematic for carbon dioxide reduction to different products.

This concept was commercialized by a startup company, INI Power Systems.

His collaborations and projects expanded into several more areas, such as protein crystallization with Chip Zukoski and other Illinois faculty, and cell biology with Deborah Leckband, Rex Gaskins, and others at the Carl R. Woese Institute for Genomic Biology.

"My research program is quite broad and is sitting at the crossroads of engineering and all the sciences. We know enough about chemistry and biology to apply engineering concepts such as transport phenomena to them. From a research point of view, we can pursue exploratory research on chemical or biological problems without the risk of ending up outside the boundaries of the chemical engineering discipline," he said.

Leading CO_2 reduction research

At Illinois, Kenis has always been active in electrocatalysis, first with a focus on fuel cells. Then about a decade ago that research led to carbon dioxide reduction via electrolysis, which basically resembles running a fuel cell in reverse. On a Friday afternoon in 2009, one of Kenis' students (Devin Whipple, PhD '11) switched a catalyst from platinum to tin and ran the fuel cell in reverse. It worked: formic acid was being formed!

This approach of using CO_2 as a feedstock reduces atmospheric CO_2 emissions, and offers a path to chemicals that are typically derived from fossil fuels. It can also be an efficient means of storing otherwise wasted renewable electricity from intermittent sources at times when supply exceeds grid demand.

"We were one of the first ones to pursue electrochemical CO_2 reduction at the time," he said. "We also quickly realized that converting CO_2 to CO or ethylene would be much more interesting, be it for the production of synthetic fuels (Fischer-Tropsch) or other chemicals. Finding catalysts that selectively steer exactly towards the C2 products like ethylene and ethanol is one of biggest challenges we are facing now."

The Kenis research group has become a well-known leader in this area. Together with collaborators Andrew Gewirth from Chemistry at Illinois and Professors Nakashima, Yamauchi, Fujikawa, Fujigaya, and Lyth from I²CNER in Japan, his group has developed some of the world's most active and selective catalysts and electrodes for the production of CO and ethylene. Most recently the group, with researchers at I²CNER and Rice University, showed how simple, cheap, nitrogen-doped carbon materials are adept at catalyzing carbon dioxide into a mixture of hydrocarbons.

"The question is, how to turn such a promising result into a technology that can help to reduce atmospheric CO_2 emissions while at the same time we reduce our dependence on dwindling fossil fuel reserves?" Kenis said. "Indeed, companies such as Siemens have taken notice and have started to test this CCO_2 electrolysis technology at pilot plant scale, based on our experimental results as well as the techno-economic analyses we performed in collaboration with colleagues from Illinois and Japan!"

New, expanded partnerships

Kenis has always partnered with industry to address their problems. In recent years, a number of major long-term partnerships have developed. For example, for about a decade his group worked with AbbVie to develop microfluidic screening tools to identify suitable solid forms for pharmaceutical formulation. A new project looks at recrystallization of active pharmaceutical ingredients in pills, to ensure their stability on the shelf.

Meanwhile, Dow Chemical continues to support his efforts to develop continuous flow microreactor technology for the synthesis of anisotropic semiconductor nanoparticles that may find application in lighting and display technology. And most recently, Shell has started to sponsor his research on CO_2 valorization in a significant way.

"The question is, how to turn such a promising result into a technology that can help to reduce atmospheric CO_2 emissions while at the same time we reduce our dependence on dwindling fossil fuel reserves?"

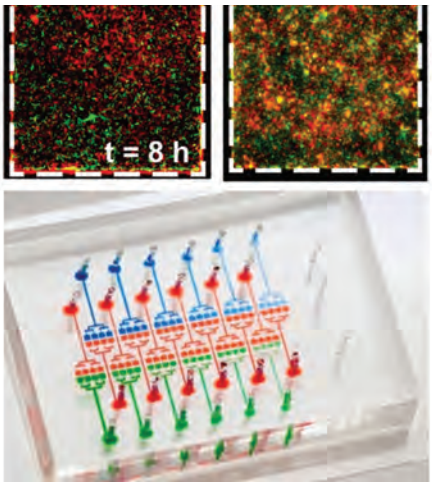
Dr. Paul Kenis, William H. and Janet G. Lycan Professor and Department Head

Other exciting projects currently underway include a "lung on a chip" effort funded by the National Institutes of Health. Kenis, Deborah Leckband in ChBE and Professor Cathy Murphy in the Department of Chemistry are interested in understanding the effects of nanoparticles on lungs. Kenis' role in this project is to create a microfluidic platform that recreates the periodically expanding and contracting endothelial epithelial membranes responsible for oxygen uptake in our lungs.

In addition to receiving funding from corporate partnerships and federal agencies, some of Kenis' research is funded by his endowed professorship established by the late William H. and Janet G. Lycan, both graduates from Illinois.

"This type of unrestricted support through legacy gifts from alumni truly helps to pursue interdisciplinary research ideas before they are ready for external funding," he said.

The diversity of his research is also reflected in the diversity of destinations among his PhDs (40+ by now) upon graduation. Many have gone into industry, to companies like DuPont, BP, Dow, 3M, UOP, P&G, and Intel, several to smaller energy or biotech companies, while others have joined academia, including Penn State, U Mass – Amherst, and MIT.



Polymicrobial model system of E.coli and P.aeruginosa in microfluidic chip for antibiotic susceptibility testing.

Dr. Paul Kenis with his advisors in Fall 2007, on the occasion of the retirement of David Reinhoudt. From left: postdoc advisor Dr. George Whitesides, Harvard University; PhD advisor Dr. David Reinhoudt, Twente University; Kenis; and undergrad advisor Dr. Roeland Nolte, Radboud University Nijmegen.

Also common to his research projects is the frequent involvement of undergraduate researchers. Many have been listed as co-authors on papers. Undergraduates not only bring an extra set of hands, they also bring more enthusiasm to the lab, he said. Working in a lab provides undergrads with hands-on, team-based project experience, and it helps them determine if they want to pursue graduate school.

A few of Kenis' former undergraduate researchers—Jason Goodpaster (BS '08) at the University of Minnesota and Brian Boudouris (BS '04) at Purdue—are now on the faculty at leading universities. Others have gone into industry, with some, rapidly assuming leadership roles, like Ajay Virkar (BS '05) who is now the Chief Technology Officer at C3Nano.

"Seeing your graduates go out and be successful is very rewarding. Without a doubt, their achievements will vastly exceed my lifetime accomplishments here at Illinois!"

Outside of work, Kenis continues to play soccer both indoor and outdoor in local leagues to stay fit. He and his partner Professor Mary Kraft travel annually to places such as Yellowstone National Park, Costa Rica, and Alaska in search of wildlife in its natural habitat. He also likes mountaineering, and has climbed Mt. Rainier in Washington, Mt. Whitney in California as well as Mont Blanc and others in Europe in recent years.

"Being in nature, away from the hustle and bustle of our daily lives a few times a year is very refreshing and allows me to recharge my battery and to think about what challenges to pursue next."

Catching up with...
TONY MCHUGH

When Tony McHugh and his wife, pianist Donna Farese McHugh, arrived in Champaign-Urbana in 1979 from the East Coast, they figured they would stay for about five years, then they'd move on. They ended up staying 23 years—"some of the best years of my life," McHugh recalls fondly.

Today McHugh is the Ruth H. and Sam Madrid Professor of Chemical and Biomolecular Engineering at Lehigh University in Bethlehem, Pa. Prior to that, he was a longtime Chemical Engineering faculty member at Illinois, teaching hundreds of undergraduate students and guiding 40 graduate students through their M.S. and Ph.D. programs.

A Fellow of the American Institute of Chemical Engineers, he has published over 200 technical articles and presented more than 250 seminars. The Ohio native received his bachelor's degree from Cleveland State University and his MS and PhD from the University of Delaware. McHugh served on the faculty at Lehigh from 1971 to 1979 before joining the University of Illinois. He was here until 2002.

Q: What have you been up to since you left Illinois for Lehigh?

My wife Donna and I live in Coopersburg, Pa., about 60 miles north of Philadelphia and 80 miles west of Manhattan, in the rolling hills of the Lehigh Valley. I was department chair (for Lehigh University's Department of Chemical and Biomolecular Engineering) for just under 10 years. I stepped down around 2013, took a sabbatical, then went back to being a full-time professor.

I teach the standard, introductory chemical engineering course—material and energy balances of chemical processes. I also teach a lab course on unit operations as well as a required chemical engineering survey course for non-majors. I've always loved teaching. I enjoy the idea of learning a subject and transmitting the information to students in such a way that hopefully they light up and learn from me. It's a very rewarding experience and a real privilege to work with young people.

Q: What research or other projects have you been involved in recently? What prompted you to write the 2015 book, *An Introductory Global CO_2 Model*?

I had a large, active group at Illinois, with superb students, competitive, highly ranked, just the cream-of-the-crop students. They played a central role in the development of my career. When I left in 2002, my research group included about 10 people. At that time I decided to ratchet-down my research activities and devote more time to administrative issues at Lehigh and hiring some excellent young faculty.

Back in the '70s when I was a faculty member at Lehigh, Bill Schiesser (now the R.L. McCann Professor Emeritus of Engineering and Mathematics at Lehigh) had funding from the National Science Foundation to develop mathematical models or computer programs of meaningful societal problems that could be distributed to a broad audience, including teachers at the two-year college level. We fell into the problem of global CO_2 distribution at a time when it was just beginning to attract attention beyond the environmental science communities. That model was modified and we made programs to distribute to two-year colleges as a teaching tool. ... (Fast forward a few decades the two researchers reconnected to produce the book, An Introductory Global CO_2 Model, published by World Scientific Publishing Corp.)

The book is not a research manuscript but rather a handbook that describes a model for the global distribution of carbon dioxide, which is being produced anthropomorphically through the burning of fossil fuels. The model addresses how CO_2 is redistributed to the upper and lower atmospheres, land biota, the oceans and marine life therein.

Bill Schiesser and I wrote the book with a co-author from England (Graham Griffiths) with the idea of making the model accessible to a general audience, all the way to the high school level. People with an elementary level of calculus will be able to easily absorb these programs and teachers could use them both as teaching tools for learning two popular computer programming codes, as well as interactively studying the environmental impacts of carbon dioxide on a global scale by modifying the model parameters. The impact of CO_2 (the major of the so-called greenhouse gases) on the environment is arguably one of the most important and pressing issues facing society today.

Q: You were at Illinois for over 20 years and advised a number of graduate students during that time. Do you ever get to reconnect with them?

There's a number of them I've kept in touch with, particularly those who've gone into academics since we often cross paths at technical meetings and other venues. Just to name a few, Bamin Khomami (Granger and Beaman Distinguished University Professor at the University of Tennessee), who did his PhD with me in the mid- to late-80s is department chair. Another student, Mike Mackay, is a materials scientist on the faculty at Delaware. Matt Liberatore, one of my last students at Illinois, was on the faculty of the Colorado School of Mines, and is now at the University of Toledo. Wes Burghardt did his bachelor's thesis project with me, stayed to get his master's and then went to Stanford where he earned his PhD. He's on the faculty at Northwestern and was chair there. These are just a few, however, all the students I worked with at Illinois were absolute gems, technically as well as being first-rate people.

Q: Have you been able to return to the University of Illinois campus since 2002? Many people will fondly remember your wife, pianist Donna Farese McHugh, and the events you hosted together.

My wife and I started a musical series in our home in Urbana called Hausmusik, Meet the Artist, which involves musical performances by world class artists in a salon setting reminiscent of the way music was originally performed before the advent of the large concert venues we know today. In fact, just this month one of our concerts was video-taped and televised on the local Lehigh Valley PBS station, Channel 39.

The concept of Hausmusik was developed in 1995 by my wife and a close friend and cellist then on the Illinois music faculty, Suren Bagratuni. It was brought to the community by way of the efforts of a spectacular group of women who were members of the university's World Heritage Society. When we moved to Pennsylvania, we didn't have plans to continue the concerts, however, our then real estate agent (now very close personal friend) encouraged us to reinstate it in the Lehigh Valley. Because of its size and the presence of my wife's two concert grand Steinway pianos, our house provides an ideal venue.

Several of our artists have performed in world class venues such as the New York and Philadelphia Orchestras and have been medal winners of major competitions, such as the Tchaikovsky, the Gina Bachauer, and the Naumberg. Hausmusik has 501(c) 3 charitable status, and we use the funds generated from the concerts to support various music scholarships as well as to promote the careers of the artists through concerts in New York and elsewhere that we sponsor. Typically we will have 40 or 50 people in our home, with cocktails, the concert, followed by a full dinner and the opportunity to meet the artists. It's been a labor of love and a phenomenal success. We host about three or four a year, about the same number of concerts as we did at our house in Illinois.

The friendships we made in Champaign-Urbana are very lasting. We've maintained relationships with close friends and will periodically meet up with them when we return or we'll meet in Chicago. On the professional side, I occasionally see some of my former colleagues from the "old days" such as Jon Higdon, Dick Alkire, Ed Seebauer and Rich Masel at technical meetings or seminars where we have a chance to catch up and reminisce about the "Illinois days." I also keep up with recent activities in the department though the alumni magazine.

Q: Is there anything you miss about the U of I or Champaign-Urbana? What do you have to do or see when you return?

Many things, of course, the milieu of the university and the Chemical Engineering Department which were and still are world class educational gems. The late Jim Westwater was chair of the department when I was hired and was a mentor to me in many ways. The late Tom Hanratty was also a colleague and friend with whom I interacted professionally – we published several papers together toward the end of my Illinois days. I miss those as well as the interactions I had with other colleagues in the department over those years. It was a truly great experience to share educational goals at such a high level.

Whenever Donna and I visit, THE restaurant we frequent with our friends is Timpone's. We have large parties there often and will celebrate birthdays and other events there.

Q: How are you spending your free time these days?

We often travel for music-related events in New York City. We're seeing Renee Fleming cap off her phenomenal Metropolitan opera career later this month with a performance of "Der Rosenkavalier" which, by the way, Donna and I will be seeing for the first time – very exciting.

I'm a music listening aficionado. I'm like a kid in a candy shop surrounded by great artists – most especially my wife. And I love to read. Donna jokes that I probably have more books on Albert Einstein than any library. There's something special about his life that I find fascinating. His science, through the Special and General theories of Relativity are, of course historic in impact. I actually enjoy delving into the math and physics. Equally important to me is that, in addition to being one of the greatest scientists of all time, Albert Einstein was also a great humanist – his thoughts on life, though generated from a perspective of the early and mid-twentieth century, remain compelling and relevant in today's world.

Although we do not have children of our own, we do instead have a "secondary" family of close friends, including former students from Donna's teaching career and professional colleagues around the world with whom we keep in touch and socialize. It has been a great experience!

Chung Sul Youn Kim (Sue Kim): **Driven to Excel**

1955 alum, who was told ChemE would be too tough for her, graduated at top of the class.

In 1953, when Chung Sul Youn transferred to the University of Illinois from Denison University — having moved 6,500 miles from her homeland of Korea, survived life under Japanese occupation, World War II, and the outbreak of the Korean War – she found herself sitting across from Professor H. Fraser Johnstone and being discouraged from studying chemical engineering.

The rigorous program would be too hard for a woman, she recalls being told. But she was determined to enter the program and asked to be admitted on a probationary basis.

"When he [Johnstone] said I would have to get at least a C average, I even bet with him that I would get at least a B average the first semester. My bold statement provided a great motivation for me to succeed," she recalled.

Two years later, Chung Sul Youn would graduate first in her class, receiving recognition from the university president, a gold pen from the wife of the Korean president, her name engraved on a Bronze Tablet, and a recognition badge from the engineering honor society, Tau Beta Pi, which at the time did not allow women to become members.

She is believed to be the first woman to have received a bachelor's degree in Chemical Engineering from the University of Illinois.

"There was definitely open prejudice, my being an Asian and a woman. However, my natural inclination was not to debate my capability, but to demonstrate it," she said.

Chung Sul recently had her biography, "Can Do!" by David Valley, published and released by Amazon.

Chung Sul (Sue) at Commencement 1955 with University of Illinois President Lloyd Morey; her mother, Yong Kim, and Liberal Arts & Sciences Dean Joseph R. Smiley. Credit: University of Illinois Archives.

> "At Illinois, I soon found out I was just one of many bright students in Engineering. ... I knew early on I would have to step up my drive to excel."
>
> **-Chung Sul Youn Kim (Sue Kim)**

Always a go-getter

Born in 1932 in Seoul, Korea, the fourth of seven children, Chung Sul started reading at age three. She was a bright child, advancing quickly through school and skipping two grades in high school.

She wanted to study chemistry, thinking it would be beneficial to her father's business. He manufactured a special oiled paper that was used in "ondol" flooring systems, which involves floors being heated from underneath. (Her father became president of the Korean Paper Association, and later, vice minister of finance, and president and founder of the South Korean Stock Exchange.)

In 1949, Chung Sul was accepted at Seoul National University to study chemistry, but the Korean War interrupted her studies there. Her parents helped her to continue her education in the U.S. and she enrolled at Denison University. After two years at Denison, she transferred to the U of I because of its national reputation and her desire to major in chemical engineering.

"At Illinois, I soon found out I was just one of many bright students in Engineering. ... I knew early on I would have to step up my drive to excel," she said.

She logged many hours studying in the library and in labs, but she also made time to develop friendships with other Korean students and Americans. She has fond memories of listening to music, learning jokes, and a few times she even joined other girls when they snuck out of the dorm past curfew.

In 1955, she graduated first in her class and was thrilled when the university invited her mother to travel from Korea to attend commencement.

"I was like an athlete who trains hard to excel and then suddenly finds oneself crossing the finish line first. The shock suddenly hits home as you realize you did it. I knew many of my bright classmates could have been the first. There was more than a little shock by the university—a Korean girl who had been expected to fail miserably in chemical engineering became the top student in her graduating class," she said.

Early career

Even though Professor Johnstone initially discouraged her from studying chemical engineering, it was he who would encourage her to pursue graduate studies. He recommended Cornell University and helped her to obtain a scholarship.

While at Cornell, Chung Sul decided to change her focus from chemical engineering to polymer chemistry because she was interested more in creative basic research. As a PhD student she worked in the research group of Professor William T. Miller, who specialized in fluorine chemistry and polymers.

"I felt that I would be able to design and create new useful polymer products through the understanding of the mechanisms of reactions."

In 1957, she married Eun-Chol Kim, a Korean student who came to U.S. to study Educational Administration at the State University of New York at Albany. In 1959, they moved to Cleveland, Ohio, the same year she received her PhD. She accepted a part-time position—at the time she was pregnant with her first child—at Standard Oil of Ohio. Six weeks after giving birth to her son Stanley in 1960, she returned to work and obtained a permanent position as a project leader. Six months later she became pregnant again and gave birth to a daughter, Emily. Around this time she and her husband adopted the American names of Sue and Eugene.

Being a female scientist in a male-dominated field, especially being married and raising young children, wasn't easy. But she and Eugene made it work. Sue enjoyed her research work—"I found it exciting"—and didn't plan to leave her job, as many women did in those days.

At Standard Oil, she searched for a practical approach to produce a commercially feasible acrylonitrile polymer. After many months of research she found a way to copolymerize the acrylonitrile with hydrocarbons, 1, 2 olefins. The nonpolar olefins would disrupt the orientation of cyano-groups and prevent the thermoplastic from fibrillation during injection molding. Both monomers she used were raw materials produced by the company. She was praised for her work, patents were filed, and a vice president presented the results at the Sixth World Petroleum Congress in Frankfurt, Germany in 1963. She

> "I was like an athlete who trains hard to excel and then suddenly finds oneself crossing the finish line first. The shock suddenly hits home as you realize you did it."
>
> **-Chung Sul Youn Kim (Sue Kim)**

remembers extensively coaching the executive for his presentation.

In 1962, her husband was offered a teaching position at Western Washington University and the family moved to Bellingham, Wash. There was only one potential employer in the area at the time, Georgia Pacific. As she sought employment she remembers being told, "You have two strikes against you: you are an Asian and a woman." Meanwhile she translated papers from Japanese and wrote their abstracts for the *Journal of the American Chemical Society*. Sue, however, was persistent. She visited Georgia-Pacific armed with recommendations by professors and former employers and finally landed a part-time job there. Her assignment was to create a commercial product from lignosulfonates, a waste-product from their wood pulp production. She again succeeded by creating a patented and valuable commercial product for the oil drilling industry.

California bound

In 1965, Eugene was offered a teaching position at California State University, and the family moved to the Sacramento area. After a short stint doing post-doctoral research in the Department of Biochemistry at the University of California, Davis, Sue found a job at Aerojet, a rocket and missile propulsion manufacturer in Rancho Cordova, Calif.

Because Aeroject was located near Lake Natoma, she was able to spend her lunch hours swimming, an activity she enjoyed ever since she was a child when she and her siblings swam in the Yellow Sea. She was also passionate about a number of other outdoor sports, such as windsurfing, snorkeling, scuba diving, and especially free-diving for abalone. She and her family also went on numerous skiing trips from Banff, Canada to the Lake Tahoe area of California.

In California, Sue started investing in real estate. She even toyed with the idea of becoming a full time commercial real estate broker/investor, but enjoyed science too much to give it up. However by 1973 she was ready to transition from industry to academia.

When a faculty position in organic chemistry at the California State University, Sacramento became available in 1973, she applied and was offered the job. She would later establish the Polymer Research Institute at the university, working with agencies such as the U.S. Air Force and Navy, and consulting for industrial companies. In 1989 she was awarded the Outstanding Scholarly Achievement Award, selected from over 800 faculty members. Throughout the years she also received awards from the university for her research and teaching efforts.

Retirement

At age 65, while on a dive to capture a large abalone off the coast of Mendocino, she damaged her inner ear and eventually lost much of her hearing. Around the same time, her 96-year-old father became ill in Korea. Since Sue regretted not being able to spend more time with her mother before her death in 1988, she retired at 66 and went to Korea to be with her father until his passing.

After retiring, she stayed as active as ever. Sue played on a U.S. Tennis Association Senior team and continued snorkeling, water skiing, snow skiing and more. Frequently she could be seen on a windsurfing board gliding around Mission Bay, San Diego. Over the years before Eugene fell ill and passed away in 2013, Sue and Eugene traveled around the world to Europe, Russia, South America, South Pacific, Australia and New Zealand.

She met David Valley while playing tennis and they married in 2015. Today she and David enjoy life in San Diego along with travel and frequent cruises. Vigorous sports are no longer advisable, but they still enjoy snorkeling in places like Hawaii and French Polynesia.

"I am very proud of the lives and careers of my children, Stan and Emily, and now I have an opportunity to see how my grandchildren develop. I am also very proud my siblings, five of whom came to America and were very successful. This has truly been the 'Land of Opportunity'."

Class Notes

Alumnus elected into National Academy of Engineering

Fluid mechanics pioneer and Illinois alumnus **David V. Boger** was elected into the National Academy of Engineering this spring for "discoveries and fundamental research on elastic and particulate fluids and their application to waste minimization in the minerals industry."

Election to the National Academy of Engineering is among the highest professional distinctions accorded to an engineer.

Dr. Boger is a world-renowned expert in complex fluids and he has made seminal contributions to the field of rheology, the study of how materials flow. His work has changed our understanding of complex fluids through the development of "Boger Fluids" which behave as both liquids and solids. He has worked for decades with mining companies around the world to develop processes that mitigate environmental risks associated with mining waste.

He received his PhD in Chemical Engineering from the University of Illinois in 1965, studying under Dr. James Westwater. After graduation, he joined the chemical engineering faculty at Monash University in Australia. In 2015 he returned to Illinois to deliver the Distinguished Alumni Lecture.

Others elected to the NAE this year with ties to the Illinois Department of Chemical and Biomolecular Engineering include **Jennifer Lewis** and **Michael Strano**. Lewis, the Hansjorg Wyss Professor of Biologically Inspired Engineering at Harvard University, was an affiliate faculty member from 2003 to 2012. Michael Strano, Carbon P. Dubbs Professor of Chemical Engineering at the Massachusetts Institute of Technology, was a member of the ChBE faculty from 2003 to 2007.

Recent PhD grad named Beckman Fellow

Danielle Mai, MS '14, PHD '16 (Schroeder), was chosen for a prestigious Arnold O. Beckman Postdoctoral Fellows Award. Mai is currently a postdoctoral researcher at MIT. Her project is developing bioinspired polymers for rapid and selective removal of biological toxins. Biotoxins pose significant and unpredictable threats to human health (e.g. biological warfare agents and lethal food contaminants), but current treatment limits are limited, costly, and variable, she said.

"We are inspired by nature and polymer physics to develop a new paradigm for bioseparations, which is based on selectively permeable pores in the cell nucleus. Our technology could critically enable bioseparations ranging from biotoxin removal to blood-based diagnostics to therapeutic monoclonal antibody purification," Mai said.

After completing her postdoc, Mai plans to continue her research at the intersection of polymer science, biophysics, and materials engineering as a new investigator.

"I am particularly interested in experimental multi-scale dynamics of polymers, complex fluids, and biomaterials. Importantly, the Arnold O. Beckman Postdoctoral Fellows Award provides independence in my current research, a diverse network of peers and mentors, and flexibility to cultivate my research vision as I prepare to apply for tenure-track faculty positions," Mai said.

Kristen Duda, BS '03, joined Intelex Technologies as its Vice President of Strategic Alliances. Intelex Technologies is a leading global provider of cloud-based environmental, health, safety and quality management software. Prior to Intelex she served as Vice President with CH2M, an engineering and consulting firm.

Joe Horn, BS '82, joined Tekni-Plex as a senior vice president and general manager of its Tekni-Films global business unit. In addition to his Illinois ChemE degree, Horn received a MBA from Rutgers University. Tekni-Films is a supplier of products for pharmaceutical, medical, diagnostic health and personal care companies.

Chang Lu, MS '01, PHD '02 (Masel), was named the Fred W. Bull Professor of Chemical Engineering at Virginia Tech. The Fred W. Bull Professorship recognizes excellence in teaching and research in chemical engineering. Lu has been a member of the Virginia Tech faculty since 2010 and is known for his research on microfluidic biotechnology using fluid engineering principles and physical sciences to create enabling tools and techniques for studying and manipulating cell and molecular biology.

Mark Pasmore, BS '94, was appointed Vice President of Research and Development at TS03, an innovator in sterilization technology for medical devices in healthcare. Dr. Pasmore received his PhD in Chemical Engineering from the University of Colorado.

Fei Wen, MS '06, PHD '10 (Zhao) won a National Science Foundation Faculty Early Career Development (CAREER) Award. She currently is Assistant Professor of Chemical Engineering at the University of Michigan. Fei's research group aims to develop an immunobioengineering platform for rapid and scalable biomanufacturing of universal viral vaccines.

Share your news with us! Email us at chemeng@illinois.edu, fill out the online form at go.illinois.edu/chbe_alumni_form or mail the enclosed card found at the back of this magazine.

STEVE MCLIN:
"I Find the Highest Mountain and Try to Get Up It"

Written by Deb Aronson

How does a chemical engineer like Steve McLin, BS '68, become a financial wiz?

"I liked doing hard things," he says. "I liked learning. I liked chemistry. I took three semesters of physics."

But McLin, the oldest of six children, was also interested in making a good living.

So when he got to the University of Illinois, the first thing Steve McLin (pronounced MACK-lin) asked when he arrived as a freshman in 1964 was, "What's the hardest major here?" And "What pays the most?"

The answer was Chemical Engineering. Unlike other engineering programs, ChemE required majors to take an additional 20 units in liberal arts, including subjects like philosophy, economics and a language (for a total of 140 rather than 120 units).

Liberal arts classes "whetted my appetite," he says. Besides, "too many engineers are too linear, they think in a box. It's fun to try to find different ways than the conventional way to do things."

McLin was unconventional even as a child. Because his father was an Air Force doctor, McLin's family moved every three years. When he was 11, they spent two years year in Germany. Without his usual distractions of sports and television, McLin became a bookworm, discovered a love of math, and learned German.

"I read like eight books a week. I could listen to maybe one baseball game on radio and that was it. I got really interested in etymology, the derivation of words, plus I was learning German in school," he says. "I was not thrilled to go to Germany when I was 12, but in retrospect it was the best thing that ever happened to me."

Once back stateside, McLin decided he wanted to be a DJ, so he talked his way into a job at 15 years old at KVOZ Radio in Laredo, Texas. He showed up without an appointment, waited 30 minutes, and then made his pitch to the station manager.

"I think I could be good at this job and I'll work for nothing," McLin told the manager.

"But if I prove myself with odd jobs then you'll hire me."

After a few months he got the Saturday, 8 p.m. to midnight DJ gig, McLin says. That was the least desirable slot for the other, older DJs. He earned $1.05/hour, minimum wage.

He parlayed his radio skills into DJ'ing at high school dances, eventually earning $600 in one night by hiring multiple bands that were happy to play for free and charging $1 at the door.

"They all said, 'Nobody will come at that price,' Well, I had five bands playing and we had to turn people away."

At Illinois, McLin's adviser was longtime faculty member Thomas Hanratty, a well-respected researcher and teacher who died in 2016.

"I was lucky with Hanratty," McLin says. "It was just through potluck that he was my adviser. He was a bit more studious and academic than I was, but he could sense how much I enjoyed doing things. He was interested enough to understand my goals and perspective and shape my experience. He seemed to care that I got really good advice. That meant a lot to me. I was a kid."

From chemical to financial engineer

After graduation he worked at Atlantic Richfield (ARCO) in California for a year. The best part of the job was discovering California. He's lived there almost his entire adult life. A resident of Lafayette, Calif., he is married to Cathy McLin and father to two sons and one daughter and grandfather to two grandsons.

After moving to California, McLin soon realized he had to have another degree and so he earned his MA in mechanical engineering at Stanford. While earning that degree, in 1970, McLin realized he was more intrigued by finance than engineering, so off he went for an MBA, also at Stanford. And that's how an engineer ends up in finance.

"I was a financial engineer," he says. "I applied things I learned in engineering to finance. I was thinking outside the box, I was solving problems. Hanratty encouraged that kind of thinking."

McLin worked much of his career at Bank of America (BofA) buying and selling other companies. The two biggest deals that McLin made are the subject of several books, such as *Roller Coaster: The Bank of America and the future of American Banking* by Moira Johnston and *Breaking the Bank: the Decline of BankAmerica* by Gary Hector.

> "I applied things I learned in engineering to finance. I was thinking outside the box, I was solving problems. Professor Hanratty encouraged that kind of thinking."
>
> **-STEVE MCLIN**

In the first big deal, in which BofA bought Charles Schwab and Co., (a major discount broker), McLin found a wrinkle in Glass-Steagall, a 1933 law separating commercial banks, which take in deposits and make loans, like BofA from investment banks, which underwrite and deal in securities. That wrinkle enabled the bank to buy Schwab and expand its market. The case went all the way to the Supreme Court, which in 1983 was unanimous in its support of BofA's interpretation.

In the second transaction, McLin engineered the purchase of Seafirst Bank. Buying the troubled bank would enable Bank of America to own and operate banks in another state, outside of California. That was generally prohibited by the McFadden Act of 1927, which prohibited national banks from having branches outside the state in which they already operated. But there was no telling how bad Seafirst's energy losses would be, so that was a big risk. McLin says he invented a financial structure, which he calls "shrink to fit financing," that protected Bank of America if Seafirst's losses in the energy sector became even worse than they already were.

"The things I learned at the University of Illinois wasn't stuff like the atomic weight of boron, but to be creative in solving problems and have an open mind in things," he says.

McLin left BofA in 1987 and established America First Financial Fund, which he led for 10 years. That company also bought a troubled bank, fixed it and sold it. When he sold it, investors who had invested $100 million, earned $500 million in returns, he says.

McLin has been mostly retired since, other than being involved in venture capital investment and serving for 30 years (so far) on the Charles Schwab board of directors, and managing his family foundation.

Steve and his wife Cathy McLin.

It turns out, much as he loved making money, giving it away is even better. And Illinois has benefited greatly from that.

"I never thought I'd have more fun giving money away to worthy causes than the tremendous fun I had making it in the first place," he says.

"Illinois helped shape me," he says. "I revere the institution, even if the professors I knew are no longer there."

Giving to Chemical and Biomolecular Engineering

Alumni and friends play a vital role in the success of the University of Illinois Department of Chemical and Biomolecular Engineering.

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In Memoriam

Dr. Walter M. Buehl, PhD '64, of Corning, N.Y., died March 14, 2017, at 79 years old. He graduated from the Massachusetts Institute of Technology in 1959 with a BS in Chemical Engineering and received his PhD in Chemical Engineering (James Westwater) from Illinois in 1964. He was recruited by Corning Glass Works and spent his entire professional career with the company and held three patents. In 2001 he retired as a research associate and returned to serve as a consultant. Dr. Buehl was passionate about chess and was well respected locally and nationally for his proficiency. He also was an accomplished pianist and flutist and frequently toured throughout Europe with the American Winds Concert Band.

John E. Heumann, BS '55, of Ridgecrest, Calif., died March 4, 2017, at 84 years old. He received his bachelor's degree in Chemical Engineering from Illinois in 1955. An Army veteran, he was a chemical engineer for the Naval Testing Base in China Lake.

Arthur S. Perkins, MS '55, of Moraga, Calif., passed away on April 6, 2017, at 88 years old. Born in Chicago, he graduated with a BS in Chemical Engineering from the University of Delaware and later received an MS in Chemical Engineering from Illinois. In the 1950s he served in the Army, attaining the rank of sergeant. He spent the greater part of his career at Air Liquide America as applications and process manager for pulp and paper industries and the gold mining industry. He participated in the development of several patented processes. In retirement he worked as a consultant until 2011. Mr. Perkins was an avid fly fisherman, a fine woodworker, skilled gardener and loved jazz music.

Michael C. Pitter, BS '84, of Warren, N.J., died Dec. 25, 2016. Born in Jamaica, he immigrated to the U.S. and obtained a BS in Chemical Engineering from Illinois in 1984. After two years as a chemical process engineer, he transitioned into medicine, graduating from Rutgers Medical School in 1990. He spent decades at Newark Beth Israel Medical Center and Hackensack University Medical Center as an OB/GYN doctor. He went on to pioneer the use of robotics in minimally invasive gynecological surgery. Most recently he served both as an assistant professor and director of robotic surgery at Columbia University Medical Center and New York Presbyterian/Lawrence Hospital, respectively. Dr. Pitter was also one of the founding members of the Caribbean Medical Mission.

Daniel M. Schmitt, BS '51, of Johnsburg, Ill., died Oct. 22, 2016. After serving in the U.S. Army as a medic in Germany, Schmitt returned to the U.S. and enrolled at Illinois. He earned a BS in Chemical Engineering in 1951 and was a member of Phi Lambda Upsilon. He worked as a chemical engineer at Ringwood Chemical Corporation and a plant manager at Morton Chemical Company, later advancing to corporate management at Morton. Mr. Schmitt served on the Northern Indiana Medical Center's board of directors, the Northern Illinois Medical Center Foundation Board, as a trustee of McHenry Township Fire Protection District, and was active with several other organizations.

Almar T. "Al" Widiger, BS 48, of Parma, Ohio, died Jan. 7, 2017, at 90 years old. Mr. Widiger attended Morton Junior College before transferring to the University of Illinois where he graduated with honors with a BS in Chemical Engineering in 1948. He then joined the Dow Chemical in Midland, Mich., and began a 25-year career in plastics research to develop film products such as Saran Wrap and Handi-Wrap. Al and his wife Jan met when both were employed by Dow and involved in the introduction of Saran Wrap in the early 1950's. Beginning in 1976, Mr. Widiger was based at the company's technical center in Neenah, Wis., while still traveling between there and Cleveland. He also made many trips to Europe to introduce plastic films there. He finished his career with American Can as a Senior Research Associate, retiring in 1989. During his 41 years with the two companies, he received 14 patents for his work.

Both before and after his retirement, he enjoyed golf, world travel, and his hobby, investments. He served as a judge for the Northeastern Ohio Science and Engineering Fair. In addition, Al and Jan Widiger supported higher education institutions, including the University of Illinois with a fellowship in chemical engineering, as well as Southwest General Health Center in Ohio.

Robert E. Wilson, BS '49, of Decatur, died Jan. 6, 2017, at 90 years old. A Navy veteran, he graduated with a BS in Chemical Engineering in 1949 from Illinois and in 1953, he received a Ph.D. in Chemical Engineering. In 1950 he earned an MS from the University of Minnesota. Dr. Wilson was a project leader for Corn Products Company in Chicago and a professor and head of the chemical engineering department at the University of Dayton from 1954 to 1962. There he directed the College of Engineering's graduate program. He also consulted for the Navy, Air Force and private industry. He worked for Thomas J. Lipton, International Minerals & Chemical Corp. and Heidrick and Struggles, where he became a senior vice president.

Remember When

TOP IMAGE: In this photo from 1993, Professor A.J. McHugh and graduate student Craig Bushman study the extrusion and mixing characteristics of polymeric systems. McHugh was a chemical engineering professor at Illinois from 1979 until 2002, when he left to become department head at Lehigh University. Today he is the Ruth H. and Sam Madrid Professor of Chemical and Biomolecular Engineering there. We caught up with him recently to find out what he's been up to. Please turn to page 22 to hear from Dr. Tony McHugh.

BOTTOM IMAGES: As the University of Illinois celebrates its Sesquicentennial, we decided to dig up some photos from the 2002 Noyes Centennial and the inaugural Parr Lecture, almost 15 years ago! In the first photo, campus, school and departmental officials pose on the steps of Noyes Laboratory with Steven L. Miller (front row, middle) flanked by former chancellor Nancy Cantor on the left and former ChBE department head Chip Zukoski. Miller, BS '67, former President and CEO of Shell, was the first to deliver the Parr Lecture. His topic was "The Crucible of Change."

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Save the dates

As part of the **University of Illinois Sesquicentennial**, the School of Chemical Sciences, the Department of Chemical and Biomolecular Engineering, and the Department of Chemistry are planning a special weekend on campus for alumni and friends Oct. 6-7, 2017. The celebration will include a rededication of the renovated Chemistry Annex, a ceremony marking the Dr. Herb Gutowsky Chemical Landmark Designation, panel discussions, and more.

As part of **Homecoming** weekend on Oct. 27-28, 2017, the department will host an event honoring the late **Dr. Thomas J. Hanratty**. The weekend will include discussions, tours, and other activities. The department will also host a pre-game tailgate for alumni and friends on Saturday, Oct. 28. The Fighting Illini will take on the Wisconsin Badgers at 11 a.m.

We will be sending postcards and email invitations soon and more information will be forthcoming on chbe.illinois.edu.

Support the department

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You can also submit your gift in the enclosed envelope. Thank you!

Students, families, and friends celebrate the 2017 Chemical and Biomolecular Engineering convocation.