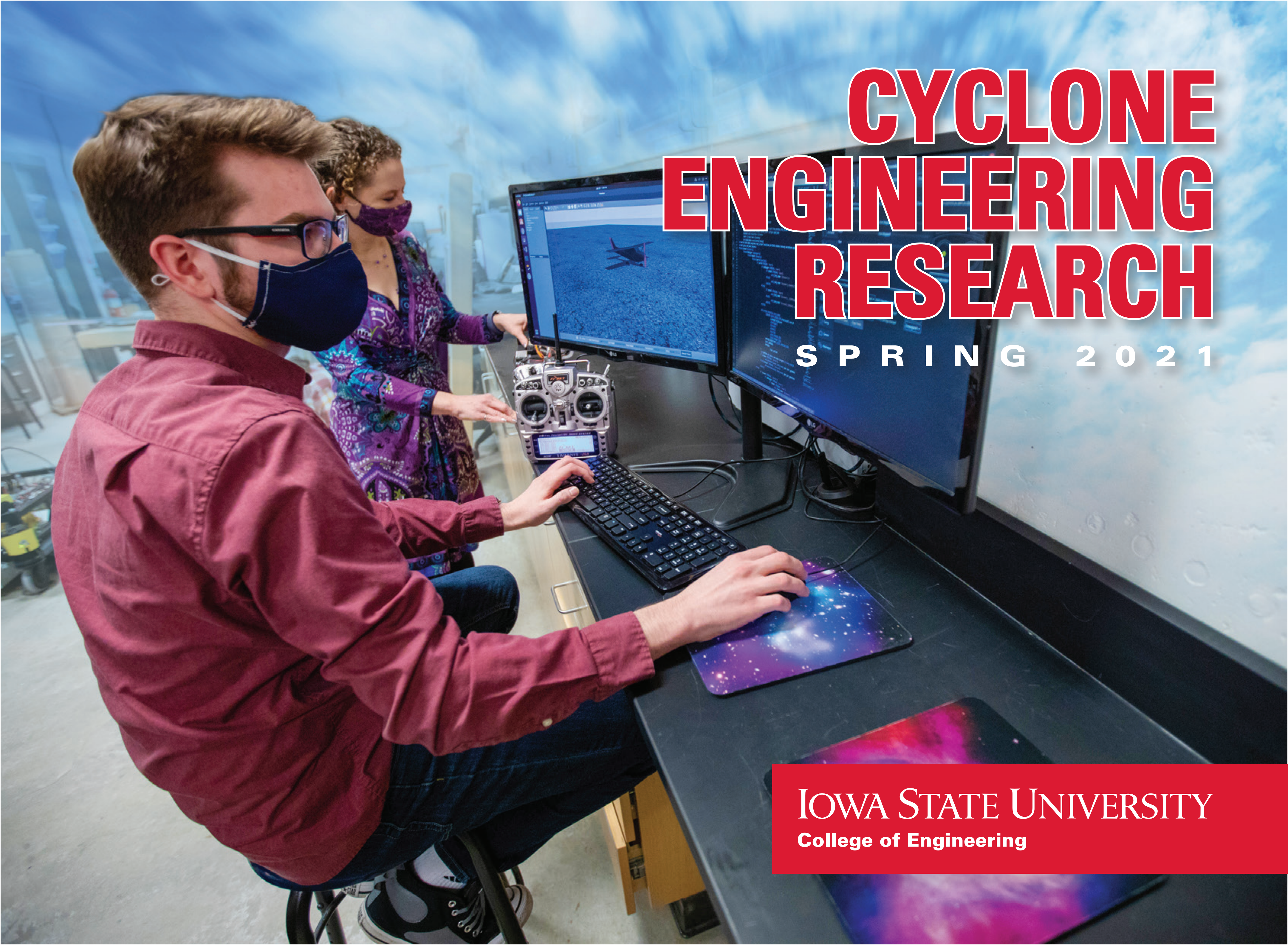

CYCLONE ENGINEERING RESEARCH

SPRING 2021

Iowa State University

College of Engineering

On the cover:

Kristin Y. Rozier, assistant professor of aerospace engineering, is mentoring **Colton Glick**, a junior in software engineering, in the new Boeing Undergraduate Research Fellowship. The program pairs undergraduate engineering students with Iowa State College of Engineering faculty and Boeing engineers to get hands-on research experience in aerospace engineering, cyber security, autonomous systems, machine learning and more.

Rozier and Glick are working on an open-source, 3D printed unmanned aerial system that will be an accessible option for research test flights.

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Chris Cornelius leads Department of Materials Science and Engineering

Chris Cornelius has joined Iowa State University as the Wilkinson Chair of the Department of Materials Science and Engineering.

"Chris is an accomplished scholar and administrator who brings a great breadth of experience to this position," said **W. Samuel Easterling**, James L. and Katherine S. Melsa Dean of Engineering. "His broad-based work in both higher education and industry are key attributes that will support the department and the college moving forward."

Prior to coming to Iowa State, Cornelius was a chemical engineering professor at the University of Nebraska-Lincoln (UNL) and diversity coordinator for the Mid-American Transportation Center at UNL. He also served as associate dean for research in the UNL College of Engineering.

Cornelius also has years of industry and professional experience, including engineering and technical positions at Sandia National Laboratories, 3M and Dow Chemical. He received master's and doctorate degrees in chemical engineering from Virginia Tech and a bachelor's degree from Montana State University.

Cornelius' research areas and interests include fundamental material interrelationships; transport of molecules, ions and electrons in complex structures and interfaces; electrospinning organic and inorganic materials; and material surface design.

"I am very fortunate to join an exceptional department with great people that will surround me, and I am equally excited about building a collaborative vision with them and contributing to the excellent reputation of the college," Cornelius said.

Nanostars guide the way to better disease treatment and diagnosis

Rizia Bardhan, associate professor of chemical and biological engineering and Iowa State University Nanovaccine Institute researcher, is making life-saving advances in disease diagnosis and treatment by integrating nanoparticles and Raman spectroscopy.

Predicting immunotherapy success

Immunotherapy is a groundbreaking new treatment for cancer and other immune system related diseases. But, right now only 20–25 percent of patients respond to immunotherapies – and there's no way to predict response or evaluate treatment effectiveness.

In a project supported by the National Institutes of Health, Bardhan uses an image-guided approach to solve this challenge by designing immunoactive gold nanostars. The gold nanostars will combine two medical imaging techniques, Positron Emission Tomography (PET) and Raman spectroscopy, which are widely used in guiding clinical therapies.

These nanostars will simultaneously detect both tumor cells expressing PD-L1 biomarker and also immune cytotoxic CD8 T cells directly in real time in vivo in animal models engrafted with breast cancer patient tumors.

"By tracking both cell types, our approach will help oncologists determine which patients are good candidates for immunotherapies and distinguish those who will not respond even before the start of treatment," said Bardhan.

Tailored colorectal cancer treatment

Leveraging the strengths of Raman spectroscopy as a cancer diagnostic, Bardhan leads a Department of Defense-funded project to predict how colorectal cancer patients will respond to molecular therapies.

***Rizia Bardhan**, associate professor of chemical and biological engineering*

Metastatic colorectal cancer is highly lethal with limited treatment options, so rapid, accurate diagnostic tools are key to getting patients the most effective treatment at the earliest time point possible.

But how to determine what is the best treatment for each patient? Bardhan's answer is using "organoids," 3D culture systems that closely mimic the human tumor microenvironment.

"Drug discovery studies often use the 'one mouse, one patient' paradigm, where each mouse is engrafted with an individual patient tumor. But that approach is too expensive, slow and low-throughput for effective, timely clinical decisions," said Bardhan.

Her team will instead derive more than 100 organoids from each patient tumor and treat them with a panel of drugs, some of which are both standards of care in colorectal cancer patients and others in clinical trials.

They will then perform high-throughput drug screening in these organoids with Raman spectroscopy and apply machine learning to distinguish patients that will respond to drugs. Their approach will both enable individualized treatment planning for patients and increase the efficiency of drug efficacy studies.

Bardhan is collaborating with **Jonathan Mochel**, associate professor of biomedical sciences at Iowa State's College of Veterinary Medicine; **Soumik Sarkar**, associate professor of mechanical engineering; and others.

Early, accurate, affordable preterm labor screening

Bardhan's expertise in Raman spectroscopy and nanoparticles extends far beyond cancer. She also leads a National Institutes of Health project to develop a cutting-edge new technology in her lab to detect biomarkers that lead to spontaneous preterm labor.

Preterm labor occurring before 37 weeks gestation results in more than 1 million childhood deaths globally, but current clinical methods to identify high risk of preterm labor have not been successful in reducing neonatal deaths. Bardhan's approach will address this ongoing global clinical challenge.

Bardhan's PRADA diagnostic platform – or portable reusable accurate diagnoses with nanostar antennas – consists of the same gold nanostars Bardhan's team uses in other research efforts, but they are now labeled with targeting agents, such as Raman molecules, to allow multiplexed detection of clinically relevant biomarkers with high sensitivity and specificity. PRADA is also reusable, allowing more than 15 uses of the same sensor chip, reducing the overall cost.

Bardhan has teamed up with obstetrics and gynecology experts to generate a unique "PRADA maternal risk score" by studying patient serum both at risk of preterm labor and those with normal pregnancy. PRADA can ultimately enable early, accurate and affordable bedside screening for pregnant patients, a significant advance compared to current clinical measures.

In one of her projects, Rizia Bardhan is using immunoactive nanostars combined with Raman spectroscopy and position emission tomography to predict patient response to immunotherapy.

Boeing Undergraduate Research

A new partnership with Boeing pairs undergraduate students with College of Engineering faculty and Boeing engineers to get hands-on research experience in cutting-edge projects in aerospace engineering, cyber security, autonomous systems, machine learning and more.

"The Boeing Undergraduate Research Fellowship has created opportunities for undergrads to learn research by doing, work on high-impact projects, and get familiar with the intellectual property considerations of industry-backed research," said **Arun Somani**, associate dean for research, Anson Marston Distinguished Professor in Engineering, and Philip and Virginia Sproul Professor in Electrical and Computer Engineering.

"What makes this program unique is that each undergrad researcher has two mentors. One is a Cyclone Engineering faculty member in whose lab the student works and gets experience. The second is a mentor from Boeing who advises on the project direction and the practicality of the project for actual industry use," said Somani. "Boeing Undergraduate Research Fellows also benefit from Innovate at Iowa State's programming on entrepreneurship, IP management and ethics. Fellows also may get opportunities for summer industry internships."

"Experiential learning and building relationships are essential to an engineer's development. This program is another great example where Iowa State students and Boeing engineers come together to jointly learn and research new technologies and approaches to some fascinating aerospace challenges," said **Ben Nimmergut** ('01 mechanical engineering), vice president of Boeing Commercial Airplanes Engineering Functions.

***Yoke Qi Ho** (left), a junior in chemical engineering and **Jun Cui** (right), associate professor of materials science and engineering*

Thirteen Boeing Undergraduate Research Fellowships are now underway during the program's inaugural year. Here are project descriptions and experiences of three of the research mentorships.

New materials for tunable noise cancellation

Yoke Qi Ho, a junior in chemical engineering, is working with **Jun Cui**, associate professor of materials science and engineering and scientist at the U.S. Department of Energy's Ames Laboratory, on new engine noise cancellation technology based on the special properties of shape memory alloys.

Right now, noise cancellation is designed for a fixed range of frequencies, but new innovations could tune noise dampening to varying noise frequencies in real time. Ho, under Cui's mentorship, is developing a shape memory mesh that's able to change its porosity according to the input electrical current, making its resistance to air flow tuned at aircraft takeoff, cruising and landing.

"This was my first time I've been involved in research and this project really helped me realize my passion for engineering," said Ho. "I've learned how to generate big new ideas to explore."

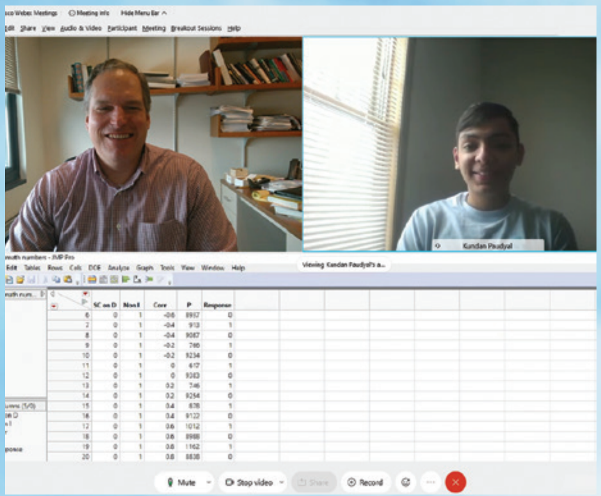
"The experiences I'm getting in the Boeing Undergraduate Research Fellowship took me beyond what's in a textbook and put me in the right place to learn from Iowa State faculty and Boeing engineers," said Ho.

Fellowship program takes flight

Integrating supply chain and product design

"The engineering problem I'm tackling is a supply chain challenge that many companies struggle with, so I know I'm getting research experience that I will use in my future career," said **Kundan Paudyal**, senior in industrial engineering. "Plus, I'm getting the perspective of Boeing mentors who are helping to guide my project and giving me a real-world look at how to be a successful industrial engineer in industry."

Paudyal is working with **Cameron MacKenzie**, assistant professor of industrial and manufacturing systems engineering, to design an engineering system that will streamline supply chain processes by integrating supply chain design into the product design phase. Research shows that supply chain costs are substantial – carrying up to 80 percent of a product's cost – so the benefits of integrating supply chain considerations into the product design process are significant.



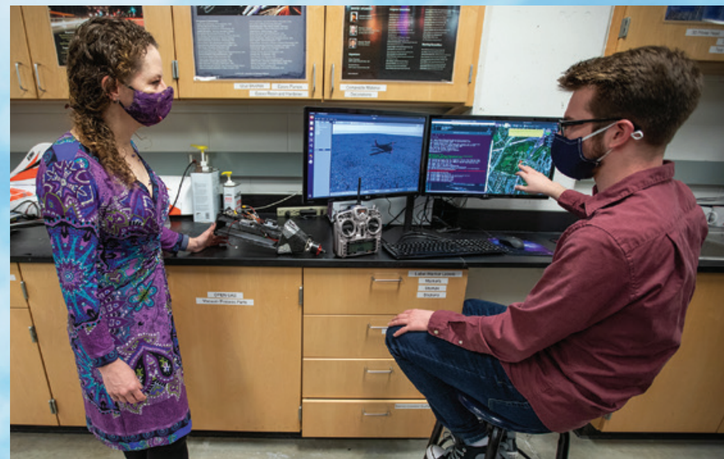
***Kundan Paudyal** (right), senior in industrial engineering and **Cameron MacKenzie** (left), assistant professor of industrial and manufacturing systems engineering*

"The Boeing Undergraduate Research Fellowship provides a unique research experience for undergraduates by supporting their research with an ISU engineering professor and connecting them to Boeing employees," said MacKenzie. "The Boeing Fellows learn how to participate in academic research and how to communicate research findings to companies."

Open-source unmanned aerial systems

Colton Glick, junior in software engineering, joined a 16-member undergraduate research team working on an open-source, 3D printed unmanned aerial system led by **Kristin Y. Rozier**, assistant professor of aerospace engineering. The goal is to create an accessible option for groups ranging from high schoolers to industrial researchers looking for an easily fixable platform to do research test flights.

"I am working on the electronics and software subteam and am assisting in the development of flight simulation, autonomous landing and obstacle avoidance for the UAS. We saw a lot of significant progress over the fall semester and completed two successful test flights," said Glick.



***Colton Glick** (right), junior in software engineering and **Kristin Y. Rozier** (left), assistant professor of aerospace engineering*

"Class projects aren't nearly as long-term or complex as Rozier's project, and I have learned so much through working with others on the team who are knowledgeable in many different areas. Having Boeing attached to my research gives it an extra sense of authenticity and importance," added Glick.

"I'm particularly grateful to Boeing for having the foresight to support undergraduate research," said Rozier. "It adds tremendously to the undergraduate learning experience and aids in decisions about whether to attend graduate school and for what degree."

Engineering sustainable, safe food

Growing new networks

A team led by **Hongwei Zhang**, professor of electrical and computer engineering, has developed CyNet, an open-source, wireless networking infrastructure to support data-driven research. CyNet takes on the challenge of quickly and reliably transmitting agricultural measurements from the crop field to plant scientists' computers – and serves as a prototype for bringing much-needed broadband to rural areas.

Connecting field to cloud

Iowa State predictive phenomic plant scientists gather detailed data from growing crop plants using cameras and other sensors. Before CyNet, a researcher would physically visit an Iowa State research farm to collect and transport data, a slow process with risks for data loss.

So, Zhang's team combined OpenAirInterface, an open-source software developed to promote new 5G-type cellular applications, with NI Universal Software Radio Peripheral, an inexpensive, flexible technology where functionality is determined by software rather than hardware.

Now cameras transmit photos of growing plants to a base station antenna tower on the farm – and, in real time, connect to Iowa State cloud computing systems.

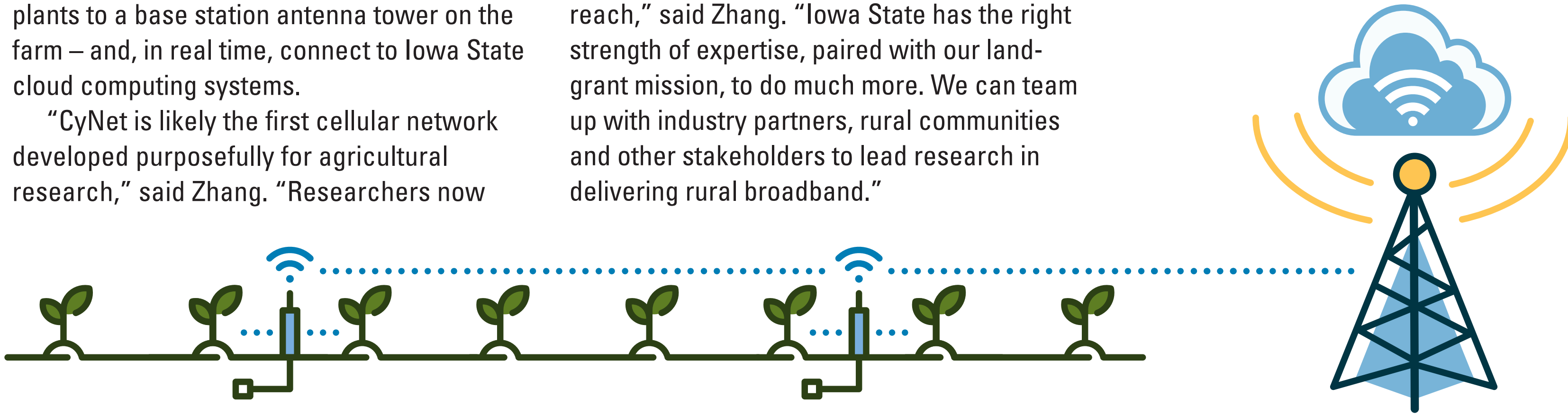
"CyNet is likely the first cellular network developed purposefully for agricultural research," said Zhang. "Researchers now reliably get the data they need for analysis in real time, without ever leaving their offices. We hope that speeding up the data transmission process will help speed advances in crop productivity."

Prototyping rural broadband

Beyond agricultural research, CyNet also has demonstrated applications in collecting sensor data needed for autonomous transportation research, but Zhang sees CyNet as an important first step in a much bigger mission: increasing access to rural broadband.

"With CyNet we've created a prototype of a new low-cost way to extend network reach," said Zhang. "Iowa State has the right strength of expertise, paired with our land-grant mission, to do much more. We can team up with industry partners, rural communities and other stakeholders to lead research in delivering rural broadband."

Co-principal investigators on the CyNet project include **Patrick Schnable**, Distinguished Professor of Agronomy and Iowa Corn Promotion Board Endowed Chair in Genetics; **Arun Somani**, associate dean for research, Anson Marston Distinguished Professor of Engineering and Philip and Virginia Sproul Professor in Electrical and Computer Engineering; **Ahmed Kamal**, professor of electrical and computer engineering; and **Anuj Sharma**, associate professor of civil, construction and environmental engineering, along with collaborators at Iowa State's Research and Demonstration Farms, Research Park and Institute for Transportation.



Sensors for food safety

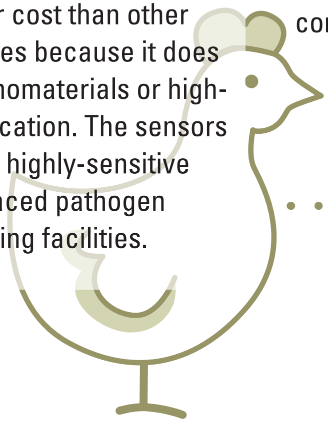
Food safety testing usually takes place in the lab by highly training technicians, but on-site, real-time, low-cost monitoring is our best tool to stop contaminated food from reaching consumers. **Carmen Gomes**, associate professor of mechanical engineering, is making key innovations in biosensor fabrication and system design to ensure food safety.

Quickly sensing salmonella

Gomes' team used laser induction to fabricate highly sensitive graphene-electrode immunosensors that electrochemically quantify salmonella pathogens in chicken.

"Making the sensor technology possible is graphene, a material that's a carbon honeycomb, only an atom thick and known for its strength, electrical conductivity, surface area and biocompatibility. Making graphene practical on a disposable food-safety sensor is low-cost laser induction that's a one-step direct-write fabrication process that uses a CO_2 laser to create electrodes for electrochemical sensors to detect foodborne pathogens," said Gomes.

The technique is lower cost than other graphene-based electrodes because it does not require expensive nanomaterials or high-temp, high-pressure fabrication. The sensors showed the kind of quick, highly-sensitive results needed for fast-paced pathogen detection in food processing facilities.

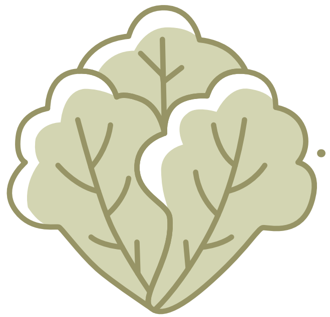


Keeping listeria out of lettuce

Gomes was the first to develop and demonstrate a platinum interdigitated microelectrode biosensor to detect contamination in hydroponic lettuce growing facilities.

"Hydroponic systems present a major challenge to controlling pathogens, like listeria, but we've shown we can do real time, on-site sensing to help prevent contaminated lettuce from reaching consumers," said Gomes.

The sensing system is incorporated into the growing system sediment traps, uses smartphones to read data, features sensors that can be reused several times – all while complying with all regulatory standards.

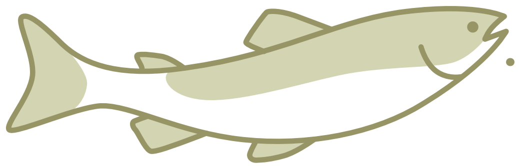


Flagging high histamine levels

Gomes, collaborating with colleague **Jonathan Claussen**, associate professor of mechanical engineering, used aerosol jet printing to create graphene electrochemical histamine sensors to detect levels most likely to trigger severe allergic reactions.

"This histamine sensor is not only for fish. Bacteria in food produce histamine. So, it can be a good indicator of the shelf life of food. The high-resolution electrodes produced by aerosol jet printing is necessary for electrochemical sensors to detect small molecules, such as histamine," Gomes said.

The technique developed by Gomes' team can also likely be used for a wider range of sensing challenges, from environmental toxins and nutrients in soil, to foodborne pathogens and health monitoring and diagnosis.



Virtual Reality, Real Cybersickness

Cybersickness. No, it's not being tired of the constant stream of new emails in your inbox. It's the physical illness some people feel in virtual reality environments.

Angelica Jasper, a Ph.D. student in Human Computer Interaction, is studying how to prevent VR users from experiencing nausea, disorientation, and oculomotor strain.

Motion sickness standing still

"We don't really know why cybersickness happens physiologically, but a lot of the symptoms are very similar to motion sickness," Jasper said. "And they show up in three major ways. You have nausea or symptoms related to nausea. You have what's called oculomotor strain, basically eye strain or issues with your eyes. And general disorientation.

"Cybersickness, compared to motion sickness, occurs with the absence of physical motion. An individual's eyes and brain are convinced the individual is moving due to what is perceived on the screen they're viewing, whereas, off screen, their body is at a standstill."

But even without knowing why cybersickness happens, the need to develop strategies for how to prevent it is growing, all thanks to technological VR advancements made in the education field and workplace – and increasing use of VR for gaming and entertainment.

Considering all angles

In an effort led by **Stephen Gilbert**, associate professor of industrial and manufacturing systems engineering, Jasper conducts both experimental and survey-based studies of cybersickness.

The team has run participants through a VR experience called The Corn Maze, which was designed to induce cybersickness, and examined individual differences in sickness severity and which mitigation techniques work best (taking the VR headset off was best but switching to a static VR image or doing hand-eye coordination tasks also offer relief).

Now, Jasper is collecting survey data asking participants about their interest in VR, access to head-mounted VR displays, past VR experiences and bouts with cybersickness. Her dissertation will focus on the efficacy of non-invasive cybersickness mitigation techniques, including blurring peripheral vision within VR environments.

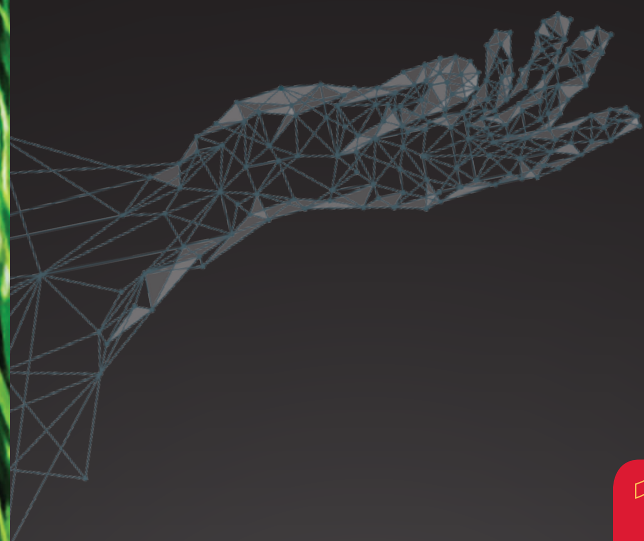
"We're going to be able to use both the survey and experimental research data to help us understand individual differences in cybersickness susceptibility, adaptivity and recovery. We'll be able to use this information to develop virtual environments that are more widely accessible and usable to people within a variety of settings, including entertainment, education, healthcare and more," said Jasper.

Human Computer Interaction graduate program

Iowa State University's multidisciplinary graduate program in Human Computer Interaction (HCI) is an established leader in the study of the human-technology interface.

The HCI program draws on the expertise of Iowa State faculty in engineering, psychology, communications, education and more – as well as researchers at Iowa State's Virtual Reality Applications Center.

HCI offers a graduate certificate, M.S., or Ph.D., including all-online certificate and master's degree options. Alumni have gone on to industry and academic positions in a variety of positions in user-centered design, such as usability engineering, product design, software engineering and web development.



Smorphacade

/smȯr fəˈsäd/ noun 1. A new design paradigm that integrates a smart morphing façade as a "live" structural system, resulting in lighter, less-expensive tall buildings with improved performance.

"The Smorphacade project is the first-of-its-kind collaboration between structural engineers, wind engineers and control engineers to turn a passive building façade into a live façade that protects the building against wind load and turbulence," said **Alice Alipour**, associate professor of civil, construction and environmental engineering.

Alipour leads a team that's combining a network of pressure, velocity and acceleration sensors strategically positioned on building surfaces. When excessive vibration-causing flow conditions are detected, the Smorphacade will change surface roughness or smoothness to mitigate inter-story building movements.

Parametric design tool

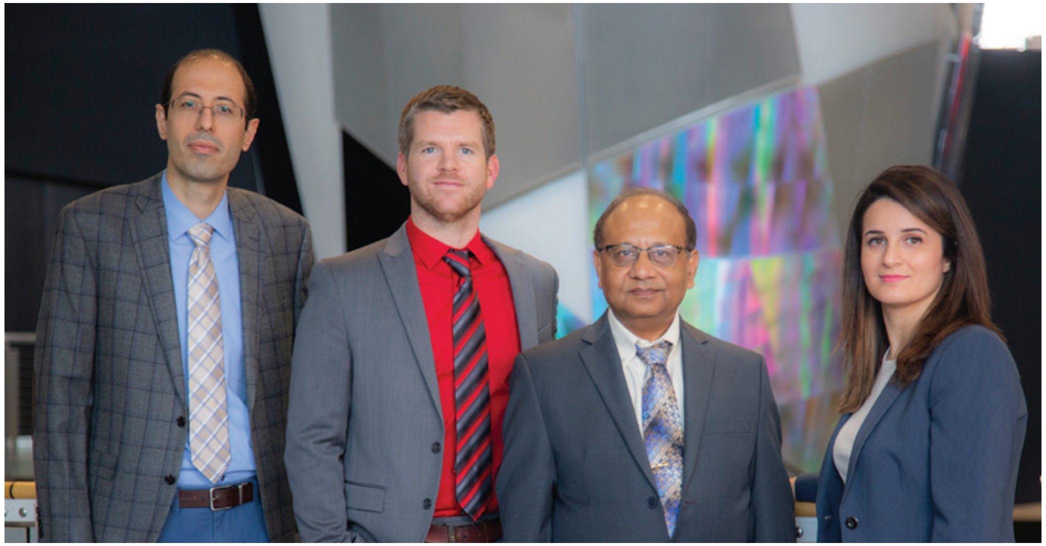
Alipour has paired extensive experimental tests in Iowa State's wind tunnel with computational fluid dynamics (CFD) simulations to produce the first design tool that accounts for nonlinear structural response to high winds.

"We have conducted a holistic set of complementary experimental tests and CFD simulations on hundreds of different shapes and orientations of building façades to create a large design space that will be used in conjunction with statistical learning methods to optimize the building envelope," said Alipour.

Real wind testing

Using data from their robust aerodynamic analysis and modeling, Alipour's team designed and created a Smorphacade and tested it in Iowa State's wind tunnel. The team has also successfully developed the control mechanism to morph the facades in real-time to allow for the development of the "alive façade" concept.

"We are very excited about the prospects of this project. Our computational models validated with extensive experimental tests have highlighted that the use of morphing envelopes to change the aerodynamics of the buildings provides a very effective way of reducing the wind-induced vibrations. Along



***Behrouz Shafei**, associate professor of civil, construction and environmental engineering; **Jared Hobeck**, assistant professor of mechanical engineering at Kansas State University; **Partha Sarkar**, professor of aerospace engineering, and **Alice Alipour**, associate professor of civil, construction and environmental engineering*

the way, we have made major contributions to state-of-the-art building design under wind events," said Alipour.

Tomorrow's multi-use façades

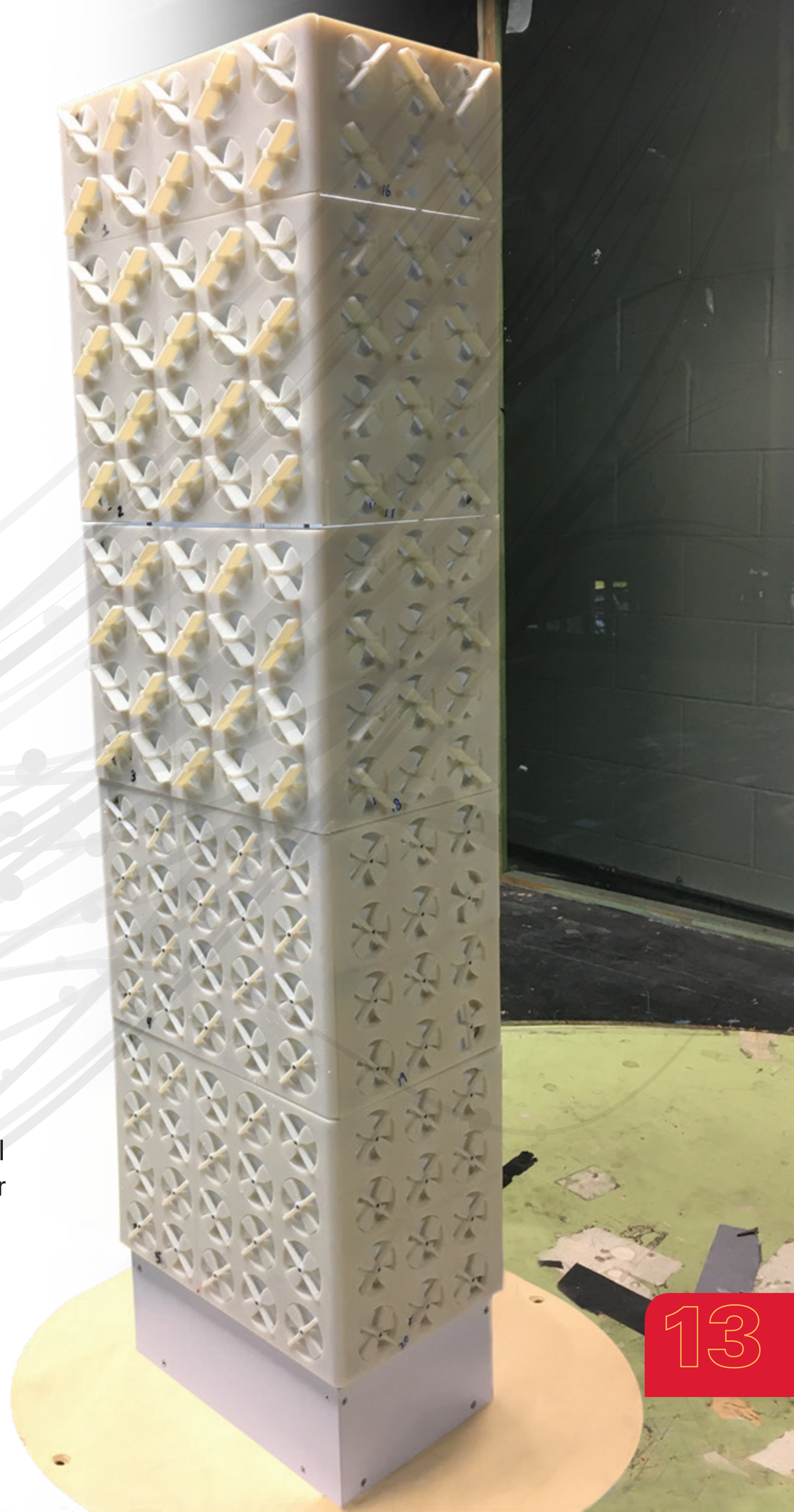
Current adaptive building façades respond to the external climate conditions to meet occupants' comfort needs and save energy. Alipour sees a beneficial partnership between energy-saving building façades and her team's Smorphacade.

"Using adaptive façades for multiple purposes is a win-win. Façades that are used for not only infrequent wind effects but also for year-round energy savings mean lighter and more economical building solutions," said Alipour.

Building strong collaboration

"We started from the established strength in structural and wind engineering here at Iowa State and from that base we built an interdisciplinary team of complementary expertise," said Alipour.

Cyclone Engineers **Partha Sarkar**, professor of aerospace engineering, lends extensive wind-testing expertise, and **Behrouz Shafei**, associate professor of civil, construction and environmental engineering, specializes in innovative structural systems with a potential for both sustainability and resilience. Additional collaborator, **Jared Hobeck**, assistant professor of mechanical engineering at Kansas State University, offers expertise in developing advanced control systems capable of active or passive vibration suppression.



NEWSBITES

Highest ASEE diversity recognition

Iowa State College of Engineering has received the highest honor from the American Society for Engineering Education Diversity Recognition Program, placing the college among the nation's leaders in inclusive excellence.

"This recognition highlights the array of student services we provide that focus on the academic, professional, social development and success of our students who hold a variety of unique identities," said **LeQuetia Ancar**, assistant director of engineering student services and director of multicultural student success. "The honor acknowledges that we have been and are continuing to work at meeting the holistic needs of our underrepresented students."

New instruments for new materials

Two Cyclone Engineers have received awards from the Department of Defense under the Defense University Research Instrumentation Program.

Valery Levitas, Anson Marston Distinguished Professor of Engineering, Vance Coffman Faculty Chair Professor in aerospace engineering, and scientist at the U.S. Department of Energy's Ames Laboratory, is designing and constructing a new type of dynamic panoramic diamond anvil cell (DAC) and dynamic rotational diamond anvil cell (RDAC) to examine materials at high-strain rates under high pressure and large deformations.

Sid Pathak, assistant professor of materials science and engineering, will expand the capabilities of the Alemnis in-situ micro-mechanical system to measure mechanical properties under extreme temperatures and high strain rates.

Connecting manure management and antibiotic resistance

Adina Howe, assistant professor of agricultural and biosystems engineering, leads a team in a $1 million grant from the U.S. Department of Agriculture's National Institute of Food and Agriculture to study how manure management systems in livestock production affect the development of bacteria capable of resisting antibiotics.

Howe, along with **Michelle Soupir**, professor of agricultural and biosystems engineering, **Daniel Andersen**, associate professor of agricultural and biosystems engineering, and others, will identify specific antibiotics and bacterial strains in pig manure samples as well as the specific genes that confer resistance. They'll also examine methods to stop the spread of resistant bacteria, including decomposition with composting and anaerobic digestion.

Read the latest on Cyclone Engineers' groundbreaking research in advanced materials and manufacturing, engineered medicine, engineering education, energy systems, resilient infrastructures, secure cybersecurity and autonomy, and more at **news.engineering.iastate.edu**

Restoring wind-dominant power grids after blackouts

In Iowa more than 40 percent of electricity is generated from wind, but what happens when a storm blows through or another disaster takes down transmission towers? Bringing wind power back isn't a typical step-by-step blackout recovery.

Hugo Villegas Pico, assistant professor of electrical and computer engineering, is leading research on how to orchestrate the restoration of wind-dominant grids. Working with **Bill Gallus**, an Iowa State professor of geological and atmospheric sciences and a storm researcher; MidAmerican Energy Co.; and the National Renewable Energy Laboratory's National Wind Technology Center, Villegas Pico plans to explore a variety of innovation solutions including creating novel automatic synchronization methods, combining artificial intelligence tools with new forecasting tools for dynamic restoration plans, and using batteries to help restart wind energy systems.

Shaping next generation science policy

Emily Rinko, a Ph.D. student in materials science and engineering, co-chairs the Students, Post-Doctoral and Early Career Subcommittee (SPEC) a new subcommittee of the President's Council of Advisors on Science and Technology (PCAST).

"I want to help create a positive and supportive environment for future scientists," said Rinko, noting that her subcommittee's feedback on PCAST reports and policy will help make science feel more accessible to students like herself.

Rinko studies powder-based aluminum-nickel-cobalt magnets in the research group of **Iver Anderson**, adjunct professor of materials science and engineering and scientist at the U.S. Department of Energy's Ames Laboratory.

Two new CAREER awards

Nigel Reuel, assistant professor of chemical and biological engineering, will develop novel, real-time sensors and reinforcement learned, dynamic control policies to improve reproducibility in large-scale manufacturing of differentiated, cell therapies. Reuel will benchmark the new control approach against static differentiation recipes using a range of model cells and will broaden impact with an interactive art exhibit, new course modules and a tool development workshop.

Zhaoyu Wang, assistant professor of electrical and computer engineering, is developing new optimization and probabilistic graph learning methods to make possible data-driven, real-time electric power network modeling, rapid detection of outages, and robust distribution system state estimation. He'll also make available open-source data sets, create training for energy professionals and develop interactive smart grid educational activities for high schoolers.

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Secrets for desalination success

Baskar Ganapathysubramanian, the Joseph C. and Elizabeth A. Anderlik Professor in Engineering from the mechanical engineering department, along with **Biswajit Khara**, doctoral student in mechanical engineering, contributed their high-performance computing, 3D modeling and applied mathematics expertise to examine why some desalination membranes are more efficient than others.

Ganapathysubramanian and Khara were members of a research team that found that uniformity in membrane density down to the nanoscale is crucial for maximizing the performance of reverse-osmosis, water-filtration membranes. Their work was featured on the cover of Science.