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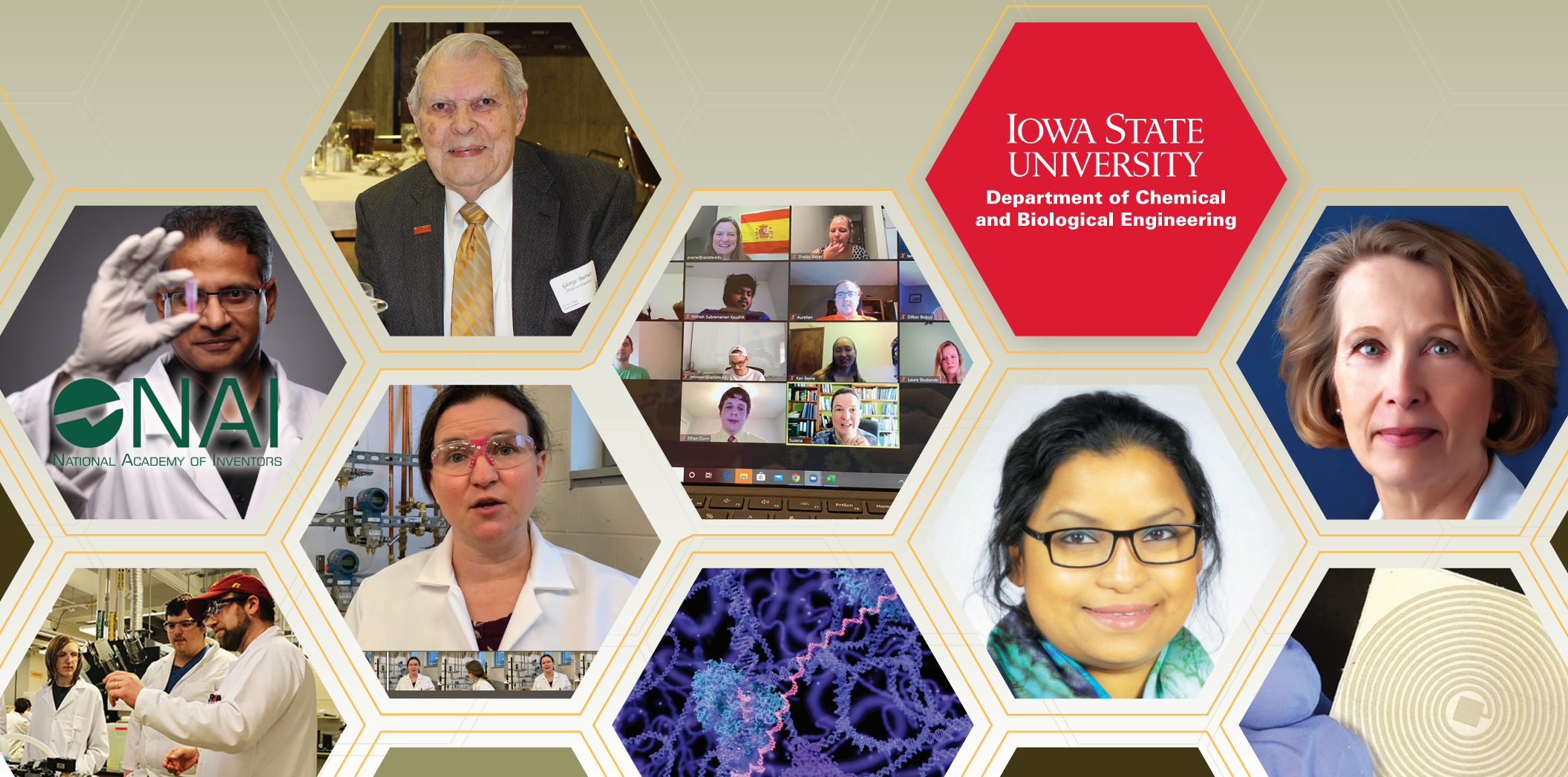
Iowa State University **Chemical and Biological Engineering** • Issue No. 31, Fall 2020



2020 ISSUE CONTENTS

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Dear Alumni and Friends,

Warm greetings to all from the Department of Chemical and Biological Engineering at Iowa State University. We hope that you enjoy this 2020 installment of *ActiveSite*, our annual departmental newsletter.

What a year it has been. Last fall, we were enjoying a typical autumn in Iowa. We had a bustling campus full of students, staff and faculty hard at work in our classrooms, laboratories and offices. Little did we know that in just a few short months, our world would get upended by a global pandemic and we would experience a nationwide movement for racial equality and social justice.

In response to the pandemic, in March of 2020 we converted all of our classes to online and students were sent home to finish the spring semester remotely. This obviously created quite a challenge for everyone involved. You can read about some of the impacts on our activities and the remarkable job everyone did to respond to these challenges in a series of stories in the section: **Addressing The Unexpected**.

Despite the pandemic, we have kept busy and have moved forward with research and teaching. You will see some of this highlighted on the pages within. Several faculty and their research are described, including a story about the challenging problem of droplet breakup (**Droplet Research – Vigil, Fox and Olsen**), efforts to produce biofuels and bioproducts (**Nonconventional Yeasts – Shao**), and highlights from the research of our award-winning young faculty related to the gut microbiome (**CAREER award – Mansell**), advances in two-dimensional materials (**Si Nanosheets – Panthani**), and development of an inexpensive and disposable COVID test (**COVID Testing – Reuel**). You will also see an article featuring two of our current faculty and one of our Hall of Fame alumni on women in chemical engineering (**Women in ChE**). A new version of undergraduate research with an industrial twist is highlighted (**A New Flavor – Kaiser**). You will also see a selection of many of the recent awards to our outstanding students, alumni and personnel, and pictures from various events.

Thanks to all of our many friends for your continued support of our program and people. Your friendship and generosity is critical to so many important efforts, including recruiting and retaining the very best students, staff and faculty, providing state of the art facilities for teaching and research, providing financial assistance to students through scholarships and fellowships, and supporting all sorts of new initiatives to support our mission of world leading research and education.

Please send me any comments, updates or suggestions you have for future issues of *ActiveSite* (hillier@iastate.edu). Let me also take this opportunity to invite you back to campus. I would be delighted to host you once we have this pandemic in our rear view.

Be safe, be well, and share my warmest wishes to all of you for a happy, healthy and productive year.

Go Cyclones!

Andrew C. Hillier

Andrew C. Hillier
Professor and Reginald R. Baxter Endowed Department Chair

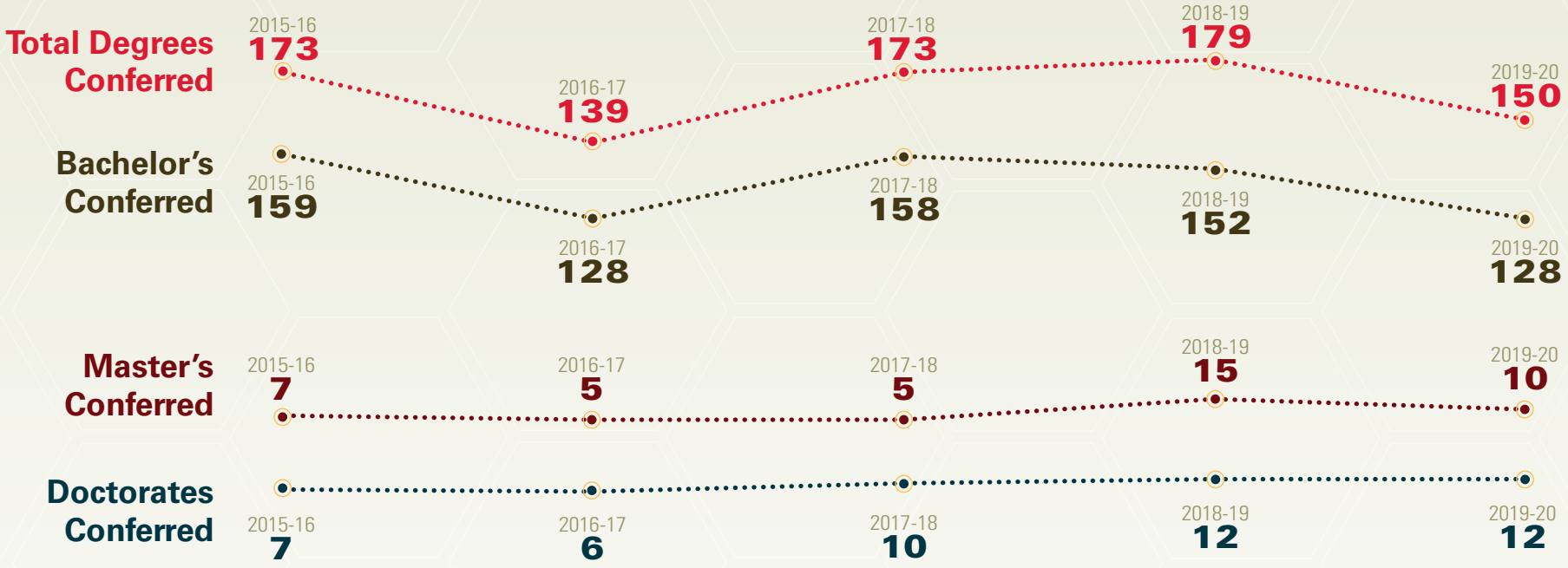
CBE By The Numbers

Number of Faculty
Publications
124

Number of Faculty
Citations
10767

Research
Expenditures
$9.43M

Average Faculty Research
Expenditure
$409,901



Undergraduate
Enrollment Fall 2020

585

35% Female

Undergraduate
Scholarships

$546,234

143 Students Awarded

Graduate
Enrollment Fall 2020

72

28% Female

Graduate
Fellowships

$236,093

13 Students Awarded

Fall 2020
Learning Communities

130
Total Students

16
Peer Mentors

ISU CBE tackling a vexing droplet research issue with newly designed apparatus

R. Dennis Vigil

Rodney Fox

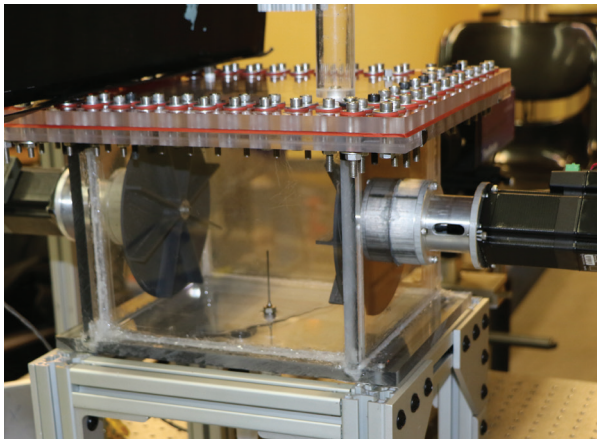
Michael Olsen

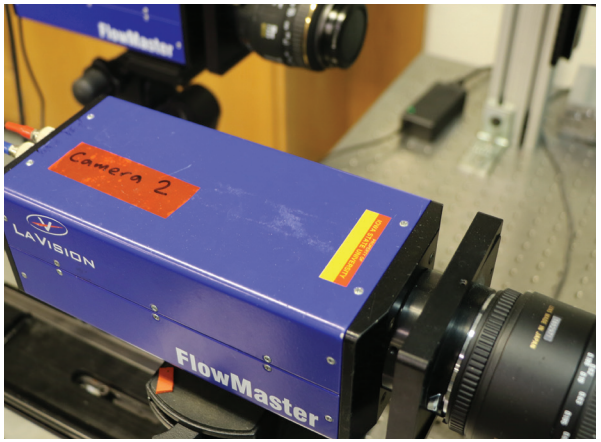
"Predicting breakup is hard to do." Those are the words of Professor **R. Dennis Vigil**, an Iowa State University chemical engineering professor.

What he's talking about is the understanding of a vexing research issue: How immiscible droplets of liquid suspended in another liquid (think oil and water) break apart when agitated. It is this knowledge that is important to industrial processes involving emulsification, like the homogenization of milk and various other food products and emulsion polymerization, a process that creates polymers used in things such as synthetic rubber and latex paints.

Over several decades, many models for droplet breakage events in turbulent flow have been developed for application to these and other chemical manufacturing processes where greater control over mass transfer is crucial for producing products both reliably and efficiently, according to Vigil. "Although drop breakage has been studied for a long time, the existence of multiple breakage mechanisms and the lack of well-controlled experiments capable of producing detailed information to understand the underlying physics of drop breakage has hindered the development of mathematical and computational models that accurately predict breakage rates and droplet size distributions."

To address these shortcomings, Vigil is working with his chemical engineering colleague, Anson Marston Distinguished Professor in Engineering and Hershel B. Whitney Professor, Global Initiatives **Rodney Fox**, as well as **Michael Olsen**, a professor in the Department of Mechanical Engineering at ISU. The three have developed a new fluid flow apparatus for studying drop breakage that provides the means for carefully controlling the fluid flow characteristics while also providing optical access for high-speed photography of breakup events and acquisition of 3D velocity fields. The data obtained from this apparatus could provide a much deeper understanding of the physics of drop breakage and the development of new models for prediction and control of processes involving breakage.





The high-speed cameras shown are capable of capturing many thousands of images each second and can be used to slow down and analyze individual droplet breakage events to determine the mechanism and statistical properties of those events.

Although Fox, Vigil and Olsen have all previously worked to better understand the behavior of dispersed phase bubbles, their current work was catalyzed when Fox came across a paper by French physicists who used a specially-designed small box called a von Karman swirling flow apparatus to generate uniform mixing so that they could observe the breakup of clusters of solid particles. He recognized that this technique for generating homogeneous isotropic turbulence (uniform mixing) could be used for droplet breakup studies.

The project is being done in collaboration with the German company BASF, one of the largest chemical producers in the world, and through Iowa State's Center for Multiphase Flow Research and Education (CoMFRE), which integrates the skills of ISU investigators and industrial members to deliver advances in the field to industrial applications and end-users.

The research lab space in Sweeney Hall includes a recently-constructed area of framework, platforms and special pieces of apparatus, including lasers and high-speed photography equipment that gets to the heart of the matter.

"One of the main limitations of previous studies of droplet breakage is the lack of control of the fluid mixing," Vigil explains. "Stirred tanks, which are widely used in industry because of their simplicity, have turbulence characteristics that are spatially very non-uniform, which in turn complicates the understanding of how the fluid mixing impacts drop breakup." In addition, the apparatus features precise control of the size of the droplets introduced into the flow cell before they undergo breakage.

Regarding their method of introducing droplets into the von Karman box. "This is another variable over which we have unprecedented control compared to previous studies," says Vigil.

High-speed photography of drop breakage events, a laser-based method called particle image velocimetry (PIV) is being employed to gather detailed information about the fluid flow around droplets undergoing breakage.

According to Vigil, PIV combined with high-speed photography of individual breakage events will make it possible to rigorously evaluate the validity of existing drop breakage models and to propose improved models. "The expertise in particle image velocimetry brought to this project by Prof. Olsen, who has decades of experience using this method, is a crucial factor in the success of the project."

Work continues with a variety of parameters employed. Following further research, a paper presenting the team's discoveries is planned.

CoMFRE

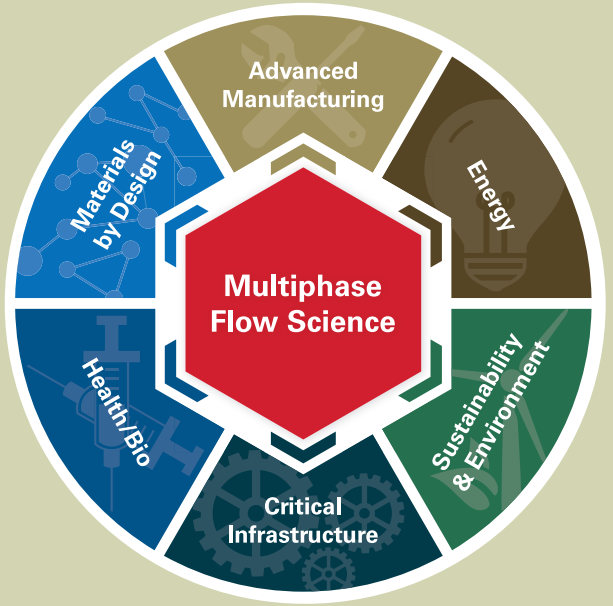
Center for Multiphase Flow Research and Education

Iowa State University's Center for Multiphase Flow Research and Education (CoMFRE) brings together faculty, students and industry leaders interested in advancing real-world applications for multiphase flows.

Industries where multiphase flows are found range from energy and power generation to agricultural and pharmaceutical companies to materials and construction.

- Nearly 30 Iowa State faculty and staff are CoMFRE members – with expertise in chemical, mechanical, civil and aerospace engineering and other disciplines.
- A growing list of industry partners including AbbVie, Ansys, BP, BASF and Roeslein Alternative Energy.

If your company is interested in becoming a member of CoMFRE, contact **Ted Heindel** at *theindel@iastate.edu*
CoMFRE web site: https://comfre.iastate.edu



Nonconventional yeasts in the spotlight with bioenergy research led by CBE's Shao

Biofuels and bioproducts continue to be an area of great significance in the worldwide quest to reduce greenhouse gasses and to develop sustainable energy resources.

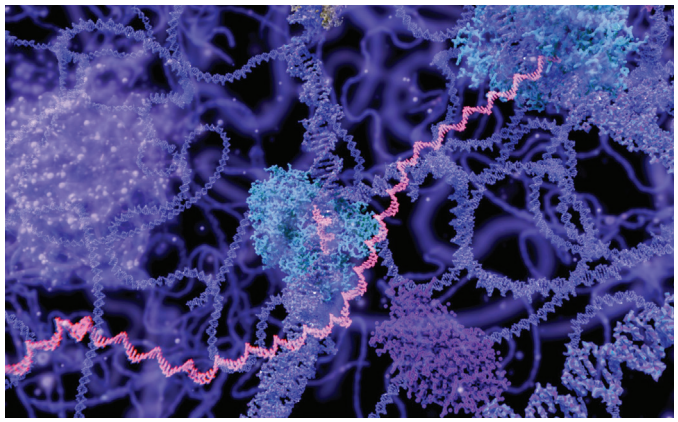
Department of Chemical and Biological Engineering (CBE) associate professor **Zengyi Shao** is part of a large group of investigators at work in this arena with support from the Department of Energy (DOE) CABBI (Center for Advanced Bioenergy and Bioproducts Innovation). It's one of four DOE Biorenewable Research Centers and exists to develop efficient ways to grow bioenergy crops, transform biomass into valuable chemicals, and market the resulting biofuels and other bioproducts.

"Probing the integration and expression hotspots of nonconventional yeasts for producing high-value chemicals" is a to-be-published group research discovery that includes Shao and is supported by more than $447,000 from DOE for a three-year period.

The research centers on engineering of three nonconventional yeasts as the production hosts for wax esters and itaconic acid. Itaconic acid is a biopolymer precursor and wax esters are premier lubricants. "Development of those nonconventional microbes as production hosts is currently constrained by the lack of efficient genetic manipulation tools," said Shao.

"My group is working on applying a transposon-mediated strategy and the nonhomologous end-joining mechanism to probe the integration and expression hotspots that will significantly enhance the production."

A transposon is a class of genetic elements that can "jump" to different locations within a genome. "The goal is to improve the production levels of wax esters and itaconic acid," Shao explained. "The amount of the enzymes catalyzing the synthesis reactions is dependent on where we insert the corresponding genes. We are exploring two strategies to identify the optimal insertion location."



Using the revolution of synthetic biology, the Shao lab works to understand molecular mechanisms in complex biological processes, reprogramming of genetic coding, and creating novel functions. The long-term goal is to develop the functional genomics of high-performing microbial species.

"Currently, we are developing an itaconic acid biosensor to facilitate the screening of high-producing variants and investigating the production of wax esters from soybean-derived oils," Shao reported, and explained the importance of the research: "The sensor is needed to enable high-throughput screening of high-producing variants created based on genome-scale mutagenesis. The typical screening format relying on analytic equipment can give an accurate quantification, but the screening throughput is only dozens per day. The sensor we are constructing allows for the screening of hundreds of clones per day."

Postdoctoral research associate **Yuxin Zhao** and graduate student **Wan Sun** are also involved in this project.

Additionally, Shao's Iowa State University research group is at work on "Leveraging the Hermes Transposon to Accelerate the Development of Nonconventional Yeast-based Microbial Cell Factories," a research project supported by an Iowa State University bioscience-based research seed grant made possible through funding by the Iowa Legislature.

It's one of two biobased projects university-wide to receive this funding through the Office of Vice President for Research to encourage industry-university collaborations. Industry partners on the project are Kemin Industries, Cargill and Puretein Bioscience. The effort deals with genetic engineering of high-performance yeast strains to create microbial mediums that offer the potential to more cost-efficiently produce larger quantities of high-value compounds.

Cyclone Engineer Tom Mansell receives prestigious NSF CAREER award

Tom Mansell, assistant professor and Karen and Dennis Vaughn Faculty Fellow, has received a National Science Foundation CAREER award to create engineered probiotics that may be a new way to treat illnesses like obesity, diabetes and heart disease.

CAREER awards are the NSF's most prestigious awards given to early-career faculty. The support aims to build a firm foundation for leadership in integrating research and education. Mansell will receive more than $500,000 over the next five years to support his project.

Tom Mansell (left) checks the progress of a student in a CBE lab.

Disease fighting from the inside out

Mansell's CAREER project will create a two-step strategy so that probiotics can be successfully introduced – and flourish.

Our gut microbiome – a collection of complex and varied microbes – is important to health far beyond our digestive tract. We know that too much "bad" bacteria can make us ill, but the opposite may also be true. Engineering "good" bacteria could be key to fighting illness.

Mansell seeks to overcome one big challenge of introducing new good bacteria into the gut environment: When we eat foods rich in live cultures or take a supplement that introduces probiotics into our gut, then the probiotics themselves need something to feast on if they are to multiply and remain in place.

His team will first create new prebiotics, nutrients that are not normally found in the gut, and genetically modify probiotics so that they can use these unique energy sources. Step two will be introducing these engineered probiotic-prebiotic pairs to the gut to create an environment where the probiotics can thrive.

When probiotics grow strong on a steady diet of custom-paired prebiotics, they can be engineered to add disease-fighting capabilities.

"Probiotics may someday be able to make the drugs right in the gut, providing a pain-free way to deliver protein-based drugs that now require injections, to deliver anti-inflammatory agents or to secrete antimicrobial peptides to cure infection," said Mansell.

Inspiring future problem solvers

Mansell's CAREER project also includes the development of an interactive lab that will show high school and undergraduate students first-hand the competition between engineered gut bacteria and native gut bacteria. Inspired by games like Pokémon Go, the activity will assign certain attributes to each strain, then allow students to predict the outcome of the culture "battle."

Mansell's group will also create an interactive educational module about the microbiome to be featured on LearnGenetics.com, a popular resource used by teachers and students.

"Tom's CAREER project is poised to both offer innovative, disease-fighting engineering solutions and to inspire the next generations of students to study engineered health," said **W. Samuel Easterling**, James L. and Katherine S. Melsa Dean of Engineering. "Congratulations to Tom on the CAREER award, which is evidence of his exceptional creativity and vision."

Mansell began his career with Iowa State's Department of Chemical and Biological Engineering in August, 2015. He earned his bachelor's and master's degrees in chemical engineering from The Johns Hopkins University in 2004 and 2005, respectively. In 2011, Mansell earned his Ph.D. from Cornell University in chemical and biomolecular engineering.

WOMEN in ChE

It's no secret that women are seriously underrepresented in the field of engineering. And while chemical engineering can claim some of the largest numbers of woman professionals, educators and students, there is much work to be done toward gender equity, and perhaps even more importantly, general attitudes toward women in engineering.

*For this story, written exclusively for ActiveSite, we spoke with two Department of Chemical and Biological Engineering (CBE) woman faculty members – **Rizia Bardhan**, who began her time in the department within the last year – and **Laura Jarboe**, who has been on the department's faculty since 2008. We also spoke with **Mary Jane Hagenson**, an Iowa State biomedical engineering alumna, retired chemical engineering executive from Chevron Philipps Chemical Company, a member of the CBE Hall of Fame, and a department supporter. We asked for their thoughts and opinions on different subjects involving women in engineering and in the field of chemical engineering.*

Engineering has traditionally been – and continues to be – a male-dominated field. What are the points of pride being a woman in engineering and the points of challenge?

Rizia Bardhan

Bardhan: "I feel both honored and proud to be a woman in engineering given this is such a male-dominated field. As a woman I relate differently to students in both the classroom and in the research lab. I have now trained five female graduate students, ten female undergrads and all of them told me it was important to them to have a woman mentor and leader. Yet this is a very time consuming job, and to me the most challenging aspect is having work-life balance. It takes significant effort to have family time outside of the demands of this job and balance how much travel I do to ensure I am not compromising my time with my children."

Jarboe: "It can be challenging at times to not be bothered by the microaggressions. Students often do a double take or express confusion when they arrive at my office, having expected 'Dr Jarboe' to be a male. I've had a colleague decline to participate in a K-12 outreach activity because they didn't want to be the only male in a room full of females, not seeming to realize that it's not uncommon for me to be the only female in a room full of males. I also worry that my obviously female first name makes me vulnerable to implicit bias from reviewers, and thus my proposals and papers need to be perfect in order to account for this possibility."

Chemical engineering has some of the largest numbers of woman students and professionals in engineering (though still far behind many other fields). Can you share thoughts about that?

Laura Jarboe

Jarboe: "I wrote a paper on this subject:" (L.R. Jarboe, Regional, institutional, and departmental factors associated with gender diversity among BS-level chemical and electrical engineering graduates, *PLOS ONE*, October 9, 2019). Among the points the research looks at are: In 2018, a female chemical engineer was awarded the Nobel Prize in Chemistry, and two female engineers were elected to the U.S. House of Representatives. However, engineering remains the least gender diverse STEM (Science, Technology, Education, Mathematics) discipline. The paper explores that fact, and the importance of the correlation of having interaction with a female STEM expert with increased commitment of female students in pursuing a STEM career; and that pairing of first-year engineering students with other female engineering students increases retention.

Jarboe says in her opinion the subject comes down to "The Scully Effect," a study conducted by the Geena Davis Institute of Gender in the Media and J. Walter Thompson Intelligence, which is a theory based on the character of Dana Scully in the TV series "The X Files." She was one of TV's first multidimensional female characters in a STEM field. The study found that Scully was viewed as an important role model for women and girls and helped inspire them to have an interest in pursuing STEM-related fields. Having more and highly visible female role models in engineering is one of the key ingredients to increasing gender diversity.

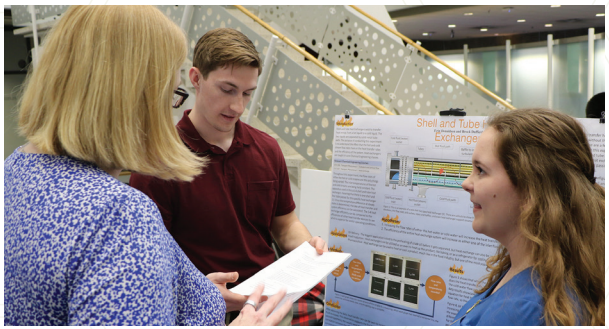
Being a woman engineer, have you experienced any particular challenges in your education or in your professional life?

Bardhan: "I have found as a woman I am often underestimated and disregarded relative to my male counterparts. My potential for success has been doubted by many of my colleagues, and I have had to work three times harder to prove myself. However, these experiences occurred prior to arriving at Iowa State."

What would you like to see from the field of engineering in general to pave the way for more women to become engineers or engineering educators?

Jarboe: "If we accept the idea that K-12 students are more likely to pursue a field in which they have seen people like them in that role, then students need exposure to these diverse engineers."

Bardhan: "Mentoring workshops where female students are educated on their career paths and choices. Research and internship opportunities for undergraduates, and a concerted effort at the university level to hire more female faculty who can be role models."



Laura Jarboe, here discussing a research poster with undergraduate CBE students, works hard to increase engagement of female students in engineering and has had a paper published on the subject.

What type of feedback or feeling do you get from your woman students regarding equity in engineering?

Jarboe: "Students often comment that their interactions with other students are more problematic than their interactions with faculty. It is great to provide training to faculty about inclusive teaching, but we also need to make sure our students receive training on inclusive teamwork."

How do you feel about student organizations, such as Society of Women Engineers (SWE), and the role they play in helping women succeed in the field?

Bardhan: "SWE and other organizations are great for getting women together to network, communicate, and share their experiences. This is highly effective in ensuring young women engineers feel they have a community, and that they can thrive and succeed in that community."

Mary Jane Hagenson received a B.S. in physics from Iowa State in 1974; a M.S. in biomedical engineering in 1976; and a Ph.D. in that curriculum in 1980.

She, along with her husband Randy, is a strong supporter of the CBE department and is an outstanding example of the success women can achieve in engineering. She is retired vice president of research and technology for Chevron Philipps Chemical Company. She is also a past chair of the Department of Chemical and Biological Engineering's Advisory Council, and is a charter member of the department's Hall of Fame, which began in 2013. In 2015 the Hagensons made the lead gift to establish the Richard C. Seagrave Professorship in the Department of Chemical and Biological Engineering. She also shared thoughts on the subject of women in chemical engineering and advice for young women pursuing a career in the field:

"Many people have preconceived notions about what engineering is and what careers in engineering would be like. Sometimes these stereotypes keep promising young students, and especially women, from pursuing a career in engineering. But long gone are the days of engineers working in isolated cubicles. Today's engineers have vibrant careers working in cross functional teams to solve complex problems. They travel the world to work with global manufacturing, products, and customers.

Mary Jane Hagenson

"Increasing numbers of women engineers are fully engaged on all fronts and enjoying challenging and rewarding careers.

"During the course of my 27-year corporate career I have had the honor and great pleasure of working with and mentoring many young engineers and scientists. Women engineers are on equal footing with their male counterparts. Securing a college degree in engineering and establishing a successful career takes intelligence and a lot of dedication and hard work. I have certainly found that women are not afraid of working hard! Women should not be timid or reluctant to pursue a career in engineering if that's what they aspire to. Many scholarships and other resources are available to those who take the initiative. And many employers are looking for dynamic talented women engineers. Don't be afraid to pursue your dreams and remember that you are in charge of making them come true!"

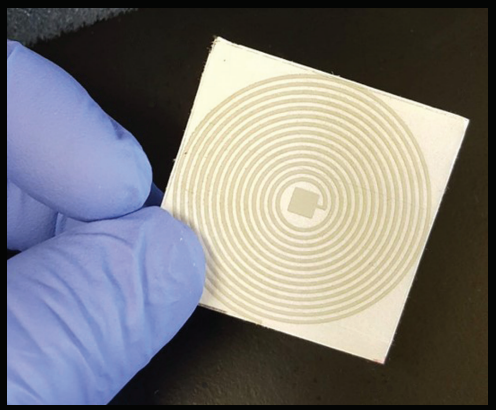
Mail-in, no-touch fast scan testing for COVID-19, other outbreaks is focus of Nigel Reuel research

As COVID-19 continues to spread, the worldwide threat demands answers. A solution to the need for simplified rapid disease testing is in the works with Iowa State's University's Department of Chemical and Biological Engineering (CBE).

Assistant professor and Jack R. and Carol A. Johnson Faculty Fellow **Nigel Reuel** and his research group are developing a no-touch, mail-in, fast-scan system for diagnosing not only COVID-19, but potentially other future disease outbreaks that could impact the world.

The work is being fast-tracked by a one-year $200,000 Rapid Response Research (RAPID) grant from the National Science Foundation (NSF). Those grants allow the NSF to provide quick process and support for research that addresses an urgent need. "Our proposed approach off-loads the burden of diagnostics from health workers, eliminates the increased use of limited personal protective equipment, and provides a better response to outbreaks," said Reuel.

At the heart of the new approach are tightly coiled, screen-printed resonant sensors which Reuel's current research has been applying to sensing problems in closed systems such as soil, wounds, and bioreactors. In this project, the resonant sensors are screen printed on cardstock as part of an in-home, personal COVID-19 test. To complete the test, a person would take their own nasal or cough samples, apply it to a sensor card, place the card in an envelope with a virus-killing coating, and it would be mailed to locations with readers (municipal facilities, hospitals, etc.). There, the unopened envelope is electronically scanned to determine a positive or negative test result – and those results would then be texted or emailed back to the sender. All this convenience could possibly cost a consumer as little as $1 or less to purchase, thus enabling widespread and frequent testing.



A close-up of one of the Reuel lab's screen-printed resonant sensors that could help fight future disease outbreaks.

The key to exquisite sensitivity in the new sensor system is the use of "toehold switches" that detect target RNA genetic material. That detection triggers production of "reporter" proteins that degrade portions of the resonant sensor and cause a dramatic shift in the frequency of a sensor's signal.

During an academic conference last winter, Reuel heard more about the toehold technology from Keith Pardee, an assistant professor with the Leslie Dan Faculty of Pharmacy at the University of Toronto, who works in partnership with **Alexander Green**, an assistant professor with the Biodesign Center for Molecular Design and Biomimetics at Arizona State University. They had done prior work with the Zika virus and recently demonstrated a direct, electrical interface of their toehold circuit. They're now collaborators with Reuel on this project.

Reuel said he thought the toehold technology could fit some of his ideas for a closed, contact-free diagnostic sensing system using paper-based resonant sensors. In January of 2020 he began a project to explore using this technology, aimed at general disease targets. With the subsequent outbreak of COVID-19, the focus quickly narrowed to this one critical disease, and led to seeking the RAPID grant.

Resonant sensors are simple circuits composed of inductive, capacitive, and resistive elements (LCR circuit) that tunes the resonator to oscillate current at a specific resonant frequency. The resonator can be used as a sensor by engineering the inductance, capacitance, and/or resistance elements to modulate when exposed to the desired analyte, which in turn affects the resonant frequency. They've been demonstrated previously measuring such things as temperature, humidity, and pressure. Reuel has been part of a research team working on a project to develop materials and methods for scalable manufacturing of flexible resonant sensors and their wireless readers. The group received a $750,000 award made available through the NSF Partnerships for Innovation (PFI) program in 2018. It included industrial partner

DuPont with two co-PIs from their Advanced Electronics business. Reuel's use of resonant sensors embedded in wound dressings also recently resulted in a prestigious 3M Untenured Faculty Award (2020). Reuel has also spun out his resonant sensors used for measuring cell viability in a startup company, Skroot Laboratory Inc. (Ames, Iowa) which is supported by NSF SBIR funds and has employed three CBE graduates.

ISU chemical engineering graduate students **Adam Carr** and **Jared Dopp** have been instrumental in developing individual components of the newly-planned COVID-19 diagnostic sensors. Plans currently call for the finished product to be a multilayered assembly on thick, color-coded paper. The top layer would hold collected nasal or cough samples, middle layers would contain the toehold switch and bottom layers a printed, coiled resonant circuit that can be scanned for telltale frequencies. "Make it very user-friendly, color-coded," said Reuel in a television news interview about the project. "Put your sample on this color. Put it on this other one, let it sit overnight. And then just stuff it in the envelope and mail it in."

If there's target COVID-19 RNA in the samples, the toehold switch would allow production of proteins that degrade a coating on the circuit resulting in a positive signal. If there's no virus RNA, there's no protein production, no coating degradation and a negative signal.

Reuel predicts it could be at least May of 2021 before this project would be finished, approved, purchased, and employed. He says even if officials have managed to get tighter control of COVID-19 by then, the technology can still be used in the future. "Let's say there is a mutation to the current disease, or a new pandemic surfaces," said Reuel. "Essentially, a lot of the device platform all stays the same and you just have to swap out a few different pieces and then you're ready for the next test."

Panthani Si-Nanosheet Research

Using a full array of combined scientific techniques, Department of Chemical and Biological Engineering associate professor and Herbert L. Stiles Faculty Fellow **Matthew Panthani** and his research team are rethinking the way science is exploring the applications of Si-nanosheets (silicon nanosheets – SiNSs).

Matthew Panthani

The work was recently published as a cover story in the journal *Chemistry of Materials* (Vol. 32, No. 2, January 28, 2020), "Silicene, Siloxene, or Silicane? Revealing the Structure and Optical Properties of Silicon Nanosheets Derived from Calcium Disilicide."

Lead investigator Panthani, Iowa State CBE assistant professor **Luke T. Roling**, and Iowa State chemical engineering graduate student **Bradley Ryan** and then-graduate students **Utkarsh Ramesh, Rainie Nelson** and **Yujie Wang** are among the authors.

A nanosheet is a two-dimensional nanostructure with a thickness between one and 100 millimeters. Because of unique electrical and chemical properties compared to much larger-scale materials, nanosheets have become a fast-growing segment of nanoscale applications in industry. Since 2017 Si-nanosheets have been used as a prototype material for the next generation of many processes, including electronic, optoelectronic, spintronic, and catalytic, which have many potential industrial applications.

The paper discusses the fact that though Si-nanosheets were first synthesized more than 150 years ago, there is a lack of consensus in scientific literature regarding the structure and optical properties of the material. The Panthani group project has provided conclusive evidence of the structural and chemical properties of SiNSs produced by the deintercalation (removal of a molecule inserted between two others) of calcium dicilicide through a cold aqueous process.

The study used a wide range of techniques including XRD, FTIR, Raman, solid-state NMR, SEM, TEM, EDS, XPS, diffuse reflectance absorbance, steady-state photoluminescence, time-resolved photoluminescence, and thermal decomposition; when they are combined together, these techniques enable unique insight into the structural and optical properties of the Si-NSs.

The paper finds that the results are encouraging for a variety of optoelectronic technologies, such as phosphors, light-emitting diodes, and CMOS-compatible photonics and states that results provide critical structural and optical properties to help guide the research community in integrating Si-NSs into optoelectronic and quantum devices.

In 2018 Panthani received the National Science Foundation CAREER award for research into using optoelectronic properties through nanoscale sheet technology for transmission of data as an alternative to wiring.

Internships, co-ops and jobs: Chemical engineering graduate students share their success stories

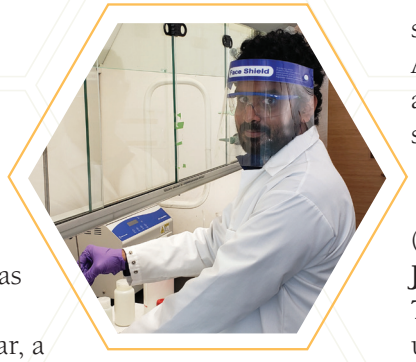
Fatima Enam

"Internship" and "co-op" are types of work experiences most often heard in regard to undergraduate students to help them achieve real world work experience before graduation. But for those who pursue graduate degrees, co-ops and internships are equally important for grabbing the brass ring once they receive their advanced degrees.

Both current graduate students and some who have received their degrees and have entered the workforce shared thoughts about their ISU internship and graduate experiences and how those helped them succeed on their career path.

Fatima Enam could be found in the hallways and labs of Sweeney Hall from 2015-2019 as she pursued her Ph.D. in chemical engineering. Today you'll find her at Stanford University working as a postdoctoral research fellow in the Lab of **Justin Sonnenburg** in the Department of Microbiology and Immunology in the School of Medicine.

Enam did her graduate work under the guidance of CBE's Karen and Dennis Vaughn Faculty Fellow and assistant professor **Tom Mansell**. Her work focused on harnessing the programmability of microbes to understand the role of prebiotic oligosaccharides (carbohydrates that are formed when sugars link together). Her current research focuses on developing approaches to engineer the gut microbiota and using in vivo gnotobiotic mouse models to understand underlying host-microbe interactions. She was named an MIT Chemical Rising Star, a Leader of Tomorrow by the 2020 GapSummit and was selected as a delegate to the 70th Lindau Nobel Laureate Meeting in Germany.



Daniel Sahayaraj

While at ISU she interned with Cargill's Biotechnology Research and Development in Plymouth, Minnesota. She says, "From day one, I was handed a project and I saw it to completion. I had an amazing mentor who had complete faith in me. I helped develop a tool that could potentially save the company millions of dollars annually. The impact that you get to make in industry is immense and that was very gratifying. The best part of the internship was the people I got to work with and the professional network I created."

Of her time in CBE, Enam says, "I have a deep sense of gratitude for the department. It really is a wonderful community and I constantly felt surrounded by caring people. I always felt all of the faculty and staff were really invested in my wellbeing and I am very grateful for that."

Archer Daniels Midland Company (ADM) is a business that has recognized the promise of Department of Chemical and Biological Engineering students. Graduate students **Hamed Bateni** and **Daniel Vincent Sahayaraj** did simultaneous internships in ADM's Process Chemistry and Catalysis Group starting in November of 2019.

Hamed Bateni

"Dr. Tessonnier (associate professor **Jean-Philippe Tessonnier**), informed us about this incredible NSF program providing supplemental funding for students working on an active NSF grant to pursue an internship in a non-academic research setting," said Bateni. "He encouraged us to take advantage of this opportunity to obtain an industrial experience sooner rather than later. We discussed this opportunity with Dr. **Karl Albrecht** (an Iowa State Chemical and Biological Engineering graduate) and Dr. **Erik Hagberg** (an ISU organic chemistry graduate) at ADM, and they showed interest in hosting us in their group."

Bateni's primary project was about the development of a catalytic process to produce a target product with a substantial business interest at ADM. Sahayaraj's project involved the investigation of the technological feasibility of a reaction route for the synthesis of a specialty chemical. Both students reported extensive collaboration with several colleagues at ADM as well as external collaborators, and both echoed the value it brought to their professional development. "It was definitely a pleasure working with this very talented set of colleagues with amazing personalities that made the whole experience truly phenomenal," remarked Bateni.

Bateni is expecting to receive his Ph.D. in the next two years; Sahayaraj looks to receive his degree in the fall of 2021.

Albrecht supervised Bateni and Sahayaraj in their internships. "Both Daniel and Hamed made meaningful and measurable progress during their internships," he remarked. Their six-month NSF Fellowship duration allowed sufficient time to more fully grasp the challenges associated with their research, create hypotheses and perform the appropriate experiments.

"Throughout their internship, we took the approach of including Hamed and Daniel on all aspects of project management and execution. Our goal was to provide as broad of an experience in industrial research as possible. Daniel and Hamed also benefitted from mentoring interviews with several ADM leaders. ADM benefited from the diversity of experience, expertise and outside perspectives Daniel and Hamed brought from their own projects at Iowa State."

Sadaf Charkhabi did graduate research work in the lab of assistant professor and Jack R. and Carol A. Johnson Faculty Fellow **Nigel Reuel**, and landed an internship with DuPont in Wilmington, Delaware, in 2018. She worked on developing conductive pastes for screen printing resonant sensors as well as exploration of the effect of different processing parameters on the sensor quality signal.

Her Ph.D. research centered on design and development of inexpensive contact-free resonant sensors. These sensors can potentially be used in an enclosed controlled system for real-time monitoring of biological analytes. She also worked on different applications of these sensors for monitoring many things, including bacterial growth for food safety applications. After graduating in the summer of 2020, she received a job offer from 3M and will be a senior research engineer in the company's Biomaterials Cluster in St. Paul, Minnesota. "I met with 3M in an on-campus interview and then received the job offer," she said.

"I worked on multiple projects and there were research failures at times," she said of her graduate experience. "However, my determination to pursue my career in this field, as well as the help and support I received from others, drove me forward. It's the ultimate reward. In order to be a successful graduate student researcher, you must take ownership of your work and direct it toward your goal," she added.

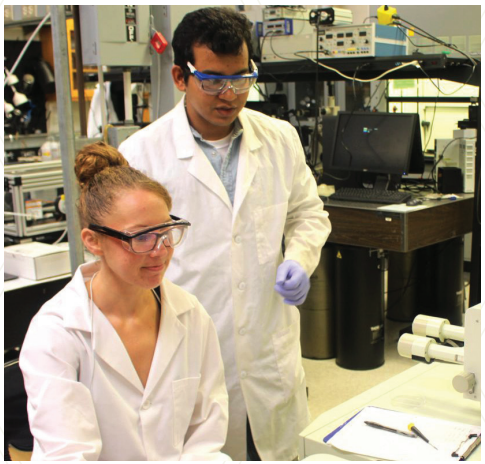
Oregon is the new home of **Russell Mahmood**, who received a Ph.D. in chemical engineering from Iowa State in May of 2019. He's now a lithography process engineer for Intel, supporting nanometer technology to create intricate nanoscale patterns on silicon surfaces which become functional microprocessors in computer devices that are used every day.

When Mahmood was at Iowa State he worked in the lab of professor and Reginald R. Baxter Endowed Department Chair **Andrew Hillier**. Mahmood said, "My research was very much aligned with my current job. In Dr. Hillier's lab, I advanced the capability of interference lithography to pattern unique nanostructures, which proved useful in building several types of photonic devices."

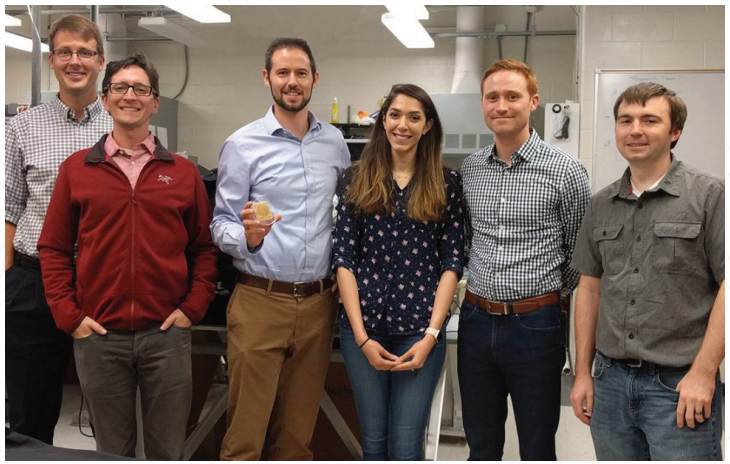
He interned at the Eastman Kodak Company in Rochester, New York. "I worked on an interesting project involving spatial Atomic Layer Deposition (sALD) technique. It's a technique where we deposit materials atomic layer by atomic layer," he said. "I developed a prototype to deliver materials in the aqueous phase. I designed and built the prototype using stereolithography printing. I also automated the moving parts.

"I am immensely grateful to Dr. Hillier for the independence he offered me in my research at Iowa State. My projects were open ended, and I could steer them in any direction I wanted, but he was always there to guide me whenever I felt lost.

"The ISU chemical engineering department has provided me with great opportunities to learn and grow," he said, and added he thinks every Iowa State chemical engineering graduate student should develop certain skills during their graduate work: communication skills, developing contacts outside of ISU and developing skills in working as a team – and that his Iowa State experience helped him achieve all three.



*As a ISU graduate student **Russell Mahmood** oversees the work of an undergraduate in the CBE department.*



***Sadaf Charkhabi** (center) is shown as part of an Iowa State research group with her major professor **Nigel Reuel** (holding sample).*

A New Flavor of Undergraduate Research

John Kaiser and ChE 490 offer a different kind of internship

Undergraduate research and independent study have long been a part of the chemical engineering program at ISU. Students can expand their understanding of engineering research and also earn credit towards their degree by working with faculty on various projects as part of the ISU course "ChE 490, Undergraduate Research/ Independent Study."

In 2019, CBE professor of practice **John Kaiser** introduced a new flavor of this course with what he likes to call "Applied Industry Research." His version of ChE 490 sparks interest in both the students and the businesses involved.

"We encourage all our undergraduates to do co-ops and internships," says Kaiser, "because they provide such valuable experience and preparation for their careers." However, not all students have that opportunity. In response, Kaiser created a version of a professional internship that students can pursue while still on campus.

How does this course work? Companies sign up and provide semester-long engineering projects for the students to work on with them hand-in-hand. Students usually work in teams. In the spring 2020 semester, there were projects with a company that deals with mint flavoring, a world leading manufacturer of collagen (gelatin) products, a wine maker and an ice cream manufacturer.

"This class provides them with an extra level of hands-on involvement directly with a company," Kaiser says, "and additional training that can prepare them for rapid on-boarding during that first job out of school."

A group of ChE 490 students gather for a group shot with Kaiser (far right).

Companies have a modest buy-in to participate and the intellectual property rights (plans, processes, etc.) used in the program are owned and retained by the company. However, if a participating student develops a new process which the company wants to protect, he or she is given credit as an inventor. "Now, that's a valuable achievement to have on your resume," says Kaiser.

Participating companies are encouraged to have the students visit their offices and facilities whenever possible. One company arranged for students to travel to an agricultural growing region in Indiana to obtain first-hand insight into strategic crop and processing aspects together with farmers, brokers and technical experts. "And, sometimes the scope of the project becomes much larger," Kaiser reported.

Kaiser knows from experience how a program like this can impact engineering graduates. He spent years working with prospective and new hires when he was with Mars Chocolate prior to joining the Iowa State CBE faculty. And he's seen the gaps in training that exist for students just coming out of college. "I helped create this course at Iowa State because as an engineer in the field I saw what new hires needed in experience. With this experience you can walk out the door after graduation with a huge edge in real-world training. Students who participate get exposure and application to project management, IP training, literature and IP searches, ideation and much more. Skills that might take two years for a new hire to learn in training otherwise."

Kaiser says at the start of a semester he presents a handful of classroom sessions, and after that, the students quickly begin work on their respective projects. They perform lab and pilot work with facilities in the Department of Chemical and Biological Engineering and also use the facilities in Iowa State's Department of Food Science and Human Nutrition.

"The companies don't expect the students to have all the answers to their needs in just one semester, but the students' work is on a timeline and progress is closely tracked – and, that is a big dose of real-world practices," Kaiser remarks.

Though it's offered by CBE and many of the participating companies to date are involved with foods, Kaiser stresses it is not limited only to chemical engineering students, and not to food

industry businesses. “The gelatin project has a direct link to the pharmaceutical industry, and this program is open to all businesses where process engineers play a role.”

The only prerequisite for the program is ChE 210. Therefore, it’s open to a large number of CBE undergraduates – from sophomore to senior. This semester the program has five sophomores, six juniors and ten seniors. Thirteen of the students are female.

“The opportunity these students have – what they have delivered so far and will continue to deliver is amazing,” says Kaiser. “It’s a wonderful opportunity for everyone involved.”

Any industry representatives who would like information about how to get involved with the program should contact Kaiser at jkaiser@iastate.edu

A group of ChE 490 students address a lab task in the fall semester of 2019.

Monica Lamm expands her reach to ISU faculty as CELT Fellow

Known for her commitment to education of Department of Chemical and Biological Engineering (CBE) students, **Monica Lamm** is now extending her influence to students across the entire Iowa State University system. Lamm, a CBE associate professor, is one of the first two faculty fellows with Iowa State’s Center for Excellence in Learning and Teaching (CELT). Her term with CELT began in 2019.

Lamm serves CELT as faculty fellow for programming. Her duties include expanding CELT’s professional development offerings for faculty, including the development of a Teaching and Learning Academy for new faculty members and leadership of the Teaching Partners program.

The CELT Teaching and Learning Academy began in 2019. This program is for instructors who have between one and five years of teaching experience at Iowa State University. Instructors apply to be considered for the academy and a new cohort is formed each academic year. The academy meets one afternoon per month during the academic year. The monthly sessions address course design, evidence-based teaching strategies, inclusive classroom practices, peer review of teaching, and documentation of teaching effectiveness.

The CELT Teaching Partners Program pairs a new instructor with a senior instructor from a different discipline who is a successful and experienced teacher. Junior partners are in their second or third year at Iowa State University. Partners discuss teaching and learning topics, complete classroom observations, and focus on documenting teaching effectiveness for continuous improvement efforts of use in teaching portfolios.

Lamm has long been a key part of education in CBE (shown here with a superior teaching award from the College of Engineering) and now shares her expertise with other faculty members university-wide.

Lamm has been with CBE since 2003. She has received numerous Iowa State teaching awards and has co-authored papers pertaining to classroom learning techniques.

CELT was launched in 1993 with a mission to support, promote, and enhance teaching effectiveness and student learning at ISU. It provides resources for instructors, faculty, staff, graduate students, and postdoctoral researchers interested in teaching.

How to do a study abroad without going abroad: CBE's Oviedo, Spain summer lab stays home

"Adapt and overcome" is a phrase usually applied to the military. But it played out in the summer of 2020 in the Department of Chemical and Biological Engineering (CBE) with one of the department's most recognized undergraduate student programs – the Oviedo, Spain Summer Lab Program held in late May and early June each year, in conjunction with the University of Oviedo.

When the COVID-19 pandemic hit and international travel was restricted, all Iowa State study abroad programs for the summer of 2020 were canceled, including Oviedo. But as with much of ISU's educational programs, online courses became the norm, including Oviedo. And as with almost everything Iowa State did during this time, a wholesale shift in thinking and functioning had to be employed.

The five-week Oviedo program packs a lot of punch credit-wise, with participating students getting the nod for two chemical engineering lab courses plus elective credit in that short time. This summer's program was to offer no less. Eleven students who had pre-registered for the course long before "COVID-19" was a part of anyone's vernacular, would – along with faculty mentor teaching professor **Stephanie Loveland** – share in an unplanned adventure of navigating the course online here in the U.S., not in the classrooms and laboratories of the University of Oviedo. Whereas the course has always required the students to think on their feet, the disruption of plans this year resulted in significant adaptations on the fly for Loveland as well.

Lab experiments are a major part of the program, and Loveland had to work hard to shift the focus to online presentation. "For some experiments, I went to the lab and video recorded the apparatus and equipment and explained it all to the students, and then recorded myself running the experiments," Loveland said. "These clips were edited into a single video about 10-15 minutes long for the students to watch and then they were given data to analyze and assigned to write a report. For others, I went into the lab with my teaching assistant, graduate student **Nithish Subramanian Kaushik**, and we ran a live Zoom session going over the experimental apparatus and theory, did a trial run and sent the students a complete set of data afterward."

"For a couple of experiments, we used some of the data I had from last time we went to Oviedo and we also ran simulations using programs to model what the process is supposed to do and to compare to the 'real' data from the experiment."

For one experiment, liquid-liquid extraction, more new techniques were successfully employed. Loveland used the help of laboratory supervisor **Ryan Arndorfer**, who conducted live Zoom sessions from a Sweeney Hall lab for the students, who were divided into groups. Based on data from prior experiments, each group made targeted projections for the rate of flow of a solvent to achieve the desired result. They submitted their information to Arndorfer, who, along with Kaushik, ran the experiments with those numbers and shared the results with each group. One adjustment could be made if the target projection was not met.

Above: *Improvisation was key in the socially distanced farewell party for the Oviedo lab students as Loveland prepared Spain-inspired treats and yard decorations for the gathering – a rare chance for the 2020 participants to gather in person.*

Left: *The typical on-location photo of students in the Oviedo, Spain lab was replaced in 2020 by a group shot of students together electronically due to the COVID-19 pandemic.*

A final project mirrored one Loveland said she often assigns in another class, where the students design a new experiment that could be built in the lab and then present a proposal to convince Loveland why it should be added to the course curriculum. "The students did a combination of written reports, memos and recorded oral presentations – which we called 'autonomous presentations,' since they are PowerPoint presentations, that the students create," she said. "They then record a 'voice over' narration, kind of like a training webinar."

These alternative methods of presenting the course work – and the value they brought to the student experience – was not lost on the participants, who acknowledged they still took a plethora of valuable skills out of the planned exercises – even though not in the learning environment of Spain.

"The program became an experiment in itself," said senior **Shelby Baker**. "The most beneficial part of this experience was working at such an intensive pace and being forced to be adaptive. Both of these challenges allowed me to learn more about how I function under pressure. I can take what I learned and apply it to situations in life and my future workplace."

Senior **Aurelien Le Denmat** was quick to echo the "real world" aspect of the virtual class format and how through its uniqueness, it provided value in jump-starting exposure to what will be encountered in many professional environments: "I think the thing that benefitted me most was learning to work with a team in a virtual environment. I was in a group with two others and doing work was not as easy as meeting at the library for two hours and getting things done. Making sure we had times to meet and having time to get the reports we had due ready in a timely fashion was hard, but it taught me some skills that I think are different than when you are meeting in person."

The program still ended at the pre-arranged date the in third week of June. There were no planes to catch back to the U.S. or to other European destinations for post-lab travel. But Loveland still arranged some memorable activities for the students, including a socially-distanced gathering with all involved and an online session with Loveland and a couple of students providing live Andalusian (flamenco) dancing to add some authentic Spanish flavor. Loveland also put together "goodie bags" for the departing students with some special items that captured the flavor of Spain.

"I think it was very kind of Dr. Loveland to do all this. The party was a great way to connect with everyone and meet Ryan and Nithish in person, and end the program on a fun note!" said Baker.

And it's clear the efforts of all to conduct the program in an unprecedented new way will have its legacy. Baker added: "I think the thought process that went into this unique situation will greatly benefit all of us in the future. I know Dr. Loveland would like to take some of the techniques employed to use in other ways. I hope to see it implemented into more typical chemical engineering labs, as I believe it will benefit other students."

Students, advisers deal with disruption

The sudden move to distance instruction when the COVID-19 pandemic struck and the Iowa State University campus shut down in March 2020 caused a huge disruption to the lives of students, faculty and staff. But, as engineering students are adept at by nature, the ability to analyze and adapt became a top priority for them and those involved with their educational experience. The Department of Chemical and Biological Engineering (CBE) was no different.

Students say they missed physically attending classes, in-person meetings for group assignments and hands-on work in labs. But, there were silver linings in those dark pandemic-induced clouds.

"As disappointing as it was to spend the end of my senior year away from friends and campus, I found that distanced learning took away a lot of stress since I had no scheduled obligations," said **Laura Studanski**, a spring 2020 CBE graduate. "I also liked having access to lecture videos for every class that I could re-watch if necessary."

With that extra electronic flexibility came additional self-discipline. For many students, there was an added challenge of finding the best time management and the motivation to match.

"For me, the biggest challenge was keeping my motivation and accountability up with all of my classes. While I was sure to complete every assignment, without the set class structure I could easily get behind or miss a virtual class lecture," said **Drew Smith**, another spring 2020 CBE graduate. "Something that certainly helped was professors setting aside extra time to check in with things," he said.

For spring 2020 senior graduates, vacating campus also meant no in-person commencement activities. Those moved online as well, with CBE joining a plan that saw all engineering departments creating virtual pre-commencement ceremonies with YouTube Premier videos that were scheduled to air at a pre-arranged time, and continue to be available on demand on YouTube. The university commencement was also held virtually.

"The virtual ceremonies for CBE and the university were both very well-

Students, advisers deal with disruption cont'd

Adviser Mackenzie Schwartz

Student services specialist Matthew Brown

Adviser Nicole Prentice

made and sincere. I could tell that everyone involved put in a lot of effort to make us feel supported and recognized, which was very meaningful considering how hectic everyone's schedules must have been," said Studanski.

CBE's advising staff also felt the crunch of the sudden shift to dealing with hundreds of students in an all-electronic scenario.

"Plenty was challenging about this spring, but I'd also say a lot of changes were positive. We upped our focus on proactive advising, reaching out and emailing students prior to dates and deadlines to try and get ahead of the questions and to make sure students understand questions. We did proactive advising before COVID, but now rely on this form of checking in since the only way we have access to students is now through their emails," said **Mackenzie Schwartz**, chemical and biological engineering academic adviser.

As the changes started coming, accountability shifted to students. Not only did students have to adapt to new class structures and living arrangements, but also new advising procedures. "We asked a lot from our students to set themselves up for success amidst wide-ranging family and living arrangements," said academic adviser **Matt Brown**,

Academic adviser **Nicole Prentice** said, "I think that the transition to online learning and work due to COVID-19 for me has reiterated the importance of flexibility, adaptability and communication when trying to accomplish a goal."

Brown echoed those sentiments: "The pandemic of 2020 has taught us to be strong as a unit, to prioritize our time, and to rediscover what makes our work in higher education so rewarding. When we cannot utilize our beautiful campus and be near each other for the safety of all, we appreciate those things even more. The biggest lesson? Cyclone Gratitude," he remarked.

Meeting a department's IT challenges requires quick action and decisions

The world revolves around computers. And that became even more apparent – and more urgent – when the COVID-19 pandemic shut down in-person classes for part of the spring semester and all of the summer of 2020 at Iowa State University.

ISU president **Wendy Wintersteen** correctly said it was like nothing Iowa State had ever experienced before. Almost overnight, IT professionals and faculty members were thrust into a whirlwind of transitioning, trying to figure out how all classes would be taught online and how students were going to experience all lectures, complete all assignments and take all tests remotely. CBE's systems analyst **Colin Richey** was part of a team effort that sprang to life with many people across the College of Engineering and across campus.

"The first thing we did was figure out what methods we had available for remote learning, and what were the strengths and weaknesses of each," said Richey. "Then, we had to figure out how to effectively train faculty and staff to use programs and techniques. We had to set up existing hardware such as laptops and webcams, as well as purchase and distribute equipment to people who didn't already have it, so they could teach or work with students remotely. Things like helping faculty install software, getting webcams and microphones set up, and getting classes set up in the Canvas teaching program." Faculty members and student teaching assistants shouldered much of the responsibility in making the transition, and worked hard to find good data sets from previous classes and lab work to aid current students.

Richey said time, or lack of it, was the biggest factor. And while deciding to move to all online learning occurred just prior to spring break, which gave staff an extra week to prepare, "it was definitely a rush to get everyone as comfortable as possible before classes resumed online," said Richey.

Converting laboratory classes to an online presentation was one of the biggest challenges, and the annual Oviedo, Spain summer lab experience for undergraduate students relies heavily on lab work for students to meet academic requirements.

When all ISU study abroad programs for summer 2020 were canceled the decision was made to have students enrolled in the Oviedo program meet

their requirements online. Working with Oviedo program faculty mentor **Stephanie Loveland** department laboratory supervisors **Sarah Beckman** and **Ryan Arndorfer** helped answer the call. Video chat capabilities were set up in a Sweeney Hall lab using a lab web cam and Arndorfer and Loveland, demonstrating lab experiments that were video recorded and made available to students.

"I went to the lab and video recorded using the apparatus and equipment and explained it all, and then recorded myself running the experiments," said Loveland. "These clips were then edited into a single video about 10-15 minutes long for the students to watch and then they were given data to analyze and write a report." You can see more about how the Oviedo program adapted in a separate story in this publication.

"Having those video recordings has actually been an asset for future classes," said Beckman. "I have turned the pre-made video into a pre-lab video that can be used for future classes so they can see the experiments in action and the kinds of questions students ask."

Other considerations for the fall semester included how to set up and allow usage of computer labs in Sweeney Hall, typically areas where large numbers of students congregate. "Much of our talk turned to whether to open certain spaces, like computer labs, and if we do open them what plans do we have for sanitizing things, or spreading things out so people aren't sitting so close," said Richey. "That's on top of emphasizing and growing our remote classroom options for students and to have access the to software they need. While computer labs were closed for general use in the fall semester of 2020, computing ability was made available to students through remote connection."

Within a university-wide framework, Richey feels good about what was accomplished under very tight parameters in the spring of 2020: "Ultimately, from the feedback I've gotten, I think we were very successful in getting things moved to all-online learning."

Teaching professor and Oviedo program coordinator Stephanie Loveland sets up for and livestreams a presentation of an online course lab assignment.

Chemical engineering grad student Kallmyer is Brown Graduate Fellow

Nathaniel Kallmyer, a fourth-year Ph.D. chemical engineering student at Iowa State, has been named a recipient of a Brown Graduate Fellowship for 2020-21. Across Iowa State University, 14 of the fellowships are awarded each year.

He was selected for the honor after a Chemical and Biological Engineering departmental competition that included an oral presentation showcasing qualifications, thesis research and how funds received from the fellowship would be used to advance Iowa State research in the areas of science and agriculture.

Kallmyer's major professor is assistant professor and Jack R. and Carol A. Johnson Faculty Fellow **Nigel Reuel**. His research has involved pioneering the development of a modular optical sensor for hydrolytic enzymes along with low-cost readers and efficient data algorithms to determine kinetic rates. He has also developed a novel sensing platform that exploits surface sensitivity of single-walled carbon nanotubes (SWNT) to detect perturbations to a surrounding "corona" phase. Changes to this phase are communicated by a modulation of fluorescent signal. His work has led to study of the membranes of potentially harmful bacteria and techniques that provide near-instantaneous feedback while minimizing the risk of human exposure to infectious disease.

***Nathaniel Kallmyer** (left) is congratulated by CBE's Director of Graduate Education **Jean-Philippe Tessonnier** after being named a Brown Graduate Fellowship recipient.*

In his letter of nomination to the Brown Fellowship Selection Committee, Department of Chemical and Biological Engineering Director of Graduate Education **Jean-Philippe Tessonnier** said,"Nathaniel advances academic excellence at ISU through his exceptional dedication to research, innovation and teaching. These efforts have already had multifaceted impacts on his research group and our department. Nathaniel is one of those rare students who couples genuine curiosity with a deft ability in the lab."

Tessonnier also pointed to Kallmyer's commitment to share his research and experience with younger generations of students, particularly with underrepresented minorities in STEM programs. He is involved with the FIRST Robotics (where teams of high school students build industrial-sized robots that must complete a task) and APEX-Engineering outreach programs that host automation outreach activities for high school students and new undergraduates of underrepresented groups.

Kallmyer is listed as author on four ISU research publications, has assisted in teaching two undergraduate courses and has mentored 18 undergraduate students. He came to Iowa State in 2016 after receiving his B.S. degrees in chemical engineering and chemistry from Purdue University.

"I feel honored to have been nominated by the CBE department. This fellowship will open a lot of doors for my cell membrane study," said Kallmyer.

CBE Honors & Awards 2019-20

FACULTY

Rodney Fox, Anson Marston Distinguished Professor in Engineering and Hershel B. Whitney Professor, Global Initiatives
Inducted as Fellow, American Institute of Chemical Engineers (AIChE), 2020

Jennifer Heinen, Teaching Professor
Promoted to Teaching Professor, 2019
Teaching Innovation Award, 2020

Andrew Hillier, Reginald R. Baxter Endowed Department Chair
Inducted as Fellow, American Association for the Advancement of Science, 2019
Inducted as Fellow, American Institute of Chemical Engineers (AIChE), 2020

Laura Jarboe, Professor
Promoted to Professor, 2019
Outstanding Achievement in Teaching, College of Engineering, 2020

Monica Lamm, Associate Professor
Regents Award for Faculty Excellence, State of Iowa, 2020

A group of December, 2019 B.S. graduates smile for the camera at the pre-commencement reception.

Stephanie Loveland, Teaching Professor
Promoted to Teaching Professor, 2020

Balaji Narasimhan, Anson Marston Distinguished Professor, Vlasta Klima Balloun Chair
Named Fellow, National Academy of Inventors, 2019

Matthew Panthani, Associate Professor
Promoted to Associate Professor with Tenure, 2019

Luke Roling, Assistant Professor
Named Michael and Denise Mack Faculty Fellow, 2020

Yue Wu, Professor
Promoted to Professor, 2020
Mid-Career Achievement in Research Award, College of Engineering, 2019

ALUMNI

Michael Anctil (B.S. '08)
Young Alumni Award, College of Engineering, 2019

Brian Anderson (Ph.D. '02)
Maria Westfall (B.S. '77)
Professional Achievement Citation in Engineering (PACE) Award, College of Engineering, 2019

STAFF

Michelle Stotts, CBE Operations Manager
Outstanding New Staff Award, College of Engineering, 2019
Regents Award for Staff Excellence, State of Iowa, 2020



Seniors who were recognized in the department's May 2020 commencement were (left to right): ***Ethan Brown****, the Lawrence E. Burkhart Outstanding Senior,* ***Brittany Lende****, who provided the senior address, and* ***Laura Snyder****, who served as the outstanding senior representing CBE for the College of Engineering.*

CBE welcomes one new faculty member, three new staff members

Rizia Bardhan

Rizia Bardhan

Rizia Bardhan joined the faculty of the Department of Chemical and Biological Engineering in January, 2020 as an associate professor.

Her research focuses on the use of both soft and hard nanoparticles for molecular imaging and image-guided treatment that include immunotherapies, drug delivery, and light-based therapies. She is also an expert in Raman spectroscopy and its applications in metabolic response to treatment.

Ryan Arndorfer

Ryan Arndorfer

Ryan Arndorfer joined the department as a laboratory coordinator. He works with laboratory coordinator Sarah Beckman in handling many important and ever-expanding teaching and research laboratory-related duties, including managing and maintaining equipment, procuring new equipment, assisting with graduate teaching assistant trainings, and overseeing lab safety.

He holds a master's degree in genetics from Iowa State University and is a six-year U.S. Air Force veteran, where he worked in computer network systems.

Matthew Brown

Matthew Brown

Matthew Brown joined the department team as a student services specialist. He advises CBE undergrads, works with the department's student ambassador program and works with prospective students and student orientation.

He came to CBE after being employed in the Iowa State University Office of the Registrar. His background also includes time with the ISU Office of Student Financial Aid while attending school and later as a full-time adviser in that office.

Brown graduated with a B.S. in accounting from Iowa State in 2000 and completed a M.Ed. in the higher education program at Iowa State in 2002.

Kelsey Polaski

Kelsey Polaski

Going straight from Iowa State graduate to Iowa State employee, Kelsey Polaski joined the Department of Chemical and Biological Engineering staff as a graduate student and data analytics specialist.

She received her undergraduate degree in management information systems from Iowa State's Ivy College of Business. She worked in the ISU accounts receivable office and for the Iowa Department of Transportation as a data analytics intern. As an undergraduate she was also the head team manager for Iowa State volleyball and has coached youth volleyball.

Distinguished Professor Emeritus George Burnet, wife Martha Anderson, receive Alumni Medal

Department of Chemical and Biological Engineering (CBE) Distinguished Professor Emeritus **George Burnet** and his wife **Martha Anderson**, both Iowa State University alumni, have each been announced as recipients of the Alumni Medal from the ISU Alumni Association.

The Alumni Medal is presented to individuals demonstrating long loyal service to the university through alumni-related activities, and is the premier award given to alumni by the association.

Burnet received a B.S. (1948), M.S. (1949), and Ph.D. (1951) in chemical engineering at Iowa State. After a few years in industry, Burnet enjoyed a 39-year career as an active faculty member in the ISU Department of Chemical and Biological Engineering and served as department head from 1961-1978. He retired as Anson Marston Distinguished Professor Emeritus in 1995 and has remained involved in the CBE department. He was a key figure in planning the department's centennial in 2013, which included authoring a book on the department's first 100 years.

Martha Anderson is a 1948 home management alumna of Iowa State. She and George have been frequent guests at department events in recent years.

*Research Excellence Award recipient **Sean Kelly** is congratulated by **Balaji Narasimhan**, his major professor. **Fatima Enam**, who graduated from Iowa State earlier in the fall, was also honored.*

***Alaric Siddoway** receives his Teaching Excellence Award from assistant teaching professor **Karen Burt**.*

***Deon Ploessl** speaks to those in attendance after receiving his Teaching Excellence Award from Director of Graduate Education **Jean-Philippe Tessonnier** and **Burt**.*

***Adam Carr** receives his Teaching Excellence Award from assistant professor **Nigel Reuel**.*

Maria Westfall *(B.S. '77) was named a recipient of the College of Engineering Professional Achievement Citation in Engineering (PACE) Award. She's shown here enjoying an Iowa State men's basketball game with department chair* ***Andrew Hillier*** *(far left), her husband* ***Mike*** *and James L. and Katherine S. Melsa Dean of Engineering* ***Sam Easterling*** *(far right).*

Brian Anderson *(Ph.D. '02), left, and* ***Michael Anctil*** *(B.S. '08) were honored with the College of Engineering's Professional Achievement Citation in Engineering (PACE) Award and Young Alumni Award, respectively, in October of 2019.*

CBE faculty gather for a group photo at their annual retreat prior to the beginning of the fall 2019 semester.

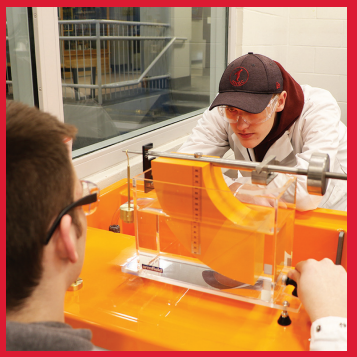
The top three finishers in CBE's Perfect Pitch 2019 research presentation competition were honored by the department. ***Atefe Hadi*** *(center, first),* ***Adam Mullis*** *(right, second) and* ***Moises Contreras Ramos*** *(third) are shown. Graduate students have 90 seconds and one Power Point slide to convey the importance of their research.*

Kia Birnbaum *was named the Lawrence E. Burkhart Outstanding Senior for the fall 2019 CBE commencement.*

Kyle Jackson *was selected as the outstanding senior in CBE representing the College of Engineering for the fall 2019 commencement.*

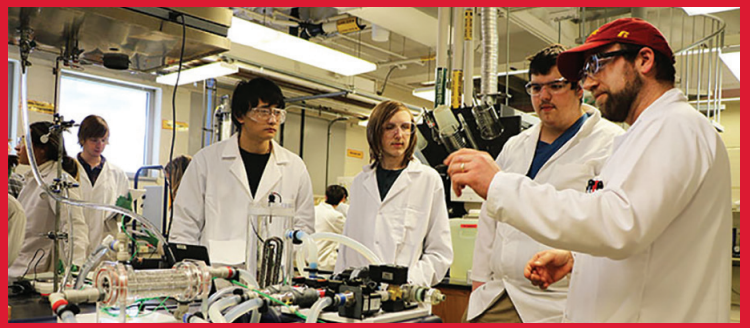
Alumni gifts add new equipment, new opportunities

Students in ChE 160 collect pressure drop data with a flow meter demonstration unit purchased with a gift from ***Gary and Mickie Griswold****.*



Students in ChE 160 learn about hydrostatic pressure by observing force exerted on a submerged object with equipment from the ***Gary and Mickie Griswold*** *gift.*

A dynamic thermal process in ChE 421 is at the ready with equipment purchased by a gift from ***Craig Wheatley****.*



Teaching laboratory coordinator ***Ryan Arndorfer*** *explains the operation of a shell and tube heat exchanger to students in ChE 160 with equipment made possible by the gift from* ***Gary and Mickie Griswold****.*

Recent Faculty Publications

Rizia Bardhan

Y-C. Ou, X. Wen, C. A. Johnson, D. Shae, O. Ayala, J. A. Webb, E. C. Lin, R. C. DeLapp, K. L. Boyd, A. Richmond, A. Mahadevan-Jansen, M. Rafat, J. T. Wilson, J. M. Balko, M. N. Tantawy, A. E. Vilgelm, R. Bardhan, Multimodal Multiplexed Immunoimaging with Nanostars to Detect Multiple Immunomarkers and Monitor Response to Immunotherapies, *ACS Nano*, 2020, 14(1), 651-663.

Kaitlin Bratlie

A. Boddupalli, D. Akilbekova, K.M. Bratlie, Poly-L-Arginine Modifications Alter the Organization And Secretion of Collagen In SKH1-E Mice, *Materials Science and Engineering*, 2020, C 106, 110143.

Eric Cochran

L. Shen, T.-P. Wang, F.-Y. Lin,S. Torres, T. Robison, S.H. Kalluru, N.B. Hernández, E.W. Cochran, Polystyrene-block-Polydimethylsiloxane as a Potential Silica Substitute for Polysiloxane Reinforcement, *ACS Macro Letters*, 2020, 781-787.

Rodney Fox

M.C. Baker, B. Kong, J. Capecelatro, O. Desjardins, R.O. Fox, Direct Comparison of Eulerian–Eulerian And Eulerian–Lagrangian Simulations for Particle-Laden Vertical Channel Flow, *AIChE Journal*, 2020, 66(7), e16230.

Kurt Hebert

Mishra, P. Yavas, D., Alshehri, A., Shrotriya, P., Bastawaros, A. F. and Hebert, K. R., Electrochemical Impedance Spectroscopy Analysis of Corrosion Product Layer Formation on Pipeline Steel, *Electrochimica Acta*, 2020, 346, 136232.

Andrew Hillier

R. Mahmood, M. Johnson, and A.C. Hillier, Massive Enhancement of Optical Transmission across a Thin Metal Film via Wave Vector Matching in Grating-Coupled Surface Plasmon Resonance, *Analyial Chemistry*, 2019, 91(13), 8350-8357.

Laura Jarboe

Y. Chen, E. Boggess, E. Rodriguez Oscasio, A. Warner, L. Kerns, V. Drapal, C. Gossling, W. Ross, R.L. Gourse, Z. Shao, J. Dickerson, T. Mansell, L. Jarboe, Reverse Engineering of Fatty Acid-Tolerant Escherichia Coli Identifies Design Strategies for Robust Microbial Cell Factories, *Metabolic Engineering*, 2020, 61, 120-130.

Wenzhen Li

X. Chadderdon, D. Chadderdon, T. Pfennig, B.H. Shanks, W. Li, Paired Electrocatalytic Hydrogenation and Oxidation of 5-(hydroxymethyl)furfural for Efficient Production of Biobased Monomers, *Green Chemistry*, 2019, 21, 6210-6219.

Surya Mallapragada

H.J. Kim, W. Wang, A. Travesset, S.K. Mallapragada and D. Vaknin, Temperature-Induced Tunable Assembly of Columnar Phases of Nanorods, *ACS Nano*, 2020, 14, 6007-6012.

Thomas Mansell

F. Enam, T.J. Mansell, Prebiotics: Tools to Manipulate the Gut Microbiome and Metabolome, *Journal of Industrial Microbiology and Biotechnology*, 2020, 46, 1445-1459.

Balaji Narasimhan

D.A. Wagner-Muniz, S.M. Kelly, N. Peroutka-Bigus, R.J. Darling, A.C. Petersen, B.H. Bellaire, M.J. Wannemuehler, B. Narasimhan, Single Dose Combination Nanovaccine Induces Both Rapid and Long-Lived Protection Against Pneumonic Plague, *Acta Biomaterialia*, 2019, 100, 326-337.

Matthew Panthani and **Luke Roling**

B.J. Ryan, M.P. Hanrahan, Y. Wang, U. Ramesh, C.K.A. Nyamekye, R.D. Nelson, Z. Liu, C. Huang, B. Whitehead, J. Wang, L.T. Roling, E.A. Smith, A.J. Rossini, M.G. Panthani, Silicene, Siloxene, or Silicane? Revealing the Structure and Optical Properties of Silicon Nanosheets Derived from Calcium Disilicide, *Chemistry of Materials,* 2020, 32, 2, 795–804.

Nigel Reuel

A.R. Carr, Y.H. Patel, C.R. Neff, S. …Charkhabi, N.E. Kallmyer,H.F. Angus, N.F. Reuel, Sweat, Monitoring beneath Garments Using Passive, Wireless Resonant Sensors Interfaced with Laser-Ablated Microfluidics, *Digital Medicine*, 2020, 3 (1), 1–9.

Derrick Rollins

M. Yong, T. Huynh, R. Khor, D.K. Rollins, Simulation Studies Comparing Feedback Predictive Control to Model Predictive Control For Unmeasured Disturbances in the Artificial Pancreas Application, *Journal of Dynamic Systems, Measurement and Control*, 2019, 141, 091009.

Brent Shanks

J. Huo, B.H. Shanks, Bioprivileged Molecules: Integrating Biological and Chemical Catalysis for Biomass Conversion, *Annual Review of Chemical and Biomolecular Engineering*, 2020, 11, 63-85.

Jean-Philippe Tessonnier

S.S. Chen, D.C.W. Tsang, J.P. Tessonnier, Comparative Investigation of Homogeneous and Heterogeneous Brønsted Base Catalysts for the Isomerization of Glucose to Fructose in Aqueous Media, *Applied Catalysis B: Environmental*, 2020, 261, 118126.

Dennis Vigil

C. Campbell, M.G. Olsen, R.D. Vigil, Jet Breakup Regimes in Liquid-Liquid Taylor Vortex Flow, *International Journal of Multiphase Flow*, 2020, 131, 103401.

Qun Wang

B. Reding, P. Carter, Y. Qi, Z. Li, Y. Wu, M. Wannemuehler, K. M. Bratlie, Q. Wang, Manipulate Intestinal Organoids with Niobium Carbide Nanosheets, *Journal of Biomedical Materials Research Part A*, 2020, published online.

Yue Wu

Y. Bao, W. Zheng, P. Gurrala, B. Xu, J. Song, Y. Wu, Electromagnetic Radiation Driven Phase Transition in Telluride-Iron Oxide and Iron Telluride Nano-Composites, *ACES Journal*, 2020, 35, 424-429.

Advisory Council 2020-2021

The Department of Chemical and Biological Engineering relies on the expertise, experience and advice of its advisory council, a group of chemical engineering professionals who are alumni of the department. The council plays a key role in helping to shape department policies and procedures in many areas, including curriculum development, accreditation, undergraduate and graduate student affairs, industry engagement, budget and more. The advisory council holds its annual meeting in the department each April, where interaction with faculty and students, review of data and other topics are used to help set plans and goals for the coming year.

Members typically serve two consecutive three-year terms. Degrees shown below are in chemical engineering unless otherwise noted.

Amy Determan
B.S, 2001; Ph.D., 2006
Advanced Product Development Specialist
3M

Tess Duckett
B.S., 2002
Principal Systems Engineer
General Mills

Christian Edmiston
B.S., 1998 (double major with Econ.)
Senior Director, Sourcing and Risk Management
Land O'Lakes

Eric Fasnacht
B.S., 1989
Plant Manager
Archer Daniels Midland

Jane Newman-Ford
B.S., 1991
Associate Project Engineer
Burns & McDonnell

W. Mark Saltzman
B.S., 1981
Goizueta Foundation Professor of Chemical and Biomedical Engineering, Yale University

Jack Starr
B.S., 1987
Director of Engineering R&D
Cargill

Jeff Underwood
B.S., 1994
Vice President, Enterprise Innovation
Kent Corporation

Meghan Watt
B.S., 2002
Responsible Care Leader
FilmTec Corporation

Derek Winkel
B.S., 1998; MBA, 2015
Executive Director, Manufacturing Operations
Renewable Energy Group

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A. Douglas and Helen F. Steffenson Memorial Endowed Scholarship
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Mark Schomers

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Noah Patchin
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Chemical Engineering Scholarship
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Dr. Thomas D. Wheelock Scholarship
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Micah Hollenbeck
Taylor Schlagel

Edward W. and Joyce C. Backhaus Scholarship in Chemical and Biological Engineering
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Ryan Shustrin
Kaleb Still
Emma Svoboda

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Liam Herbst

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Blake Eder
Mattea Miller
Josef Schmitz
Sophia Vaughan
Jacob Wenger

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Vander Linden Scholarship
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Divyesh Kumar
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Jaret Olderbak

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Narayan Acharya

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Chemical Engineering Graduate Fellowship
Randalynn Greene

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Dhananjay Dileep

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Peter J. Reilly Grad Scholarship
Gabriel Cutshaw

George W. Parrott Centennial Graduate Fellowship
Hyun Ju Lee

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Jeniffer Perea-Lopez

Frederick Martinson Chemical Engineering Scholarship Fund
Peter Meyer
Lilly Synan

Judson M. Harper Graduate Scholarship in Chemical and Biological Engineering
Prathamesh Prabhu

Sweeney Family Memorial Scholarship
Prathamesh Prabhu

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