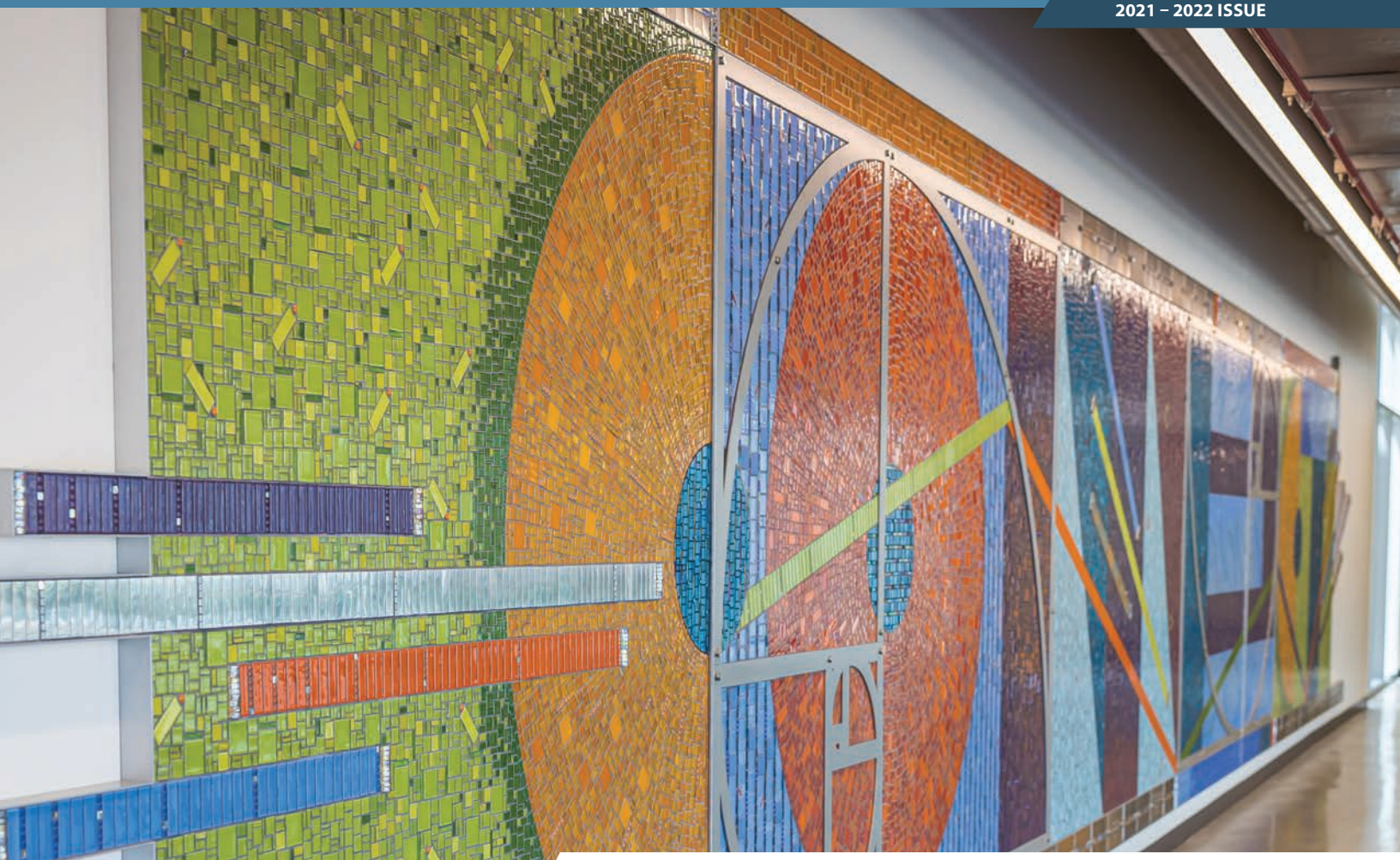
CLEVELAND STATE UNIVERSITY

WASHKEWICZ

COLLEGE OF ENGINEERING

2021 – 2022 ISSUE



A DYNAMIC CONNECTION BETWEEN ENGINEERING + ART

INSIDE: ROCKWELL CONNECTED ENTERPRISE LAB GRAND OPENING

Message FROM the DEAN

GREETINGS!

Many exciting events and changes have taken place in the Washkewicz College of Engineering in 2021. Here are just a few highlights.

The Rockwell Connected Enterprise Lab was formally dedicated in September 2021. Our students now have access to state-of-the-art industrial control equipment, which will be used in numerous courses across our engineering disciplines. With this generous gift, Rockwell Automation continues its commitment to the college to enrich our curriculum and to help us prepare the next generation of engineers and computer scientists.

The college welcomed seven new faculty this year with expertise in renewable energy, biosensors, biomaterials, separation technologies, artificial intelligence, manufacturing systems and engineering design. Multidisciplinary research and education are flourishing with numerous collaborations across the colleges. We are working with Law, Education, Health Sciences, Mathematics, Urban Affairs and even our Office of Facilities Management, to create a true interdisciplinary experience for our future engineers. External grant support to the college has more than doubled in the past year.

The College of Engineering plays a major role in the synergistic enterprise of the newly-established Cleveland Innovation District funded by JobsOhio. Cleveland State University is excited to be a strong collaborative member of this five-institution district. The university's role is to help fuel the economic growth of Ohio by increasing the number of highly-skilled graduates in the life science and technology fields. Our college's degree programs in computer, software, chemical and biomedical engineering and computer science will ensure that CSU continues to play a leadership role in the region.

The co-op program is an essential part of experiential learning and the classroom-to-workplace transition. This fall, more than 500 students participated in the Engineering and Computer Science Connections Fair, which was conducted both in-person, and two weeks later, virtually. Employers responded enthusiastically to the options, with a 30% increase in the number of companies participating compared to pre-pandemic levels.

And for the third year in a row, one of our student teams earned the 1st place award in the national competition of the National Fluid Power Vehicle Challenge!

Finally, our magazine cover features the CONNECT mosaic, which was installed on the first floor of Washkewicz Hall in 2020. This beautiful artwork truly elevates the space in which we teach, conduct research and engage with our community. I invite you to visit our college to view this breathtaking and inspiring work of art for yourself!

Sincerely,

Joanne

JOANNE M. BELOVICH, PH.D.
Professor and Interim Dean

WASHKEWICZ
2021–2022 ISSUE

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A Dynamic CONNECTION BETWEEN ENGINEERING + ART

An 800-year-old mathematical formula and the belief that engineers improve lives underpin the mosaic splashed across the first-floor hallway wall of Washkewicz Hall.

Brushed silver steel binds a multitude of tiles that glisten in the reflected light of the airy entryway. A range of deep, rich colors – from sky blue and leaf green to dazzling orange and mustard yellow – surge across the space, catching the eye when seen from the street, and inviting a closer look.

Titled "CONNECT," the 55-foot long, 8-foot-high mosaic is the work of Bonnie Cohen, an internationally recognized artist who lives and works in Akron, Ohio. Cohen responded to a national call for entries from the Ohio Percent for Art Program of the Ohio Arts Council, which provides funds for commissioning art for new or renovated public buildings. Cleveland State University and the Washkewicz College of Engineering contributed funds and reviewed competitive entries from a variety of national artists.

Cohen based her vision for the space on conversations with Washkewicz students and faculty. "As I asked students and staff what kinds of images would represent engineering, each had different ideas based on their own engineering field. A computer engineering student said zeros and ones. An environmental engineering student wanted to see sustainable materials used. Members of the faculty committee mentioned a wheel or timeline."

But they all had one thing in common. All agreed that engineers make people's lives better, no matter what the specialty. Cohen wanted her design to encompass every aspect of the engineering profession now and years into the future. She realized that the finished art must be on a grand scale and have a sense of place, purpose and timelessness.

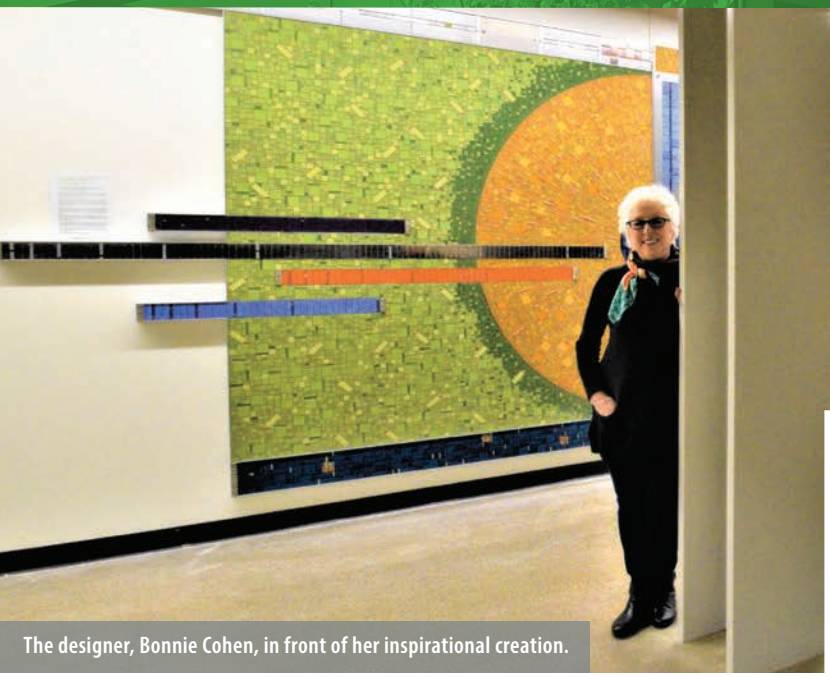
Cohen's research led her to the Fibonacci sequence, the mathematical formula introduced to Western mathematics in 1202 and still used today by engineers, architects and artists. The Fibonacci sequence and the Golden Rectangle, another ancient measurement that defines the "most pleasing" ratio of a rectangle's length to width, gave Cohen the structure; the partnerships between Washkewicz and local industries and hospitals offered her the theme of connection.

"Connection is what engineers do," says Cohen. "They connect people, places, energy, formulas, material, patterns and systems to make people's lives better."

CONNECT began with hundreds of sketches of the word "connect" and working with the Fibonacci sequence and the formula for the Golden Rectangle to draw the letters. "It was amazing to follow the mathematical formula to lay out the letters in a way that achieves balance and beauty," notes Cohen.

By looking closely at the different patterns used for each letter, the viewer can see how the Fibonacci numbers dictate the design, combining groups of tiles and linear design elements using 1, 3, 5, 8, 13 (and so on) tiles for each element.

The design also conveys a strong sense of place. According to Cohen, the letter "E" represents Lake Erie. The pattern changes in those panels, with the water-colored luminous tiles set in a flowing pattern called *andamento*, which is the Italian word for flow.



The designer, Bonnie Cohen, in front of her inspirational creation.

Cohen also wanted to recognize Cleveland's steelmaking history, and called local steel companies—who are used to selling millions of tons for ships' hulls and skyscraper girders—to see if she could "buy about 100 square feet of steel."

Olympic Steel, a Cleveland steel mill founded in 1954, generously opened their factory for Cohen to tour and donated over 41,000 pounds of steel used in the mosaic's framework. The only type of steel now made in Cleveland is carbon steel, which begins to rust the moment air hits it. Olympic Steel's technical expertise helped Cohen overcome these hurdles.

CONNECT's size and materials presented process hurdles, too. Because of its finished size, Cohen divided the piece into 32 panels to be able to work on and move it around her studio, as well as to transport and install the piece more easily when completed. Cohen put together a bold color palette inspired by the bright colored accents found in other spaces of the building, and one which would also be visible from the street.

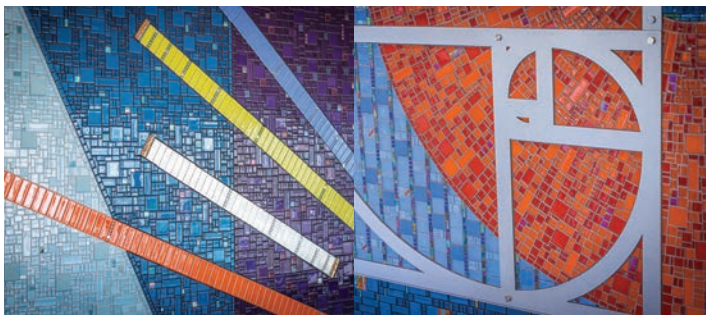
The mural also features 14 inspirational quotes about connection from scientists and artists, engraved in steel tiles framing the piece.

While she usually works with dimensional, handmade tiles, this project's high-traffic location called for different materials. The tiles in CONNECT are predominantly glass, with stainless steel accents, and range in sizes from 6 by 12 inches to one-quarter inch square. Cohen sourced materials from American companies whenever available and used as many recycled tiles as possible; some are made from car windshields. The design also includes pieces of marble and mirror for textural interest.

Cohen and two assistants worked daily to cut, grind, glue and grout the piece, working on one panel at a time; each panel took several weeks or longer to complete. Since her studio did not have 55 lineal feet in which to lay out the entire piece at one time, the team often moved panels around the studio to check patterns and color fit. Another team member handled all budget, purchasing, carbon steel handling and final installation coordination.

CONNECT took 18 months to produce, from commission to installation in January 2020. While the pandemic shut down plans for an opening event, CONNECT has reached beyond Washkewicz's walls. It was awarded the Best Architectural Mosaic of 2021 from the Society of American Mosaic Artists, an annual competitive exhibition of innovative design and techniques with entries from some of the best international mosaic artists.

"I think mosaic art is a metaphor for life. Every single piece is an important part of the picture and no piece can stand alone… they are all connected!," Cohen pointed out. Just as it happens in engineering.



ROCKWELL AUTOMATION DONATES NEW LAB

IMAGINE YOUR DAILY MORNING ROUTINE. You wake up, eat a bowl of oatmeal, brush your teeth, get in your car and drive to work. In that brief time, you've experienced multiple products made in part by Rockwell Automation. Rockwell helps put the bristles on your toothbrush, packages your food, makes your car, and then helps to power it. You won't find their name on the products, but they're behind the scenes making it happen.

Rockwell is a global leader in industrial automation and digital transformation, connecting the imaginations of people with the potential of technology to expand what is humanly possible. With customers in more than 100 countries, Rockwell serves all major manufacturing and process industries including energy, raw materials production, pharmaceutical, automotive including electrical vehicles, water/wastewater treatment, semiconductor, transportation, food and beverage and more.

Headquartered in Milwaukee, Wisconsin, Rockwell has three facilities in Northeast Ohio (Twinsburg, Mayfield Village and Mayfield Heights) that employ a diverse range of talent including engineers, software developers, manufacturing associates and marketing support professionals.

The ribbon cutting of the new laboratory on September 28, 2021. From left to right: Michael Cook, Director of Global Academic Partnerships, Rockwell Automation; Jeff Petro, Senior Manager of Business Operations, Software & Control, Rockwell Automation; Marzell Brown, IoT, Engineering, and Academic Enablement Manager, Rockwell Automation; Harlan Sands, President of Cleveland State University, Dr. Joanne Belovich, Interim Dean of the Washkewicz College of Engineering, and Dr. Michael Adams, Chair of the Department of Engineering Technology.

For over 30 years, Cleveland State University has enjoyed a close relationship with Rockwell Automation. Rockwell has donated significant investments in time, talent and resources to help prepare CSU graduates for high-tech engineering careers. The company recently established the new Rockwell Automation Connected Enterprise Laboratory in Washkewicz Hall. Advances in automation, controls, and robotics have driven demand for new types of technological and solution-based skillsets. Rockwell designed this state-of-the-art lab to teach students how to use the same equipment found in today's advanced manufacturing facilities.

The lab is a high-tech, hands-on, and ultra-modern learning environment, very different from a traditional classroom. It includes a lecture space with the very best electronic teaching tools. After lecture, students can immediately engage with programmable logic controllers (PLCs), human-machine interfaces (HMI touchscreens), cloud technologies, and beyond. The lab has 14 workstations in all, capable of accommodating up to total 28 students. The workstations represent the automation equipment and programming environment that students will see in modern industry.

"PLCs are everywhere," said Mike Adams, Ph.D., lab supervisor and chair of the Department of Engineering Technology. "Possibly the most common controller in modern industry."

Students can write code on the workstation, upload it to the controller, then wire the inputs and outputs, allowing the system to control and automate a wide range of applications. The controllers can also talk to each other and other labs at the university and beyond via the cloud.

Rockwell selected CSU as the beneficiary of this prestigious donation based on their relationship history, inclusive and diverse culture, academic synergies and prominent position in serving regional industry. The growth of this partnership in this regard will provide many students with career opportunities at Rockwell as well as in Rockwell's extensive network of supported industries.

"Rockwell and Cleveland State University have a long-standing partnership, spanning sponsored events, seminars, recruitment activities, senior design, industrial advisory volunteers, part-time teaching and scholarly work," Dr. Adams said

Engineering students have already started using the laboratory for their PLC courses.

"The relationship with Rockwell goes beyond just getting a lab sponsored. The whole thrust is engagement with the community and uplifting the region, and the lab serves as that connection point. This hands-on facility is the newest component to fulfill our mission to produce 'ready-to-go engineers.'"

The lab is fully "Industry 4.0," connecting manufacturing with automation and the industrial Internet of Things (IoT). It is flexible and configurable, capable of engaging a wide range of participants, including high school STEM challenges, freshman-through-senior design projects, graduate research, faculty development, and industrial training and certification.

Students from all five departments within the Washkewicz College of Engineering will have access to the lab, and new curricula are being actively developed to leverage the facility into a cornerstone of the engineering student experience.

Michael Cook (left) of Rockwell Automation shows one of the equipment of the lab to CSU President Sands

"THE RELATIONSHIP WITH ROCKWELL GOES BEYOND JUST GETTING A LAB SPONSORED. THE WHOLE THRUST IS ENGAGEMENT WITH THE COMMUNITY AND UPLIFTING THE REGION, AND THE LAB SERVES AS THAT CONNECTION POINT. THIS HANDS-ON FACILITY IS THE NEWEST COMPONENT TO FULFILL OUR MISSION TO PRODUCE 'READY-TO-GO ENGINEERS.'"

DR. ADAMS

"The opportunities presented here, for multiple constituencies of Northeast Ohio, will help to raise the skill level of the region and positively contribute to the Ohio economy," said Joanne Belovich, Ph.D., interim dean of the Washkewicz College of Engineering.

CSU alumnus Jeff Petro (MBA, '97), Rockwell's senior manager of business operations, software & control, has been working as the company's CSU sponsor since 2014 and helped facilitate the donation. Marzell Brown is a member of Rockwell's Global Academic Organization (GAO) which promotes academic partnerships, fosters engagement, supports campus sponsors, and drives educational outcomes.

As GAO's IoT engineering and academic enablement manager, Brown coordinated the lab's development and implementation as well as led training sessions for CSU staff on how to use equipment.

"We collaborated with our sales team on what industry is looking for, what customers are using, and what that would look like in an educational setting on a campus," said Brown.

Dr. Laura Bloomberg, Provost of Cleveland State University, checks one of the equipment of the laboratory.

Dr. Joanne Belovich, Professor and Interim Dean of the Washkewicz College of Engineering speaks at the grand opening ceremony of the new laboratory

> "THIS FACILITY WILL HELP PREPARE CSU STUDENTS FOR TECHNICAL LEADERSHIP ROLES IN SMART, CONNECTED MANUFACTURING."

"We view Cleveland State as a key school, a key partner," Petro added. "We have a good partnership with Cleveland State and want it to continue. Having our name on the lab is really important to get our brand out to students and let them know we are a company where they can have a great career."

"Right now, there are thousands of advanced manufacturing employment opportunities in Ohio," Brown said. "Getting CSU students trained and ready to go is important — exposing them to next-generation technology, and continuing to evolve our relationship with Cleveland State is important."

"This facility will help prepare CSU students for technical leadership roles in smart, connected manufacturing", said Dr. Belovich. Both CSU and Rockwell plan to keep this new lab up to date, but Brown said the lab's current technology will be "good for a long time."

CSU President Harlan Sands with Marzell Brown, IoT, Engineering, and Academic Enablement Manager, Rockwell Automation, Dr. Michael Adams, Chair of the Department of Engineering Technology, and Dr. Laura Bloomberg, CSU Provost.

WHAT'S NEW IN THE COMPUTER SCIENCE DIVISION

The faculty of the Computer Science division of the Washkewicz College of Engineering (pictured in rows starting from the top, left to right): Zicheng Chi, Ph.D., Assistant Professor; Sunnie Chung, Ph.D., Associate College Lecturer; Almabrok Essa, Ph.D., Assistant College Lecturer; Robert Fiske, Visiting College Lecturer; Sathish Kumar, Ph.D., Associate Professor; Sanchita Mal-Sarkar, Ph.D., Associate College Lecturer; Janche Sang, Ph.D., Professor; Nigamanth Sridhar, Ph.D., Professor; Haodong Wang, Ph.D., Associate Professor; Jackie Woldering, Ph.D., Visiting College Lecturer; Weidong Xiong, Ph.D., Visiting College Lecturer; Hongkai Yu, Ph.D., Assistant Professor; Jingru Zhang, Ph.D., Assistant Professor; and Tianyun Zhang, Ph.D., Assistant Professor (not shown: Yongjian Fu, Ph.D., Associate Professor and Associate Chair for Computer Science)

Cleveland State University's Computer Science (CS) division prepares graduates with theoretical and practical knowledge and problem-solving skills for system development and technical communications.

Established as a division of the Department of Computer and Information Science in the College of Business, it began awarding bachelor's degrees in 1978 and master's degrees in 1981. In 2015, CS moved to the Washkewicz College of Engineering and merged with what was then known as the Department of Electrical and Computer Engineering, ultimately forming the new Department of Electrical Engineering and Computer Science.

CS faculty are actively engaged in a variety of externally funded research areas, including data science, cybersecurity and Internet of Things (IoT).

Data Science

"TODAY, EVERYWHERE YOU GO, they collect your data," said Yongjian Fu, Ph.D., associate professor at CSU and associate department chair for the CS division. According to statista.com, the total amount of data created, captured, copied, and consumed globally is forecasted to increase rapidly, from today's 60 zettabytes to 180 zettabytes in five years. One zettabyte is equal to a trillion gigabytes. Some data experts estimate that 90 percent of the data that exists in the world today was created in the last two years, mainly from smart devices and sensors. Our Society increasingly relies on data to inform our world and aid in decision-making.

With so much data available, novel solutions are required to handle it appropriately. This is where the interdisciplinary field of data science enters the game. It is also sometimes referred to as "data analytics," "data mining," "data processing," and "datalogy." There is a shortage of data science professionals nationally as well as in Northeast Ohio. The demand for data scientists is expected to increase by 28 percent through 2026 according to the U.S. Bureau of Labor Statistics. In Northeast Ohio, industry and government leaders have identified three industries as economic drivers: smart manufacturing, health innovation and water technologies. Data scientists/ analysts will continue to be highly sought after in these three strategic areas.

The CS division of CSU has several faculty members actively engaged in data science, including Sunnie Chung, Ph.D., Jingru Zhang, Ph.D. and Hongkai Yu, Ph.D.

> "BIG DATA PROCESSING TECHNOLOGIES AND KNOWLEDGE DISCOVERY METHODS FOR AI HAVE BECOME IMPORTANT RESEARCH SUBJECTS IN COMPUTER SCIENCE."
>
> DR. SUNNIE CHUNG

Dr. Chung has been conducting research in *big data analytics* impacting IoT, health sciences and social media. One of her research activities is in computational topic modeling for knowledge discovery using deep learning and natural language processing to discover hidden semantic meanings in large collections of unstructured text bodies. These algorithms are used in artificial intelligence (AI) for virtual assistant technologies, such as Amazon's Alexa, Apple's Siri or Google Home.

"The quest for knowledge used to begin with grand theories," said Dr. Chung. "Now, it begins with massive amounts of data. Big data processing technologies and knowledge discovery methods for AI have become important research subjects in computer science."

Topic models are also frequently used to build decision support systems for business intelligence, such as a user product-review analysis system or a recommendation system. Dr. Chung has been studying real-time social media opinion analysis systems; her system was able to identify opinions hidden in 7 million Twitter texts to correctly predict the outcomes of both the 2016 and the 2020 U.S. presidential elections.

Dr. Chung also currently works with neurologists at University Hospitals and the Veterans Health Administration to identify a signature of metabolites in patients with brain injuries. These identified metabolites in tissues or biofluids help doctors understand mechanisms of progression of incurable brain disease such as Alzheimer's dementia (AD) and find better treatment options.

Alternately, Dr. Zhang's data science research includes algorithm and data structures, computational geometry and theoretic computer science. She designs algorithms to compute optimal solutions to problems and is currently working with students to design those that can find optimal locations for the facility construction of hospitals, fire stations and retail warehouses.

This research often provides insights on how computational methods can solve location challenges. Location theory has wide applications in both economics and conservation biology.

Not only is data growing in quantity, it is also growing in *diversity*. Visual data, including images and videos, are being generated daily as a result of the fast technology progress in cameras, smart phones and a multitude of other multimedia devices. Humans can benefit greatly with accurate, efficient extraction and understanding of the visual data.

Dr. Yu has developed several novel machine learning and deep learning-based methods for understanding large-scale visual data sets. For example, he created an algorithm for large-scale object detection and tracking in low-continuity image sequences, such as using cameras to detect and track multiple objects moving in different directions.

In a recent project funded by the Air Force Research Lab in Dayton, Ohio, Dr. Yu created algorithms to study fiber-reinforced composite (FRC) materials, which have strength and stiffness superior to that of more traditional materials. FRC materials are used in many applications, including airplanes, construction and manufacturing. Their microstructure of reinforced fibers provide superior structural properties and substantially speed up design and development of new composite materials.

In the past, material scientists needed several weeks to collect data for FRC material microstructure studies. "But after using the algorithms developed by us, they just need several days to collect the corresponding data. The efficiency is greatly improved," said Dr. Yu.

Cybersecurity

WITH THE GROWTH in the use of connected devices and the explosion of data, it is of little surprise that cybersecurity is now essential to business, government and many other organizational entities. *Forbes* reports that, by 2025, cybercrime is expected to cost $10.5 trillion per year globally. This is an area of great importance for the CS faculty, particularly Sathish Kumar, Ph.D. and Sunnie Chung, Ph.D., who teach relevant courses and conduct pertinent research.

Dr. Kumar has had extensive research experience in cybersecurity, machine learning and distributed systems. His work seeks to reduce the adverse impact of ransomware on society by studying and implementing appropriate methods, such as zero-knowledge proof algorithms.

"Cybersecurity has moved on from just being a technical issue to a complex interdisciplinary issue, and, hence, it is important to look at it from different perspectives such as law, social science, political science, business and data science," said Dr. Kumar.

"A zero-knowledge proof is a method by which a party 'A' can prove to another party 'B' that they know a value 'x', without conveying any information apart from the fact that they know the value 'x,'" he added.

Dr. Kumar is collaborating with both law and education faculty to develop a course where both CS and law students can collaborate and learn from one another by tackling cybersecurity issues.

Cybersecurity and privacy in cloud-based big data analytic systems and IoT applications have been of particular interest to Dr. Chung and her students. One of the research challenges in cloud-based applications is that it requires a zero-trust security model. "Zero-trust" means the cloud servers cannot be trusted to store and process a user's sensitive data (credit card transaction data, medical images/histories, personal biometrics or profile information). Her research solutions employ "very special encryption techniques called homomorphic encryptions and semantic preserving encryptions."

As Dr. Chung points out, these techniques "put the data in specially encrypted forms allowing the untrusted cloud servers to perform computations of deep learning while the data is still encrypted." The challenge is to make sure that such encryption is strong enough to protect sensitive data without being breakable by hackers, yet fast enough to complete the computations over the encrypted data. As expected, this area has been a focus of research in the major cloud computing industry, such as Google, Amazon, Microsoft and IBM.

Internet of Things

The term IoT has become widely used in the last few years. It is the "new frontier" for computing and networking. According to a report published by International Data Corporation (IDC) in July 2020, 75% of 56 billion connected devices worldwide will be IoT-enabled by 2025. Zicheng Chi, Ph.D. of the CS division, has been working on IoT for over 10 years.

"In this era of the *Internet of Everything*, electronic and mechatronic devices are heavily integrated into people's daily life, the industrial revolution and more fields," said Dr. Chi. "My current research is to help IoT devices to quickly integrate into our world."

IoT smart home applications can help make life easier, save energy and aid in healthy behaviors, including fitness tracking, environmental monitoring and patient behavior monitoring. In manufacturing, IoT can collect critical production data and improve efficiency.

"Wirelessly connected devices are widely deployed in environments ranging from the human body to the urban scale, and from an individual home to a factory," Dr. Chi said.

With the exponential increase in the use of these devices, Dr. Chi's research covers several crucial problems, such as: (a) how to seamlessly link the enormous number of devices that humans use; (b) how to make these devices self-sustainable and running for decades without the need to charge them or change the batteries; and (c) how to non-intrusively connect electronic and mechatronic devices with humans.

One technique, called parallel inclusive communication, allows devices that use different communication protocols (e.g., Wi-Fi and Bluetooth) to "speak" to each other. This would greatly improve network performance, preventing disconnection and promoting better wireless communication quality.

Another technique, called high-performance backscatter framework, allows for wireless communication in a passive way. In this method, signals from cell phones and Wi-Fi routers are reflected in the air, resulting in nearly zero use of energy by the device. This allows the battery in IoT devices to last for a very long time, even for decades.

"Achieving zero maintenance allows larger scale deployment of IoT devices," said Dr. Chi, adding that IoT devices can monitor locations underground, long-haul gas pipelines and other places where device maintenance is both time consuming and labor intensive.

Finally, the generic human sensing framework uses pervasive IoT devices and ambient signals to recognize human activity or gestures in a non-intrusive manner – all without devices attached to the body and without loss of privacy. For example, humans could turn on a light just by waving their hand, without the need to wear a device. Potential applications include smart health, smart home, virtual reality or augmented reality, fitness tracking, and senior or baby monitoring.

"As the IoT devices were invented to serve people, they need to sense and understand human behaviors," said Dr. Chi.

What the Computer Science Division Offers Students

Since the Computer Science division moved to the Washkewicz College of Engineering, it has grown significantly in faculty, students and academic programs. Current offerings include a Bachelor of Science in Computer Science degree; a Master of Computer Science degree; a Master of Science in Software Engineering degree, and a specialization within the engineering Ph.D. degree.

In 2018, the Bachelor of Science in Computer Science program was accredited by the Computing Accreditation Commission of ABET (abet.org). It is the only ABET-accredited computer science undergraduate program offered by a public university in the region. The Computer Science division has 15 full-time faculty members and about 900 students in all (about 250 undergraduates and 650 graduate students). It offers courses in AI, computer security, big data, IoT and connected devices, machine leaning, data mining and information security. Many students engage in research activities with division faculty.

FACULTY

YONG TAO

PLACES PEOPLE AT CENTER OF BUILDING DESIGN

WHEN WE THINK ABOUT SUSTAINABLE "GREEN" BUILDINGS, we think about energy-efficient components such as solar panels and LED lights. Yong X. Tao, Ph.D., the Betty L. Gordon endowed chair and distinguished professor, and Chair of the Department of Mechanical Engineering, has built three zero-energy buildings since 2005. His current research seeks to keep sustainable buildings energy-efficient, while making them more affordable and comfortable for those who live and work in them.

ZERO-ENERGY BUILDINGS

Dr. Tao's first building was the Solar Decathlon building at Florida International University in 2005. He led a student team which raised $1 million in cash and in-kinds to create this 800-square-foot, completely-mobile solar structure for a national competition in Washington, DC.

During the 2008 Olympic Games in Beijing, China, Dr. Tao served as project director of the Future House USA project – leading a consortium of academics, builders and industry sponsors to represent the United States in a multinational demonstration project of renewable energy and environmentally friendly construction. This resulted in the 3200-square-foot, zero-energy American House in Beijing. He raised $4 million to design and build it in the United States, then shipped it to China for assembly.

Dr. Tao's third zero-energy building was the Zero Energy (ZØE) Research Laboratory, a high-end research lab at the University of North Texas. The lab was designed to test and demonstrate various alternative energy-generation technologies (i.e., solar, geothermal, wind) in order to achieve a net-zero energy consumption.

SHBE NETWORK

"Those three buildings formed a foundation for my current Research Coordination Network project," said Dr. Tao. This project has two components. The first part is a predictive modeling network for the Sustainable Human Building Ecosystems (SHBE) Network, which has more than 250 multidisciplinary participants from 20 U.S. and international institutions.

"We call them zero-energy buildings; but once you put a human in there, it may no longer be zero-energy," said Dr. Tao. "How humans live in the building dictates how it uses energy."

Because humans use energy to live, work and function – utilizing water and electricity, cooking and keeping a climate-controlled environment with heating and cooling systems – engineers want buildings to be both green and sustainable. At the same time, humans want to be comfortable, with "comfort" meaning very different things to different people.

Dr. Tao's research focuses on how to create sustainable buildings that meet human needs in smart, economical ways. That's why the SHBE Network research places humans and human requirements at the center of building design. "In order to understand how human factors are part of this, we need to study human behavior more," Dr. Tao said.

To do this, he's collaborating with social scientists to see how they can model human behavior and allow technology to respond to human needs while saving energy. Many factors are considered, including the region's climate, as well as its social and community activities. Variables about buildings tenants, such as age, education, and income are also accounted for, helping Dr. Tao and his team determine how to design. Decisions on open concept layouts, room dividers, insulation, smart technology and more are based on this fact-finding, allowing researchers to improve on traditional building-design methods. "I am inspired by students," he said. "They want to change the world."

While green buildings often come with a high price tag, Dr. Tao is committed to seeking ways to make sustainable buildings affordable while effectively serving the people who inhabit them. This includes apartment renters and low-income populations.

"The renters probably want to save energy, but they don't have any control about what kind of buildings they want," Dr. Tao said. "The builders don't have any incentive to make the building efficient, because they don't get the benefit. That's what we call split incentive. Wouldn't it be great if renters could go into a LEED-certified building and pay less for it?

"In here is the question, 'How do you predict the future?' That's where the modeling and simulation come in and where we are trying to contribute," he added.

The elements of the Sustainable Human-Building Ecosystem

"IN THE FUTURE, BUILDINGS WILL NOT BE DESIGNED JUST BY ARCHITECTS. THEY WILL BE TEAM-DESIGNED BY ENGINEERS, ARCHITECTS, THE CONSTRUCTION COMPANY, EVEN BY OCCUPANTS."

VIFI

The second component of Dr. Tao's research is data sharing software called Virtual Information-Fabric Infrastructure, or VIFI as it is often referred to. VIFI allows researchers to search, access, manipulate and evaluate fragmented, distributed data without having to transfer or download massive amounts of raw data. Participating in a $4 million grant from the National Science Foundation, Dr. Tao has collaborated with computer science professionals in cybersecurity and data science to develop the software.

THE FUTURE OF BUILDING DESIGN

Dr. Tao believes the SHBE method is the future of building design. "It's a collaboration, really," he said. "In the future, buildings will not be designed just by architects. They will be team-designed by engineers, architects, the construction company, even by occupants." He hopes his research will aid 3D and virtual reality design. "In the future, there's no blueprint, no drawings. What you see is what you're going to build."

WHAT'S NEXT

Dr. Tao hopes to add solar panels to CSU's recently constructed Washkewicz Hall in the future. As the home of the Washkewicz College of Engineering, he believes the building is a good candidate since it is LEED Gold-certified. He worked with the CSU Sustainability Office to submit a feasibility report and believes they can be "easily installed and will save energy."

He's also interested in facilitating a Solar Decathlon Design Challenge at CSU. He'd like to form a team of students and faculty to help build a house completely powered by solar energy and encourages any interested parties to reach out to him.

MORE ABOUT DR. TAO

With over 25 years of research and teaching experience, Dr. Tao is the founding board director and president of the American Society of Thermal and Fluids Engineers (ASTFE) and an active member of the American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE). He is also a Fellow of the American Society of Mechanical Engineers (ASME).

An internationally known researcher in thermal sciences, refrigeration system performance, and renewable energy applications in buildings, Dr. Tao has produced more than 175 journal publications, book chapters and peer-reviewed conference papers over the course of his career.

He holds two patents for a new apparatus to measure fluid thermal physical properties. He also serves as editor-in-chief of the Heat Transfer Research journal. He's received more than $19 million in research funding as a single principal investigator or co-principal investigator in multidisciplinary teamwork projects from the NSF, NASA, Air Force, DSL, DOE, ASHRAE and industries.

Dr. Tao has a Ph.D. in mechanical engineering from the University of Michigan, and a B.S. and M.S. in mechanical engineering from Tongji University in Shanghai, China, and holds a PE license in Texas. He chose to come to CSU because he felt "Cleveland has tradition." In particular, he cherishes CSU's Order of the Engineer ring ceremony. Students pledge to uphold the standards and dignity of the engineering profession and serve humanity by making efficient use of the world's resources. "CSU was the first U.S. university to start that tradition," Dr. Tao said. "CSU always nurtures talent and leadership as well."

PRESERVING OUR HEALTH

Chandra Kothapalli seeks to keep humans well.

MOST OF US KNOW SOMEONE who's suffered a heart attack or has severe back pain. And surely we've all had to throw away recalled contaminated lettuce or spinach. Chandra Kothapalli, Ph.D. associate professor in the Department of Chemical and Biomedical Engineering, is currently researching solutions that address these issues and more.

He received his Ph.D. degree from the Clemson University – Medical University of South Carolina joint bioengineering program and, before coming to CSU, he performed postdoctoral research in bioengineering at the Massachusetts Institute of Technology. He has more than 65 peer-reviewed journal articles, book chapters and conference proceedings, and is a co-inventor on two patents.

Dr. Kothapalli established and directs an interdisciplinary bioengineering lab, the Biomechanics and Tissue Engineering Laboratory (BTEL) in the Washkewicz College of Engineering. He guides students there in performing research at the interface of physics, chemistry, biology and engineering. Various federal agencies and private foundations fund the research in the lab.

"The range of topics we investigate in my lab is pretty diverse. Our research combines cell and molecular biology, biophysics, microfluidic devices and mathematical modeling to understand the fundamental mechanisms by which various biological processes work in our daily lives," said Dr. Kothapalli.

"We investigate how cells and tissues in our bodies change when they experience an injury or disease or simply just by aging. In separate projects, we investigate the sources of bacterial contamination in fresh produce that we consume and develop strategies to mitigate that."

Multiscale Mechanobiology

A fundamental aspect of Dr. Kothapalli's research is understanding how various proteins in nature are synthesized, assembled and organized, leading to the formation of complex tissues in our body. "Our body is very unique in that we have significant differences between various tissues — what they're made of, how they respond to physical and chemical stresses, or when we have an injury or disease," he said.

BTEL is one of very few labs with a state-of-the-art atomic force microscope (AFM) obtained through funding from the National Science Foundation (NSF). "Biological samples such as cells and tissues are very sensitive to external load and could easily get damaged during experimentation," said Dr. Kothapalli. "But with this AFM, our team can poke cells and tissues without damaging them and investigate how they change under an injury or disease state. This has applications in developing therapeutic options to treat such conditions."

With support from the NSF, his team is working toward the development of targeted therapies to treat medical conditions such as spinal cord injury and aortic aneurysms. "Regeneration following spinal cord injury is clinically challenging, in part due to the modified tissue composition and dense scarring," he said. "Similarly, there is a significant loss of elasticity in aortic tissues under an aneurysm disease state, and it is not easy to restore elasticity in those tissues with our current knowledge."

Dr. Kothapalli is collaborating with researchers at other institutions, including Cleveland Clinic, to understand the progressive deterioration of the tissue characteristics and then develop effective regenerative therapies for such medical conditions. "Cells in our bodies constantly sense the mechanical forces exerted by their environment, and adjust their gene and protein expression as well as their performance," he said.

"They also respond to growth factors, hormones, pharmacological drugs, or environmental compounds, and their response is dependent on the level and extent of exposure. In my lab, we are investigating the cell biology from a mechanics standpoint as well, to develop a comprehensive understanding of their processes."

Mechano-adaptation

When scientists study cells, stem cells or tumor cells, they culture them in a rigid petri dish that doesn't resemble the cell's native environment in the body. This causes the cells to deviate from their original behavior and adapt to this new environment, a process called *mechano-adaptation*. "We and others are discovering that this new stiffer environment significantly alters cellular functions such as their ability to migrate, differentiate to various lineages, or multiply, and therefore should be viewed from that perspective," Dr. Kothapalli said.

His group discovered that changes in cell biomechanics, measured using AFM, serve as a reliable marker of mechano-adaptation. To reduce the changes that the cells undergo during such mechano-adaptation, Dr. Kothapalli's lab is developing hydrogel substrates that mimic specific regions of the body, such as the heart, liver or brain.

Tissue Engineering and Regenerative Nanomedicine

Millions (or billions) of cells that reside in our heart die when we experience a heart attack. The human heart is not capable of repairing itself under such adverse pathological conditions.

Currently, there are no pharmacological or surgical approaches that can replace the lost heart cells, called cardiomyocytes, or regenerate the severely injured heart tissue. "Long-term clinical trials involving direct injection of cells into the heart have shown mixed results in improving cardiac function, possibly due to issues involved with their 'homing,'" said Dr. Kothapalli. Homing means that the transplanted stem cells will stay at their injected site in the heart. "In addition, inflammation caused by the heart attack is not conducive for their survival in the heart tissue," Dr. Kothapalli said.

> **WE INVESTIGATE HOW CELLS AND TISSUES IN OUR BODIES CHANGE WHEN THEY EXPERIENCE AN INJURY OR DISEASE OR SIMPLY JUST BY AGING.**
>
> DR. CHANDRA KOTHAPALLI

His team is investigating whether the patient's own bone-marrow-derived stem cells could be transplanted to repair the heart tissue. They're coaxing such stem cells to transform into cardiomyocyte-like cells, and optimizing suitable delivery platforms for their homing, survival and tissue repair at the site of inflamed heart tissue. "This project is a classic example of bioengineers using principles of tissue engineering, drug delivery, nanotechnology, and stem cell biology, towards cellular replacement and cardiac tissue regeneration *in situ*," said Dr. Kothapalli. "Our future studies will pursue translational studies of such autologous stem cells using animal models."

Food Safety

We've all heard numerous news reports about recalled lettuce or spinach contaminated with E. coli, Salmonella or Listeria. This often occurs when uncontaminated batches of fresh produce get mixed with a contaminated batch during various steps of the farm-to-table supply chain, such as washing.

"Thousands of Americans are annually affected, and hundreds die as well from exposure to such contaminated produce, despite best practices followed by the produce wash or packaging industry," said Dr. Kothapalli. "Part of the problem is that we currently do not know when a bad batch will come in and how we can take care of it in real-time"

Sanitizers such as sodium hypochlorite (commonly termed as bleach) are widely used during produce wash to neutralize the effects of potential pathogens. Although approved by federal agencies, the amount of sodium hypochlorite used is often not enough to prevent cross-contamination.

Dr. Kothapalli established the Produce Safety Lab at CSU and received funding from the United States Department of Agriculture (USDA), the Center for Produce Safety consortium, and CSU's Office of Research.

With strong collaborations from colleagues in the Math department at CSU, his approach involves a unique and complementary combination of multi-scale laboratory experiments and mathematical modeling to predict the effectiveness of sanitizer formulations that minimize pathogen survival, transfer, and cross-contamination during wash cycles.

"Ultimately, our goal is to enable the produce wash industry to make informed real-time decisions on sanitizer levels and bacterial loads during the wash cycles — which typically last no more than two minutes in industrial settings. We work closely with industry, federal agencies and collaborators to develop a solution to this long-standing problem," Dr. Kothapalli said.

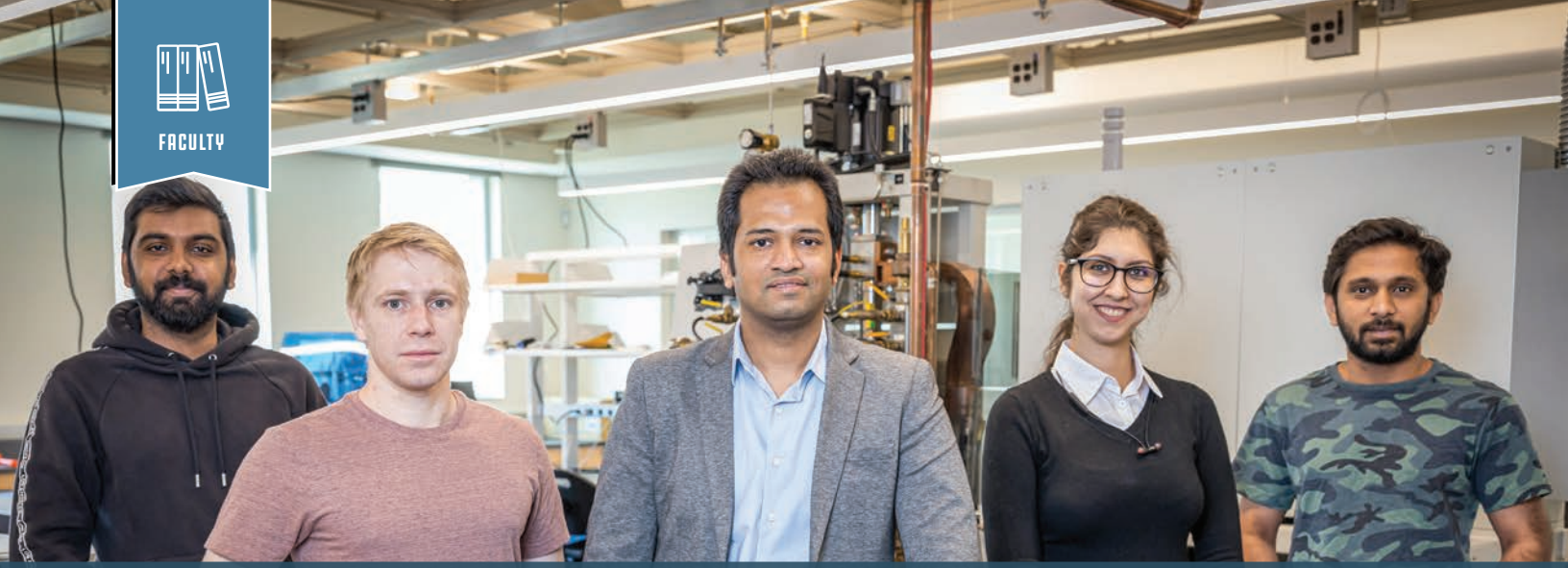
Student Mentoring

For some of the projects outlined here, Dr. Kothapalli's group utilizes techniques such as microfluidic platforms (more commonly known as "Lab on a Chip"), single-cell sequencing, cellular organoids, high-throughput screening and high-content imaging platforms. His lab has trained more than two dozen graduate students and multiple undergraduate students in these projects.

"We get more inquiries from interested students, including from local high schools, than we can accommodate in the lab. Student mentoring and training is a huge part of what we do as an academic lab," said Dr. Kothapalli. "We wouldn't be able to do some of this research without significant student involvement and contribution. We are well-positioned to train the next generation of students in cutting-edge biomedical research in our labs due to our proximity to numerous hospitals and universities, research incubators and medical schools," he added.

"CSU generously invests in undergraduate- and graduate-level research than most schools [that] I have known. We send our students to various regional and national-level conferences to present their research and network."

FACULTY



TUSHAR BORKAR
MANUFACTURING THE FUTURE

Above Photo: Dr. Borkar in his lab with his students: (from left to right) Calvin Christopher, Bradley Warga, Dr. Tushar Borkar, Taban Larimian, and Amit Patil

HUMANS HAVE BEEN CREATING objects from metal for more than 10,000 years. Advanced processing of metals and composites plays an important role in meeting the demanding requirements of the aerospace, defense, automotive, and biomedical industries. Additive manufacturing technology, commonly known as 3D printing – which involves a comprehensive integration of materials science, mechanical engineering and laser technology – is regarded as an important revolution in the manufacturing industry.

During the 3D printing process, three-dimensional solid objects are constructed using information from a digital file. A range of different metals, plastics and composite materials can be used to fabricate them. This technology allows the production of complex shapes using less material, doing so at a lower cost than traditional manufacturing methods.

American Chuck Hull invented and patented the first 3D printer in 1983, and later created his first 3D-printed object: an eyewash cup. Since then, 3D printing has changed the way many industries do business. Today, everything from shoes, jewelry, aerospace components, and even houses and office buildings have been fashioned using 3D printing technology.

Tushar Borkar, Ph.D., associate professor in the Department of Mechanical Engineering, joined Cleveland State University in 2015. Before that, he was senior research scientist at the University of North Texas, where he earned his doctorate in materials science and engineering, focusing on advanced processing and 3D printing of metallic alloys and metal matrix composites. Although part of his expertise is in 3D printing, his research has evolved over the years to include work on creating new metallic alloys and composites via advanced processing tools – all to overcome the challenges inherent to traditional manufacturing of metals.

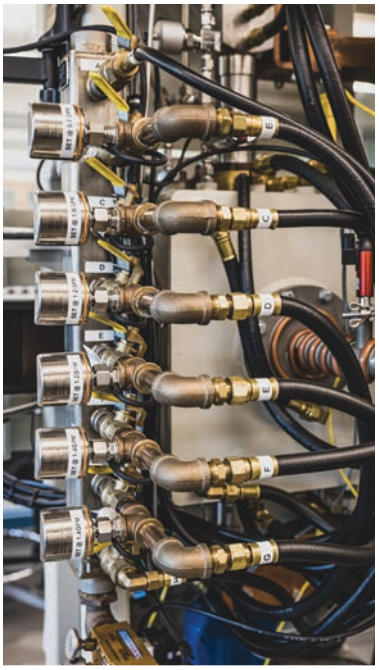
"My research focuses on the broad areas of advanced processing, including additive manufacturing of new metallic materials and materials engineering – with the primary goal of advancing the scientific and fundamental understanding of the relationship among composition, structure from atomic to micron level, processing, and properties, mainly mechanical, tribological, and magnetic," said Dr. Borkar.

"The development of a new class of materials (metallic alloys and composites) via additive manufacturing processes along with the use of advanced characterization techniques, such as transmission electron microscopy and 3D-atom probe tomography, constitute a common thread tying my multiple research activities."

CNT/GNP Reinforced Metal Matrix Composites

One of Dr. Borkar's projects, funded by the U.S. Air Force Office of Scientific Research, seeks to develop new metallic materials and composites using carbon nanotube (CNT) and graphene nanoplatelet (GNP) reinforced metal matrix composites. This material could replace expensive nickel-based super alloys used in the manufacture of some aircraft parts and could lower costs and reduce the weight of the aircraft. "CNT/GNP-metal nanocomposites have certain properties which make them potential candidates for high-performance aerospace structural applications, such as high tensile strength, stiffness, excellent wear and corrosion resistance," Dr. Borkar said. "This research project is aimed at significantly enhancing the understanding of the strengthening mechanisms in CNT/GNP-metal matrix composites."

In addition, he's working toward developing a new class of lightweight, high-strength metallic materials called *low-density high-entropy alloys*. "I'm working on some alloys that will be lighter like aluminum, but as strong as nickel or titanium," he said. These alloys could be used to create parts for cars and trucks to reduce energy consumption and CO_2 emission.



Coatings for Steel Billets

Dr. Borkar has also received funding from the Defense Logistics Agency (DLA), part of the U.S. Department of Defense (DoD). "Forged steel parts are used extensively within the DLA and DoD, especially in ground-based systems and armaments, and in the commercial marketplaces," Dr. Borkar noted.

Oxidation and decarburization occur during pre-heating before forging, which can weaken the metal and create an unsightly finish. These effects can be prevented by the application of commercial coatings. "A truly innovative aspect of this project is the goal of identifying an effective method to apply the coating", Dr. Borkar said. "In order for the coating to be implemented in a production environment, the application method must be efficient and cost-effective."

This project will explore automated and robotic application methods to reduce the application cost, improve cycle times, and provide additional safety to the operator. Dr. Borkar believes the benefits of this project will extend well beyond the forging industry, such as to steel mills and heat-treating plants.

The AM²P Lab

All of this research work has been performed in Dr. Borkar's Advanced Manufacturing and Materials Processing (AM²P) lab which has state-of-the-art advanced processing equipment and tools. One such piece of equipment is a high-energy planetary ball mill, which allows researchers to mechanically/mix elemental blend powders (such as nickel, aluminum and copper) to design new compositions.

Once the powder is milled, metallic objects of the desired shape and size can be produced using the lab's spark plasma sintering (SPS) machine, vacuum hot press, and/or ExOne metallic 3D printer. The materials can then be characterized using the electron microscope and instrumentation for measurements of microhardness, tensile and compression, and wear.

What's Next

Dr. Borkar believes that the research capabilities and curriculum at CSU are excellent to address current trends. He is currently teaching courses in additive manufacturing, hybrid manufacturing, advanced materials and manufacturing processes. He plans to develop more courses at the graduate level focusing on advanced manufacturing. He is working to establish the Center for Innovative Manufacturing, which will be focused on satisfying the growing technological and engineering needs in Northeast Ohio and beyond.

"If students are interested in manufacturing, I hope CSU will be their first choice."

> "MY RESEARCH FOCUSES ON THE BROAD AREAS OF ADVANCED PROCESSING, INCLUDING ADDITIVE MANUFACTURING OF NEW METALLIC MATERIALS AND MATERIALS ENGINEERING."
>
> DR. TUSHAR BORKAR

More about Dr. Borkar

Dr. Borkar has been active with ASM International's Cleveland chapter for three years and became treasurer in July 2021. In 2018, he started the ASM Materials Advantage chapter at CSU, known as the Cleveland State Material Society (CSMS), and he serves as its faculty advisor. In addition, Dr. Borkar serves as faculty advisor for the American Society of Engineers of Indian Origin (ASEI).

He is also an editor and reviewer of several engineering journals, including JOM, Acta Materialia, and Materials and Design. He has received two technical educator awards, from the ASM International and the Cleveland Technical Societies Council (CTSC), in recognition of his distinguished research and dedicated service to students in mechanical engineering.

Additions to THE TEAM

The Washkewicz College of Engineering is pleased to welcome several new faculty members. Get to know them here.

SAEED FARAHANI, PH.D., ASSISTANT PROFESSOR

DEPARTMENT OF MECHANICAL ENGINEERING

Saeed Farahani, Ph.D. received his doctorate in automotive engineering from Clemson University. His research has primarily been in the field of advanced manufacturing, particularly in the areas of integrative and networked manufacturing systems. His work has integrated analytical models, numerical simulations, statistical and machine learning methods, sensors, and industrial IoT solutions to advance manufacturing systems for sheet metals, polymers and composites.

Dr. Farahani has over 10 years of experience working in industry in the roles of engineer, technical manager and entrepreneur. His industrial experience includes design and supervising the fabrication of more than 200 special tools for plastics, composites, and sheet metal parts, and manufacturing optimization for several mass-produced products such as polymeric cages for bearings and clinch fasteners for high strength materials. Dr. Farahani also serves as an associate editor for SAE Journal of Sustainable Transportation, Energy, Environment & Policy, board member of Society of Plastic Engineering and co-chair of Advanced Materials Manufacturing Track in ASME International Manufacturing Science and Engineering Conference.

He enjoys running and hiking with his family, and loves cooking kababs and baking different kinds of pastries.

NAVID GOUDARZI, PH.D., ASSISTANT PROFESSOR

DEPARTMENT OF MECHANICAL ENGINEERING

Dr. Navid Goudarzi received his Ph.D. in mechanical engineering from the University of Maryland. Prior to joining CSU, he was an assistant professor at the University of North Carolina-Charlotte and a postdoctoral fellow in the Center for Advanced Lifecycle Engineering at the University of Maryland.

His externally funded research covers a variety of physics-driven and data-driven techniques around renewable wind/ocean energy, and has supported over 10 doctoral and master's students. He has published three book chapters, 18 journal articles, over 50 peer-reviewed articles in conference proceedings, and holds three patents. He teaches courses in thermal-fluid sciences, renewable energy, design, and data-driven techniques in engineering applications.

Dr. Goudarzi is actively involved in the renewable energy community. He is recently selected as the executive committee member of the American Society of Mechanical Engineers-Power Division and is the Technical Program Chair of the ASME Power 2022. He is an associate editor of Energy for Sustainable Development and has been a reviewer of manuscripts and proposals for over 40 journals and funding agencies.

Outside of work, he likes traveling, skiing, playing soccer, tennis and hiking.

CHELSEA MONTY-BROMER, PH.D., ASSOCIATE PROFESSOR

DEPARTMENT OF CHEMICAL AND BIOMEDICAL ENGINEERING

Chelsea Monty-Bromer, Ph.D. received her doctorate in chemical and biomolecular engineering in 2009 from the University of Illinois Urbana-Champaign. Prior to joining Cleveland State University, Dr. Monty-Bromer spent 11 years in the Department of Chemical, Biomolecular, and Corrosion Engineering at The University of Akron, most recently as an associate professor. She is also the CEO and founder of RooSense, LLC, a wearable health technology startup.

With expertise at the intersection of reactions engineering, electrochemical engineering, and device development, she studies bio-electrochemical interfaces to better understand biological processes and guide the development of novel biomaterials and biosensors. She has authored over 20 peer-reviewed publications and has an issued patent.

Her research is currently funded by the Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA), Ohio Water Resources Committee (OWRC), the National Science Foundation (NSF), and the Department of Energy (DOE). Dr. Monty-Bromer was named a notable woman in STEM in 2019 by *Crain's Cleveland Business* and was an Air Force Summer Faculty Fellow in 2017 and 2018.

METIN UZ, PH.D., ASSISTANT PROFESSOR

DEPARTMENT OF CHEMICAL AND BIOMEDICAL ENGINEERING

Metin Uz received his doctorate in chemical engineering from Izmir Institute of Technology, Izmir, Turkey in 2014. During his Ph.D. studies, he received the Scientific and Technological Research Council of Turkey International Research Fellowship and worked on the development of multi-functional gene delivery systems for cancer treatment as a visiting scholar at Iowa State University (ISU). He then joined ISU, working first as a postdoctoral fellow and then as an associate scientist in the Department of Chemical and Biological Engineering and the Nanovaccine Institute.

His research covers biomaterials, stem cells, tissue engineering, flexible electronic biointerfaces, nanoscale drug/gene delivery systems and polymeric membranes. His has more than 20 peer-reviewed publications in journals, book chapters and conference presentations. He was named the Baxter Young Investigator in 2016 and received the ISU Postdoctoral Scholar Research Excellence Award in 2018, and has demonstrated entrepreneurial activities by completing the National Science Foundation-funded ISU I-Corps Site and ISU Startup Factory programs. Dr. Uz co-founded Degimflex LLC start-up in 2019 and acquired patents on developing novel fabrication techniques for biodegradable, implantable, and flexible electronics.

He likes swimming, biking, running, skiing and watching soccer games. He is also a certified scuba/free diver and former soccer player.

IHAB WATTAR, DR.ENG., ASSISTANT PROFESSOR OF PRACTICE

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Ihab Wattar, Dr.Eng. has over 25 years of national and international experience in industry and academia holding senior positions in management and engineering. Before joining CSU as an assistant professor of practice in the Department of Electrical Engineering and Computer Science in 2021, Dr. Wattar was assistant professor at Al Ghurair University. He has held positions as proposal/bidding manager at ABB, deputy general manager with ITAS Group, chief operation officer at the Syrian Qatari Holding, senior design engineer for Bailey Controls/ABB, and senior application engineer for Intel. From 1988 until 2018, he taught a variety of electrical engineering and computer science courses as adjunct faculty or part-time instructor at several academic institutions, including CSU. Dr. Wattar received his Doctor of Engineering degree from Cleveland State University in 2000. He has completed numerous certifications, receiving academic awards and recognitions from the companies and institutions in which he worked. In addition to his academic and industrial activities, he has also spent time on social activities to serve his community.

He loves swimming and horseback riding and he enjoys nature.

SHAOWEI YANG, PH.D., ASSISTANT PROFESSOR

DEPARTMENT OF CHEMICAL AND BIOMEDICAL ENGINEERING

Shaowei Yang, Ph.D. joined Cleveland State University in January 2021 as an assistant professor. He received his doctorate in chemical engineering from the University of Cincinnati in 2016 and spent five years as a research scientist at Georgia Tech before joining CSU.

Dr. Yang's main research interest is to develop microporous materials and membranes for energy and environment-related applications. The goal is to develop energy-efficient separation technologies (i.e., membrane or adsorption-based separations) to reduce the carbon footprint in industrial chemical separation processes. This endeavor involves materials science, fundamental thermodynamics and transport phenomena studies. In addition, he teaches Advanced Transport Phenomena and Chemical Engineering Thermodynamics courses.

Dr. Yang has published 20 journal articles in reputed journals, such as Angewandte Chemie International Edition, Science Advances, and the Journal of Membrane Science. He has one approved and two pending U.S. patents. Outside of work, he enjoys hiking and taking road trips. He is also interested in learning the electronic and mechanical basics of daily life items, repairing vehicles and home appliances.

TIANYUN ZHANG, PH.D., ASSISTANT PROFESSOR

DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Tianyun Zhang, Ph.D. received his doctorate in electrical and computer engineering from Syracuse University in 2021. His research interests include model compression on deep neural networks, energy-efficient and high-performance implementations of deep learning and artificial intelligence systems, adversarial robustness on artificial intelligence systems, and convex and non-convex optimization. He has published his work in competitive conferences such as ASPLOS, ECCV, ICDM, DAC, PAKDD, ACC, as well as in IEEE Transactions on Neural Networks and Learning Systems.

Dr. Zhang is employing mathematical optimization techniques on the research of deep learning. He aims to solve the weight-pruning problem on deep neural networks using the alternating direction method of multipliers , a state-of-the-art model compression method. He has also proposed a unified min-max optimization framework on robust learning over multiple domains.

In his spare time, he likes playing basketball and hiking.

"TRIAL" BY FIRE

Valedictorian aims to prevent accidents

FLAMES RAVAGED his family home. Lightning had struck the backyard and caught the furnace on fire in the middle of the afternoon. Fortunately, all who were inside Jacob Vitale's home at the time made it out unharmed. While no irreplaceable photos or videos were lost, they all needed to live elsewhere for six months during repairs.

"It was the weekend after my freshman year," said Vitale, Cleveland State University's Spring 2021 Valedictorian (Bachelor of Chemical Engineering, Spring 2021). "It burnt a decent portion of the back of the house and caused smoke damage throughout everything. A lot of the stuff we lost were things like clothes that could be replaced."

Due to this experience, Vitale shifted his career goal to safety. "It's important, as an engineering student and a future engineer, to focus on helping others and preventing incidents at chemical plants and factories," he said.

Vitale chose to study chemical engineering because he excelled at chemistry in Eastlake North High School of the Willoughby-Eastlake City School District in Northeast Ohio, where he maintained a GPA above 4.0. "I had a high school teacher that pushed me to take AP chemistry after honors chemistry and I fell in love with it, so I decided chemical engineering is for me," Vitale said, adding that his time at CSU helped him grow as a student, engineer and person. "I went from a very shy person at the start of college, but now I don't think I'm that shy anymore," he admitted.

Vitale maintained a 4.0 GPA every semester he attended CSU. Due to his academic excellence, he's a two-time recipient of the annual *Outstanding Student in Chemical Engineering* award.

"I'm absolutely honored to have been chosen as university valedictorian, Vitale said. "I couldn't have done it without the support of my friends and family. [The awards are] of major importance to me, as the awardees are selected by the professors of the Chemical and Biomedical Engineering department."

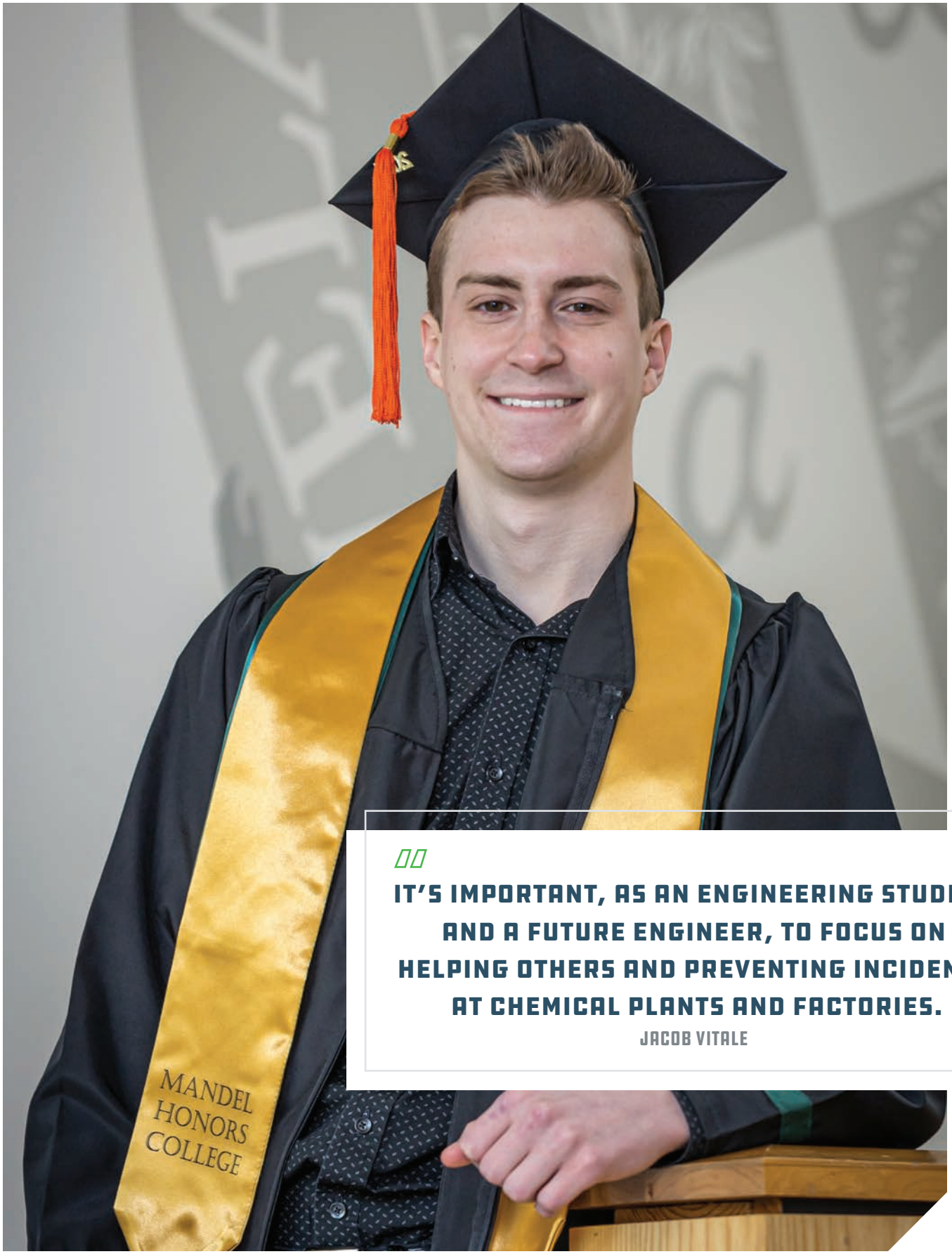
As an undergraduate chemical engineering student, Vitale was also enrolled in the Mandel Honors College of CSU and in the accelerated master's program. Outside the classroom, Vitale did research in the lab of Dr. Geyou Ao, assistant professor in the Department of Chemical and Biomedical Engineering, where he investigated boron nitride nanotubes and their applications, such as biosensors, antimicrobial coatings and thermal coatings for medical probes.

"This position has offered me the opportunity to enhance my problem-solving skills, collaborate with other researchers, and improve my ability to communicate research to professors and students – both inside and outside of my research area," Vitale said.

Vitale recently finished a summer internship at FM Global as a consultant engineer, where he traveled to chemical and manufacturing plants in nearby states to conduct safety inspections. He also served as vice president of Tau Beta Pi engineering honor society.

"This leadership position has helped me meet a larger group of students inside the College of Engineering and gain a greater respect for the other disciplines of engineering around me," Vitale said.

Vitale returned to campus this past fall to continue his research on nanotubes and to complete his master's degree in chemical engineering. He hopes to proceed with his ambition of making chemical and manufacturing environments safer places to work after completing his degree.



> **IT'S IMPORTANT, AS AN ENGINEERING STUDENT AND A FUTURE ENGINEER, TO FOCUS ON HELPING OTHERS AND PREVENTING INCIDENTS AT CHEMICAL PLANTS AND FACTORIES.**
>
> JACOB VITALE

Successful By Design:
SENIOR DESIGN POSTER COMPETITION

THE SENIOR DESIGN POSTER COMPETITION provides an opportunity to display the capstone project of a student's engineering sojourn at Cleveland State University.

It's the place where the top-performing student teams from each engineering department, nominated by department faculty, show off hours of difficult technical work that take a problem from conception to final product.

Senior design teams typically work for two semesters on real-world engineering challenges, with the majority of these challenges posed to them by outside organizations and corporations. These sponsors also provide technical and financial support, and in some cases, access to corporate facilities and equipment in order to complete their projects.

"This is an opportunity for students to work through research, design and execution," said Nicole Tischer, coordinator of the engineering co-op program, who also assisted with the logistics of the senior design program. "They see the whole process, not just a formula."

Projects are judged by a panel of 12 guest judges hailing from a range of engineering disciplines. They review each team's final poster and five-minute video. On competition day, the teams meet with the panel for an intensive 10-minute Q&A session. Judges look for innovation, critical thinking, overall quality of content, impact of work and teamwork.

The 2020–2021 competition expanded the number of nominated teams from 12 to 16, all to better represent the breadth of the programs in engineering and computer science. It also had the added challenge of COVID-19 protocols; limited access to equipment and in-person lab time proved challenging in building strong teams over online meeting and chat platforms.

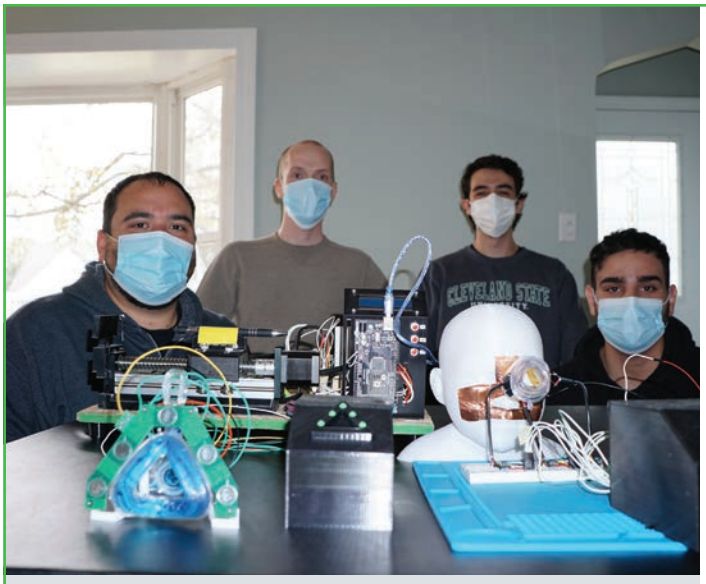
Yet the teams prevailed – that's what engineers do – and while their projects ranged widely across engineering disciplines, all teams agreed on a common takeaway: the critical importance of project management skills.

"This project felt like the capping off my time at CSU," said Sumaiya Ahmed, one of this year's winners. "We came full circle, using all that we have learned over these four years."

WE CAME FULL CIRCLE, USING ALL THAT WE HAVE LEARNED OVER THESE FOUR YEARS.

SUMAIYA AHMED

FIRST PLACE



The student team with their design (from left to right: Jordan Lindenberger, Dylan Doyle, Tyler Holdsworth, Michael Shakkour)

Sponsor: **Akron Children's Hospital**
Title: **Non-Invasive Ventilator Mask Fitting Feedback System**
Department: **Electrical Engineering and Computer Science**
Team Members: **Dylan Doyle, Jordan Lindenberger, Tyler Holdsworth, Michael Shakkour**

Babies can't tell someone when their ventilator is too tight and hurts. But two solutions designed by this winning team can. Meeting daily via chat and Zoom, the team built two successful approaches to fitting a ventilator mask properly for infants and children. One relied on flexible capacity sensors fabricated with an aerosol jet printer in the CSU lab. The other, the fail-safe in case the flexible model did not work, positioned sensors above the mask. Both designs fed pressure data into a red/yellow/green light array for the respiratory therapist to gauge.

Team tip: When team members are spread out across Northeast Ohio, use centrally located parking lots to pass off data, models, and prototypes to one another on the fly.

SECOND PLACE

Title: **Mind Controlled Prosthetic Hand**
Department: **Electrical Engineering and Computer Science**
Team Members: **Adam Cook, Timothy Land, Kareem Ghanem, Fredrick Kelemen**

Off-the-shelf electrical components and one team member's personal 3D printer produced a hand with articulated fingers that responded to thought patterns in the wearer's brain waves. Brain-to-computer interface technology is an emerging, innovative field and additive manufacturing, using 3D printers, brings faster prototyping.

Team Tip: Keep the budget under $600 per hand, so the prosthesis qualifies for most medical insurance reimbursement.

THIRD PLACE

Title: **Design of a Naphtha Refinery**
Department: **Chemical and Biomedical Engineering**
Team Members: **Jacob Vitale, Jacob Martin, Sumaiya Ahmed**

Taking on the international challenge from the American Institute of Chemical Engineers, this team used meticulous calculations to optimally design the process of refining naphtha into gasoline, all while considering the rigorous safety protocols demanded by the refinery environment.

Team Tip: Work together on projects since sophomore year, and laughingly call yourselves "control freaks who learned to trust one another."

The team and their design (standing from left to right: Mehedi Hasan; Tariq Aldhafyan; and Harpreet Kaur; sitting from left to right: David Williams, Senior Engineer, Transmission Substation Services Department, FirstEnergy; Dr. Allen Morinec, Supervisor, Transmission Substation Services Department, FirstEnergy and the team's academic advisor for the project and senior design instructor; Aishwarya Gandhi, Engineer, Transmission Planning and Protection Department, FirstEnergy; and Russel Laganzon; top right enclosure: Mahdy Alhasan)

FOURTH PLACE

Sponsor: **FirstEnergy**
Title: **Portable Digital Substation Training Laboratory**
Department: **Electrical Engineering and Computer Science**
Team Members: **Mehedi Hasan, Harpreet Kaur, Russel Laganzon, Tariq Aldhafyan, Mahdy Alhasan**

Creating a digitized training platform for power substations that met new, international standards not yet reached in North America, this team designed, configured, and tested a new training laboratory for teaching digital power substation smart grids. What they thought could be accomplished with linked devices turned out to be a complex communication among three separate software languages.

Team Tip: Rely on messaging apps and Zoom meetings at odd hours, to make sure your overseas team member can contribute.

STUDENTS

The CSU winning team with their bicycle (from left to right: Ryan Stanic, Chad Caruso, Faith Hruska, Moe San, Rachel Wenzel, Robert Howerton, and Cameron Paratore; not shown: Brittany Randolph)

STILL ON A ROLL

Engineering students win third consecutive Fluid Power Vehicle Challenge

THE STUDENT TEAM from the Washkewicz College of Engineering took home first-place for the third year in a row at the 2021 National Fluid Power Association (NFPA) Fluid Power Vehicle Challenge, which was held virtually April 14–16. They also were awarded the *Best Design – Student Choice Award* in the competition, an honor chosen by the other teams.

For this competition, Team Vikes built a bicycle that runs on hydraulic fluid power, then raced against teams from 15 other universities. The rider creates fluid motion by pedaling a pump shaft to propel the bike forward with a functional hydraulic circuit.

"The Fluid Power Vehicle Challenge is all about creating a method of human-powered motion," said Bogdan Kozul, assistant professor of practice in the Department of Mechanical Engineering, and faculty advisor and senior design instructor for the project.

Eight students comprised the team as they worked on this senior design project: Ryan Stanic, Chad Caruso, Faith Hruska, Moe San, Rachel Wenzel, Robert Howerton, Cameron Paratore and Brittany Randolph. The competition featured three races: Sprint (Vikes won first place), Endurance, and Efficiency.

A panel of at least 20 industry professionals from across the nation judged each race on a points system. Combining the three races, CSU's points added up to an overall win.

For the second consecutive year, the competition took place virtually due to COVID-19. Races were videotaped and time-stamped and needed to be sent unedited within an hour of filming. The team succeeded despite the conditions that came with the pandemic.

"It was amazing that they had very limited lab time, and extremely limited face-to-face opportunity," said Kozul. "Some students couldn't meet because of family members in high-risk situations, and others had employers, co-ops, internships that didn't want to let them meet with other organizations."

Motion and control leader Parker Hannifin allowed the students to work, two at a time, from one of their divisions. "I'd never led a group of students through that type of adversity before, and these students made me very proud in how they were able to overcome all that," said Kozul.

Using last year's innovative recumbent tricycle design, this year's team revamped the hydraulics, including building a new engine and drive mechanism. The NFPA also required electric and pneumatic systems. This year's bike weighs 185 pounds and has a top speed of nearly 31 miles per hour.

"Our team focused exclusively on a new hydraulic design with steel tubing and increased line sizes, and also incorporated a unique pneumatic control for the regenerative braking portion of our circuit, which has never been done in the competition before," said Kozul.

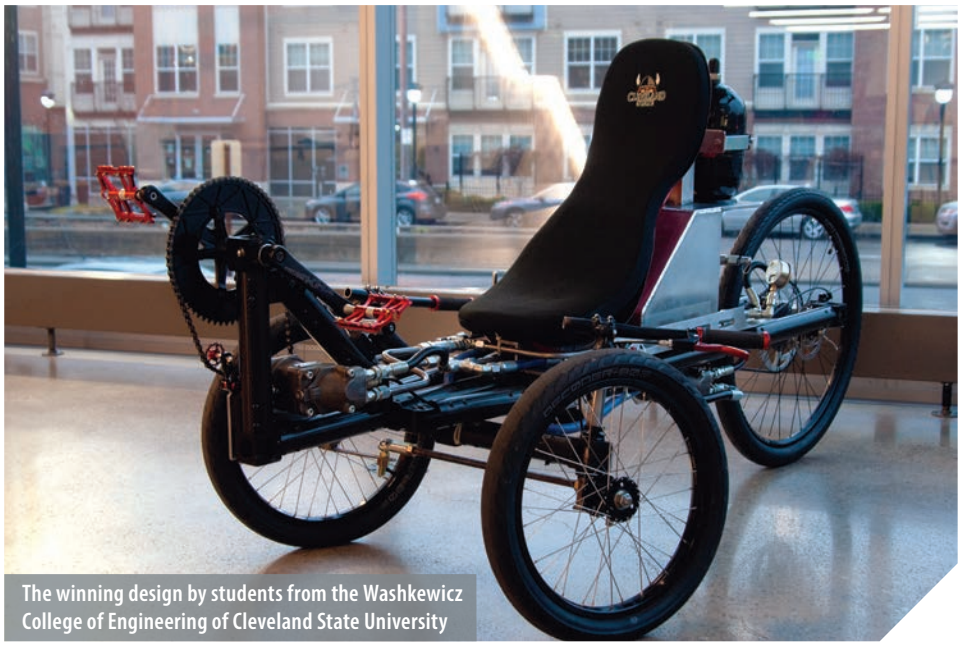
Each year, Kozul's team pledges to talk with, help and mentor the following year's team. At the end of the semester, each team creates an operation manual, as well as a paper about what they would do differently if they had the opportunity.

> "I'D NEVER LED A GROUP OF STUDENTS THROUGH THAT TYPE OF ADVERSITY BEFORE, AND THESE STUDENTS MADE ME VERY PROUD IN HOW THEY WERE ABLE TO OVERCOME ALL THAT."
>
> BOGDAN KOZUL

Naturally, Kozul looks forward to assembling a new team next year.

"For the first few years of an engineer's career, they don't have an opportunity to coach and mentor and inspire people because they are the recipients of that," said Kozul.

"So, it's nice for them to start honing that early in their careers: to be good leaders and good volunteers and mentors to a group of people."



The winning design by students from the Washkewicz College of Engineering of Cleveland State University

Above Photo: The CSU team (from let to right): Joseph Rydzinski, Brandon Hass, Scott Engram, Kaitlin Besselman, and Alex Heintz

STUDENTS SUCCESSFULLY COMPLETE '24 HOURS OF LEMONS' RACE

Five CSU mechanical engineering students successfully completed the "24 Hours of Lemons" race as their senior design project.

HELD APRIL 17–18 at the Pittsburgh International Race Complex, this two-day, eight-hour-per-day event required participants to race a "lemon" – a colloquialism for vehicles known for frequently breaking down – on a nearly three-mile track with hills and 19 different corners.

The race is cleverly named after the 24 Hours of Le Mans, a grand touring endurance race held annually at the Circuit de la Sarthe, near Le Mans, France. The CSU team consisting of Kaitlin Besselman, Scott Engram, Brandon Hass, Alex Heintz, and Joseph Rydzinski all earned bachelor's degrees in spring 2021.

> **[THIS RACE IS] A GREAT WAY TO GET HANDS-ON INTO ENGINEERING-RELATED FIELDS, ESPECIALLY WHEN IT COMES TO FIXING THINGS ON THE FLY. JUST A LOT OF PROBLEM SOLVING AND CRITICAL THINKING.**
>
> BRANDON HASS

"Whoever gets the most laps by the end of the race wins," said Hass.

Participants received a budget of $500 for performance parts, handling and power, not including safety equipment, tires, brakes, roll cage and seats.

Heintz owned a truck with a blown engine that had been sitting in a field for a year. He said he had the "majority of the parts, and the place to work on it… [and] had a good time teaching them all about the mechanics of the vehicle and some basic fabrication skills."

"At the end of the weekend, our truck made it to the checkered flag. The same could not be said for many other teams," said Rydzinski. "We completed 96 laps, or about 270 miles raced, which for a first-time team is an amazing accomplishment."

The team sold some parts, and that income helped reduce the cost of the vehicle to $50. "Most of it was a 2002 GMC Sonoma," said Rydzinski. They installed a $300 V-8 engine, which gave them twice the power of the stock 4-cylinder.

The team experienced at least seven breakdowns, which they successfully fixed each time. For a time, the alternator wasn't charging the battery, and the truck ran out of electricity after about four laps, until they replaced it.

"We also blew a couple fuses, and also lost a tire because the lug nuts weren't tight," laughed Rydzinski. "We used our CSU engineering troubleshooting knowledge to fix the problems." "We never officially broke down to where it was too bad to get back out there," added Hass.

The group was inspired to take on the project when they watched two videos. "One was a YouTube video. There were seven or eight engineers from Mazda, NASA and a company that makes turbos. They all got bored and decided to build a car and won," said Rydzinski. "And the other was a show called 'Roadkill' on MotorTrend TV."

Rydzinski, Hass, Besselman and Heintz all attended the race; each took turns driving and switched drivers "usually when something broke," said Rydzinski. The team then used their knowledge to build and repair the truck.

"We did a whole analysis on how strong the roll cage was," Rydzinski said.

"We modeled it in 3D modeling software on a computer, and through that we were able to run simulated tests on the roll cage," added Hass.

Both Rydzinski and Haas plan to have careers in automotive engineering. "Most importantly, the project really came together and accomplished our goal: to engineer a machine to survive the '24 Hours of Lemons,'" said Rydzinski.

"We all learned to work together and brainstorm different options to fix unexpected problems in an expedited fashion, thus working under pressure."

Rydzinski, Hass and Besselman are currently working on a second car and hope to join another race this year.

"I'm building a different endurance car for a future race as well," said Heintz. "I'll be building a 1961 Ford Falcon Futura to compete. The reason why is that it's a lighter platform to start off with, and it looks a lot better too."

"[This race is] a great way to get hands-on into engineering-related fields," added Haas. "Especially when it comes to fixing things on the fly. Just a lot of problem solving and critical thinking."

Marzell Brown (left) from Rockwell Automation talks about the exhibit with John Lampros and Claire Dorsett of the Great Lakes Science Center

DERBY DASH

LIKE MANY WASHKEWICZ COLLEGE OF ENGINEERING STUDENTS, Benjamin Brunson (Bachelor of Science in of Computer Science, 2019), Alonte Garnett (Bachelor of Computer Engineering, 2019), and James Millar (Bachelor of Computer Engineering, 2019) found themselves eager to tackle their Senior Design project.

Senior Design is, of course, the culmination of a student's engineering education. Under the guidance of a faculty advisor and corporate sponsor, participants construct solutions to a variety of real-world problems. Teams dedicate up to 200 hours to their project, working together to incorporate their knowledge and experiences into a final assignment. But one look at their project suggests this experience was anything but ordinary. Brunson, Garnett and Millar buckled in for a wild ride with Marzell Brown, IoT, engineering and academic enablement manager at Rockwell Automation. Brown approached the Great Lakes Science Center (GLSC) on a possible collaboration.

The timing was perfect. The museum was preparing to debut *Vroom! A Car Adventure*. Special exhibitions are usually rented, brought in from other institutions. But *Vroom!* was being curated and built entirely in-house.

Claire Dorsett, the GLSC's associate director of strategic content, suggested the CSU team be tasked with creating Derby Dash, a focal point in the larger exhibition. The interactive exhibit allows visitors to build their own cars and then race them on a menagerie of ramps.

It came to fruition after months of planning. Brunson, Garnett and Millar made extensive use of the industrial internet of things (IoT). They integrated Rockwell technology into the display. They came up with how museum visitors could build and race their own cars; smart sensors would monitor and analyze data.

But the collaboration did not come without challenges. The trio faced an accelerated timeline. While peers faced May deadlines, the science center had a launch date two months prior. This meant many nights and weekends spent at the museum during the 2018–2019 academic year. "They could have easily pushed back," Brown said. "But they were game for getting it done sooner. I really believe that's all about teamwork."

"I feel like we had a stacked team," Dorsett added. "They were great. It's such a testament to how great CSU's engineering students are."

The students needed to understand that Derby Dash was not a prototype. It would go straight into use in a major museum exhibit and the stakes and expectations around it would be high. "This did not feel like a school or class project," said Dorsett. "They had to complete a finished product. They really came together to do that."

Vroom! has proven to be so popular that it is now a permanent exhibition on GLSC's top floor. With its success, Rockwell and CSU are moving forward with Version 2.0. A second Senior Design team will enhance and repair the exhibit.

"With 'normal' design projects, we tinker with something. When it's done at the end of the semester, we go on with our lives," Brown explained. "These students can look back two, three years now and say, 'not only did we do our senior design project for the community, but they're still using it. Here's the impact it has on other people.'"

"A large part of Cleveland's reputation as a manufacturing center is linked to the automotive industry," said GLSC's president and CEO Kirsten Ellenbogen, Ph.D.

"This exhibition allows us to not only explore the marvels of STEM in automotive design and engineering, but also to collaborate with our inspiring corporate partners such as Timken, Rockwell Automation, and Lincoln Electric," she added. "Our regional strength in automotive work has allowed us to create an exhibition that is unique and very special for our guests."

Vroom! is open daily to the public and included with the price of general museum admission.

> **THESE STUDENTS CAN LOOK BACK TWO, THREE YEARS NOW AND SAY, 'NOT ONLY DID WE DO OUR SENIOR DESIGN PROJECT FOR THE COMMUNITY, BUT THEY'RE STILL USING IT. HERE'S THE IMPACT IT HAS ON OTHER PEOPLE.'**
>
> MARZELL BROWN

The Derby Dash exhibit at Cleveland's Great Lakes Science Center

CSU's CSMS officers (from left to right: Taban Larimian, President; Amit Patil , Vice President (middle top); Ganesh Walunj, Treasurer (middle bottom); and Dr. Tushar Borkar, Faculty Advisor

THE CLEVELAND STATE MATERIALS SOCIETY

WHEN THE PANDEMIC BEGAN, student organizations were forced to pivot, uprooting community building and member engagement strategies. More than a year later, in-person meetings are back in full swing. This is good news for members of the Cleveland State Materials Society (CSMS) student chapter at CSU.

The CSMS student chapter was established in January 2018 by CSU engineering students and faculty, born of the need for undergraduate and graduate student networking and idea exchanges, and to become familiar with the manufacturing and materials science field.

Since its establishment, the group has invited to CSU guest speakers from industry and professional organizations to share their knowledge and experience with students.

"Being a member of CSMS gives you a much-needed edge in the global job market and the knowledge, experience, and networking you need to begin your career successfully," says faculty advisor Tushar Borkar, Ph.D.

The group is affiliated with materials societies, such as ASM International, the American Ceramic Society, the Association for Iron & Steel Technology, and the Minerals, Metals, and Materials Society. This connection provides students with opportunities to participate in competitions and international conferences. "You really can learn and sharpen the skills you need to become a successful engineering professional and a future leader of your society," Dr. Borkar said.

Due to the pandemic, CSMS did not host any in person events last year. There were regular chapter virtual meetings, and members of the group attended virtual ASM Cleveland chapter meetings. Members also presented posters in the event "ASM International Cleveland Student night" in March 2021 and attended the virtual Materials Science and Technology 2020 and The Materials Society 2021 international conferences. The chapter is currently involved in the Maple Heights School district to organize materials-science based experiments for after-school activities.

CSMS is led by three Mechanical Engineering doctoral students. They are President Taban Larimian, Vice President Amit Patil, and Treasurer Ganesh Walunj. Membership is open to all students enrolled in the Washkewicz College of Engineering.

Standing left to right: Sanaiya Ahmed, Treasurer; Ian Wu, Vice President; Fatemah Abed, Secretary. Sitting from left to right: Nicole Tischler, Assistant Advisor and Coordinator of the Engineering Co-Op Program; Dr. Prabaha Sikder, Faculty Advisor and Assistant Professor, Department of Mechanical Engineering; and Emily Zhao, President

THE SOCIETY OF ASIAN SCIENTISTS AND ENGINEERS

EVEN BEFORE THE TRAGIC SHOOTINGS IN ATLANTA put a spotlight on anti-Asian hate crimes taking place around the world, students at Cleveland State University were working to create solidarity on campus.

The Society of Asian Scientists and Engineers (SASE) aims to empower Asian students and prepare them for success in the global workplace.

Established in December of 2020, SASE is open to both undergraduate and graduate students. In its short existence, the student chapter already boasts nearly two dozen members representing a wide range of backgrounds and interests. SASE spearheads initiatives related to career development, diversity, and service opportunities in Northeast Ohio. Elected officers bring excitement and passion to SASE's leadership.

The organization is led by President Emily Zhao (Computer Science, '22), Vice President Ian Wu (Computer Science, '22), Treasurer Sanaiya Ahmed (Biology and Chemistry, '22), and Secretary Fatemah Abed (Biology, '24). Prabaha Sikder, Ph.D., assistant professor in the Department of Mechanical Engineering, serves as faculty advisor.

FirstEnergy is the local corporate sponsor for SASE. Officers work alongside FirstEnergy representatives on professional programming too. They hope to host panels, seminars, and networking events. Zhao believes corporate support has a tremendous impact on the organization. "A direct connection to the industry is crucial for science and engineering majors," she said. "We can lean on FirstEnergy for its resources like business leads, a Co-Op/Internship Program, and a Rotational Program."

The group also hopes to recognize diversity with traditional holiday celebrations. It will commemorate its first full year as a student organization with festivities in May 2022 for Asian-American Pacific-Islander (AAPI) Heritage Month. SASE also plans to collaborate with other University organizations to inspire unity.

"While the events [in Atlanta] didn't change SASE's view on these matters, it provided evidence that these are problems that we must work towards solving together," Zhao said.

NEOVATIONS

A CSU TEAM OF ENGINEERS WON $5,000 at the inaugural NEOvations event at NEOMED on August 12, 2021. NEOvations is an initiative led by the NEOMED president, Dr. John Langel.

The team developed a product to treat hyperbilirubinemia – a condition in which there is too much bilirubin in a newborn infant's blood – in developing countries. The team's product came in second place at the event, garnering the $5,000 prize.

The team consisted of Tim Knezevich (CEO and chemical engineering graduate student), Tayluer Streat-Ricchuiti (chief engineer and biomedical engineering graduate student), Jessi Martin (CTO and biomedical engineering graduate student), and Manawini Chennoju (marketing and business, and mechanical engineering graduate student).

This was the only team made up solely of engineers. Other teams from NEOMED, The University of Akron and elsewhere had teams fortified with medical students, law students and business students.

The winning team, from left to right: Tim Knezevich, Tayluer Streat-Ricchiuti, Manaswini Chennoju, Jessi Martin and Phoebe Otchere (Student President of NEOvations)

FENN ACADEMY PARTICIPATES IN EXTERNSHOP EVENT

Dr. Brian Davis, associate dean of the Washkewicz College of Engineering, and Fenn Academy's graduate student assistant Tayluer Streat-Ricchiuti visited Padua Franciscan High School to showcase the application of robotics to the design of exoskeletal devices. This is an active area of research amongst many CSU faculty and students who strive to improve the mobility of patients who are affected by stroke, spinal cord injury or other musculoskeletal disorders. This year's inaugural event at Padua Franciscan included 33 high school students and one of their own recent graduates, John Niezgoda. He enrolled in CSU's undergraduate program in mechanical engineering and provided much-appreciated logistics support at the ExternSHOP event. In the photo, Dr. Davis and Streat-Ricchiuti (wearing the exoskeleton) demonstrate the Indego assist device. Padua Franciscan students alongside Streat-Ricchiuti are Elizabeth Shuman (left) and Leah Goebel (right). Emma Snowden is seated on the right and John Niezgoda is in the background.

WASHKEWICZ COLLEGE OF ENGINEERING SCHOLARSHIPS FOR 2021–2022

We asked our award recipients to provide us with three words that describe what their scholarship award(s) mean to them. The results are in the generated Word Cloud. As you can see, opportunity is the key word the majority of our recipients used to express what the award meant to them. Feelings of gratitude and honor closely follow the recognition of opportunity from these awards!

The Washkewicz College of Engineering has more than 50 different scholarship awards to give to our students each year. Over 250 students received awards for the 2021–2022 academic year. These scholarships come from different donors and have helped students in each of the engineering disciplines of the college. We would like to wholeheartedly thank our donors!

The ACE Mentor Program Scholarship Partnership

The Frank J. Ambrose Engineering Scholarship Endowment

The American Concrete Institute of Northeast Ohio Endowment

The John and Joan Bardou Endowment

The Edward F. Bell Memorial Scholarship

The Martin & Black Family Scholarship Endowment

The William F. Bland Endowment

The Rebecca Bompiedi On-Campus Residency Endowed Support Fund

The Richard L. Bowen + Associates Engineering Endowed Scholarship

The Albert T. Branham Scholarship

The Cleveland Iron League Scholarship Endowment

The Anthony Colnar Endowment

The Connectors Unlimited Inc. Engineering Scholarship Endowment

The Allen B Curtis Endowment

The Calvin B. Dalton Memorial Scholarship

The Dr. Bart DiLiddo Engineering Scholarship Endowment

The Chia Fan Foundation Scholarship

The Fenn Cooperative Education Endowment

The First Robotics Scholarship

The James D. & Margaret F. Heckelman Scholarship Endowment

The William R. Hill Engineering Endowment

The John H. Hemann Engineering Student Enrichment Program Endowment

The Albert Higley Company Scholarship

The Nathan N. Hoffman Endowed Scholarship

The Gary Kader Endowed Scholarship

The Theo and Sandra Keith Endowed Scholarship Funds

The Eugene and Frances Klingshirn Scholarship

The George L. Kramerich Awards for Excellence in Engineering Education

The Ronald R. Ledin Fenn Academy Engineering Education Endowment

The Lincoln Electric Company Link Program Endowed Scholarship

The Professor Albert Lord Scholarship Endowment

The Lubrizol Corporation Scholarship

The David D. and Lois E. McFarland Endowed Scholarship

The Charles and Patricia Mintz Endowed Scholarship

The Om Julka Endowment

The Parker Hannifin Community College Transfer Scholarship

The Parker Hannifin Scholarship for Incoming Freshman

The Parker Hannifin Support Scholarship

The Judith L. and Ronald C. Pasadyn Endowed Scholarship

The Dr. William A. Patterson Endowed Scholarship

The Doug Peacock Scholarship Fund

The Rudy Pepke Endowed Scholarship

The Precision Environmental Company Endowed Scholarship

The Michael David Pollock Scholarship

The Felicia Peters Pollock Scholarship

The Dr. Majid Rashidi Endowed Scholarship Fund

The John W. Robertson Endowed Scholarship

The Neil F. & Linda B. Rothman Endowed Scholarship

The Ray E. Saccany Endowment

The Lela M. Schier Endowed Scholarship in Engineering

The Richard R. Schier Endowed Scholarship in Engineering

The Byron and Dreama Smith Endowed Scholarship

The Alice and Ed Sobey Endowment

The Swagelok Scholarship Fund

The Szwed Family Scholarship Fund

The Margaret R. Taber Endowed Scholarship

John & Mary Trendell Endowed Scholarship

The Keith N. Ward Endowment

The Washington Group International Endowed Engineering Scholarship

The Donald E. and Pamela Washkewicz Scholarship

The Watson/Wolfs Bridge Book Prize Endowment

The Terrence V. and Mary K. Zuk Endowment

Our Cooperative Education Program
CONTINUES STRONG

THE ENGINEERING COOPERATIVE EDUCATION (FENN CO-OP) PROGRAM has been well known for hosting many in person events on campus for our students and corporate partners. They include the bi-annual Engineering and Computer Science Connections Fairs, the Student and Employer Appreciation Event, and many other industry presentations and workshops. During the pandemic, the program shifted its focus and continued to help our students grow professionally and find co-op assignments in a virtual environment.

During the Fall 2020 semester, the Fenn co-op office hosted its first virtual Engineering and Computer Science Connections Fair using the platform Career Fair Plus. Over 50 employers participated and conducted more than 1,300 virtual video meetings with almost 400 students interested in co-op, internships and full-time employment. This was repeated in the Spring 2021 semester, with similar success, having 48 employers and again more than 1,300 virtual meetings conducted with about 400 students.

FIRST VIRTUAL ENGINEERING AND COMPUTER SCIENCE CONNECTIONS FAIR STATS, FALL 2020

50+
EMPLOYERS PARTICIPATED

1,300+
VIRTUAL VIDEO MEETINGS

400
STUDENTS INTERESTED IN CO-OP, INTERNSHIPS, AND FULL-TIME EMPLOYMENT

The Fenn co-op staff also conducted several events via Microsoft Teams, including the Student and Employer Appreciation Event and the Diversity in Engineering Networking event. In the former event, students who completed the Fenn co-op program and employers influential to the program were honored for their participation, hard work and dedication to the program. Students made presentations and answered questions about their co-op experience to industry representatives, faculty, staff and their peers. In the latter event, diverse student organizations and groups were invited to connect with industrial representatives and learn about available co-op, internships and full time opportunities. Student groups which participated included student chapters of the National Society for Black Engineers (NSBE), the Society of Hispanic Professional Engineers (SHPE), the Society of Women Engineers (SWE) and Women in Engineering.

Most activities have moved back to in-person this past fall. Recruitment by companies has accelerated with over 130 different companies participating in the Fall 2021 Engineering and Computer Science Connections Fair, where employers could attend either in-person or virtually.

Diversity Success

The Engineering Student Success (ESS) Scholars program of the Washkewicz College of Engineering has been recognized by the magazine INSIGHT into Diversity, receiving its 2021 award for "Inspiring Programs in STEM".

The ESS Scholars Program is designed to support underrepresented minorities pursuing engineering and computer science degrees. In the 2021–2021 academic year, the fourth cohort was welcomed for a total of seventy students participating this year.

The scholars have been engaging in workshops which focus on time management and note taking skills, stress management and study skills, financial literacy, and networking etiquette. Other workshops have been offered for additional instruction in calculus, physics, and chemistry. The program started a new initiative called the "Lunch and Learn" series where companies host an informational session to talk about the company and their the co-op/internship opportunities, and allows the scholars another means to network.

The first cohort of ESS scholars graduated in May 2021. "We are very proud of our seven scholars who graduated this year", said Angela Benton-Smith, Program Manager of Engineering Diversity and Director of the ESS Scholars Program. "They are the first group to graduate from our program and they are all gainfully employed in their respective engineering disciplines."

Welcome to Our New Co-op Senior Manager!

This year, the Washkewicz College of Engineering welcomed Erin Elosh, the new Sr. Manager of the Fenn co-op program of the Washkewicz College of Engineering. She joined Cleveland State University after having over 15 years of experience in different roles in the Engineering Co-op and Placement Office at The University of Akron, from Student Assistant to Assistant Director. During her time at The University of Akron, she completed a Bachelor's of Science degree in Mechanical Engineering, which included two co-op semesters at Philips Medical Systems in Highland Heights, OH. She also received a Master's of Science degree in Human Resources Management which she decided to pursue due to her involvement in co-op and student placement.

Erin is passionate about helping to ensure students are career-ready and to provide them with as many opportunities as possible to gain real-world experience prior to graduation. She will be maintaining established relationships with engineering employers, as well as developing relationships with new employers that will benefit the Washkewicz College of Engineering overall.

Outside of the office, she enjoys watching football and hockey, listening to music and doing jigsaw puzzles.

To contact her via email: e.elosh@csuohio.edu.

Erin Elosh, Senior Manager of Cooperative Education

Couple Pays it FORWARD *by Establishing* ENDOWED FUND

ALUMNUS THEO KEITH ('64) vividly remembers his journey to obtain a degree in mechanical engineering. Theo and his wife Sandra (Finzel) Keith have first-hand experience of the financial challenges that had to be overcome to obtain the degree. They wanted to help reduce this burden by providing financial assistance to motivated engineering students.

For this reason, they chose to pay it forward by establishing the Keith Scholars Endowed Scholarship Fund. The fund can benefit any engineering student, with a preference for women. "There's not enough women in engineering," said Theo. Since its establishment in 2018, the Keith Scholar Fund has impacted nine engineering undergraduate students. Three of the nine students are women, while the remaining six are men from underrepresented groups.

Both Sandra and Theo grew up on the west side of Cleveland. Sandra graduated from John Marshall High School, and Theo from West Tech High School. They met in the summer of 1957, when both worked in the Cleveland Athletic Club building on Euclid Avenue. Theo worked as a draftsman for an HVAC professional engineer, and Sandra (and her identical twin sister) worked in a loan office.

After dating for a few years, they became engaged, and Theo took a job in the property records department of the East Ohio Gas Company located at East 9th and Superior. At night and on weekends, he worked at a gas station at 130th and Lorain. Sandra worked as a biller at the Cleveland Electric Illuminating Company on Public Square.

Just before the pair married, Theo quit his job at EOG, while Sandra continued to work at CEI. They'd saved enough money for Theo to enroll at Fenn College to pursue a Bachelor of Science degree in mechanical engineering, purchase textbooks and buy a slide rule. When Theo was an undergraduate engineering student, Fenn College was a private, mandatory co-op school. Fenn College later became part of CSU in 1964.

"The only reason I'm here today is because of the co-op program," said Theo. "I went to Fenn College because we had no money. The co-op program enabled me to staircase my way to a degree by alternating work and school. I graduated not owing a single penny. That's not always true for students today."

Theo and Sandra Keith

THE FUND CAN BENEFIT ANY ENGINEERING STUDENT, WITH A PREFERENCE FOR WOMEN.

> "THERE'S NOT ENOUGH WOMEN IN ENGINEERING."
>
> THEO KEITH

After two quarters, Theo took his first co-op assignment with RCA, located in Cambridge, Ohio – a two-hour drive from Cleveland. On Sunday night, Theo drove to Cambridge, and returned to Cleveland on Friday evenings. At RCA, he performed industrial engineer duties. They were pleased with his work and invited him to return. However, Theo did not want to continue traveling and was more interested in a position that was related to mechanical engineering.

Theo's co-op advisor recommended he consider a metallurgical technician position at the American Steel and Wire Company, part of U.S. Steel. The position went well and Theo co-oped there until graduation.

Toward the end of Theo's senior year, he accepted a government position as a naval engineer at the U.S. Navy Marine Engineering Laboratory in Annapolis, Md. Having been a co-op student enabled Theo to enter government employment at a higher grade, and during his eight years at the laboratory, he worked on computer modeling of the emergency de-ballasting system on a nuclear submarine and various propulsion problems. During this time, he also earned his masters and Ph.D. degrees from the University of Maryland College Park.

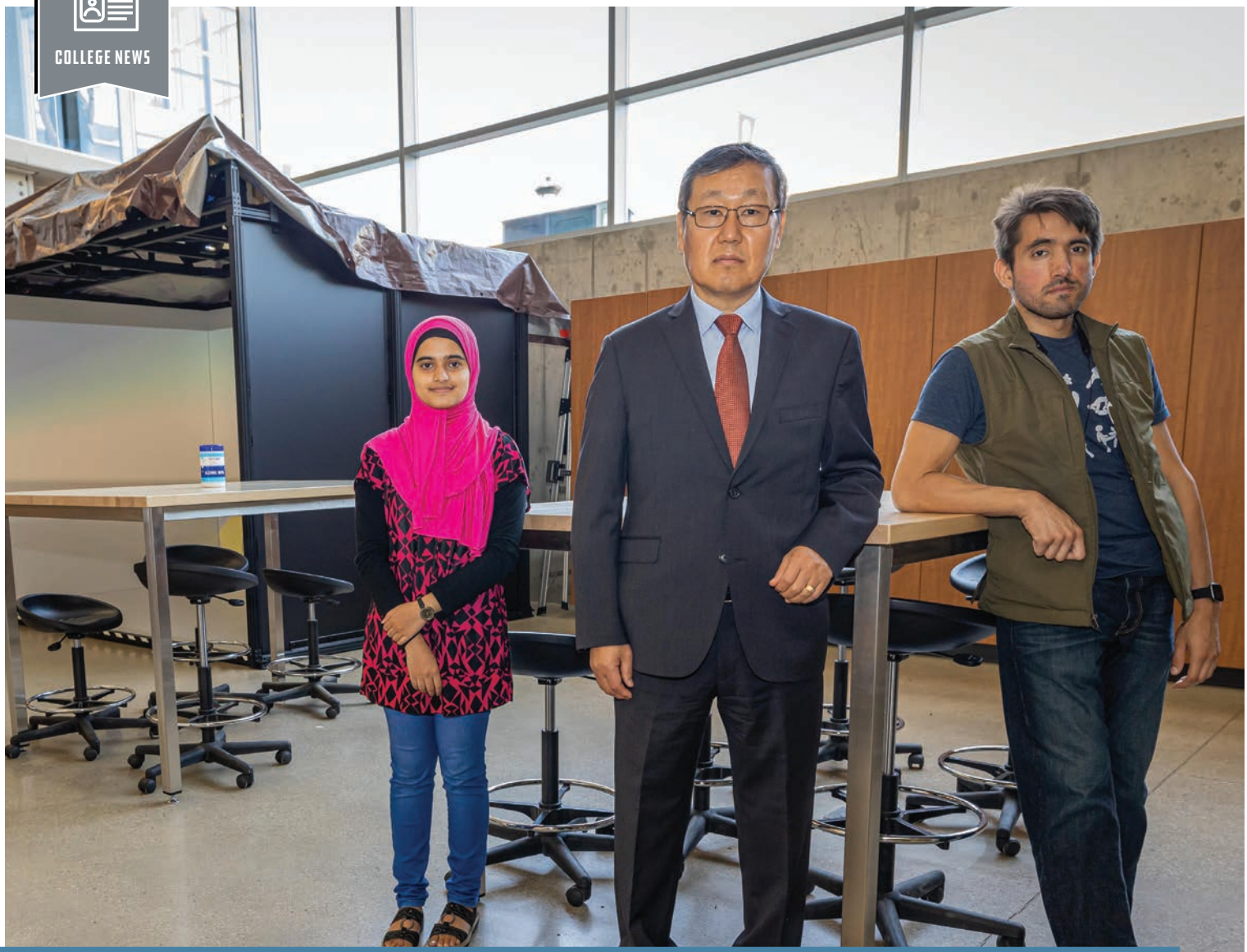
Theo's graduate advisor, Dr. James John, became chairman of the mechanical engineering department at the University of Toledo (UT) and invited Theo to come along. Theo joined UT in 1971 as an assistant professor. He served as mechanical engineering department chair for nearly eight years, and was promoted through the ranks to full professor. Subsequently, he was selected as one of 10 distinguished university professors — the highest academic rank at UT — and was reappointed for two additional five-year terms.

Fifty years after joining UT, Theo still works there as a distinguished university professor emeritus. Over those years, he's enjoyed many accomplishments. He taught numerous courses, many at the NASA Glenn Research Center. He served as principal investigator or co-principal investigator on hundreds of research awards totaling over $70 million in external funding in support of research. He advised or co-advised the theses research of 54 MS students and 34 Ph.D. students. He authored or co-authored hundreds of technical publications. And along with his graduate advisor and friend Dr. James John he co-authored a textbook on Gas Dynamics, published in 2006. He received UT's Outstanding Teaching award, Outstanding Research award and Outstanding Grantsmanship award. He's an ASME Fellow, STLE Fellow and AIAA Associate Fellow.

In addition, Theo worked part-time at the Ohio Aerospace Institute (OAI) for 10 years. He was OAI's first research director, and vice president of workforce enhancement. He was invited to serve as director of research and technology at NASA Glenn Research Center and worked there for two years.

On behalf of the students the Keith Scholars Endowed Scholarship Fund will benefit, we offer a heartfelt "thank you" to Theo and Sandra Keith for their generous donation.

Interested in scholarships? Please visit engineering.csuohio.edu/scholarships



THE VIRTUAL MAKERSPACE *is Ready to Use*

Above photo: Undergraduate computer science students Khorshid Mohammad (left) and Evan Benitez (right) with Dr. Chansu Yu, Professor in the Department of Electrical Engineering and Computer Science, in front of the VR room.

Khorshid Mohammad running a simulation in the VR room with Dr. Chansu Yu

CLEVELAND STATE UNIVERSITY STUDENTS and Northeast Ohio workers have a new entry point to the worlds of virtual, augmented, and mixed reality. CSU's Virtual MakerSpace, housed in the Dan T. Moore MakerSpace of the Washkewicz College of Engineering, will allow students and incumbent workers to develop and experience digital simulations that develop new skills and enable new forms of job training.

First, some definitions: Virtual Reality (VR) simulations are fully computer generated, self-contained environments meaning that you only interact and "move" in the virtual world. Augmented Reality (AR) environments overlay digital elements on real world objects, while Mixed Reality (MR) allows you to interact with the virtual environment that is projected onto real world objects.

The Virtual MakerSpace currently includes two types of digital experiences. One is a Visbox M4 CAVE system, a self-contained VR room with immersive virtual reality images projected onto three walls and the floor. Users wear custom goggles that decode the 3D imagery and track the position of the user's head to provide accurate perspective. Multiple users can enter the room to share the experience.

Virtual MakerSpace users can also try AR and MR using one of the Microsoft HoloLens2 units, which are wearable headsets with holographic projectors just in front of the users' eyes. The HoloLens overlays digital objects on the physical world, and allows the user to move freely and interact with the digital objects using hand gestures.

A wide range of industries are adopting VR, AR, and MR as part of their product development and training activities. For example, instead of building a miniature or mockup of a piece of equipment, or simply relying on a drawing on a computer screen, an engineer can visualize a full-size rendering of the equipment and where it will fit on a factory floor.

Similarly, augmented or mixed reality can be used to guide a worker assembling complex parts to improve quality and avoid costly rework. In health care applications, digital simulations provide much more flexibility to update or modify training compared to, for example, using training dummies.

This new capability was made possible through funding from the Ohio Department of Higher Education's Regionally Aligned Priorities in Delivering Skills (RAPIDS) program. RAPIDS investments target workforce development initiatives at postsecondary institutions that focus on furthering the career aspirations of students and the economic growth of businesses in the region.

The Virtual MakerSpace equipment is intended to support career growth in a range of fields like engineering, graphic design, and software development, as well as supporting jobs like electrical and electronic equipment assemblers, industrial machinery mechanics, medical equipment repairers and welders.

Nigamanth Sridhar Serving as Program Director at the National Science Foundation

Nigamanth Sridhar, Ph.D., professor in the Department of Electrical Engineering and Computer, is currently serving as a program director at the National Science Foundation under an Intergovernmental Personnel Act arrangement.

Dr. Sridhar is in the Division of Graduate Education in the Education and Human Resources Directorate. At NSF, Dr. Sridhar's program responsibilities are primarily in the area of cybersecurity education and workforce development, by way of the CyberCorps® Scholarship for Service program and the Secure and Trustworthy Cyberspace program.

In addition, Dr. Sridhar is also focused on broadening participation initiatives, namely NSF INCLUDES and Racial Equity in STEM Education.

Top-left: The conference organizer, Dr. Brian Davis; Right: The three co-chairs from left to right: Shaye Tiell, Brittany Sommers, Lexie Mallinos; Bottom left: Attendees at the conference

CSU Hosts the 2021 American Society of Biomechanics Midwest Conference

The 2021 Midwest American Society of Biomechanics (ASB) Conference was held in the Wolstein Center at Cleveland State University on September 15–17, 2021. ASB is a national biomechanics organization that meets annually for its national conference and sponsors regional meetings throughout the year.

This was the first in-person biomechanics conference held in two years and attracted over 130 attendees, who came from as far as Louisiana, Massachusetts and New York to attend.

While this is an expanded definition of the term "Midwest," it shows the enthusiasm attendees had for this meeting. The conference was largely student-run, organized by Brittany Sommers, Ph.D. student, Mechanical Engineering; Lexie Mallinos, Ph.D. candidate, Applied Biomedical Engineering; and Shaye Tiell, Ph.D. student, Applied Biomedical Engineering – with the help of faculty organizer Brian Davis, Ph.D., associate dean of engineering.

All the organizers are members of the Center for Human Machine Systems, a sponsor of Midwest ASB. The conference would not have been possible without the support of CSU's Center for Human Machine Systems, major sponsor Parker Hannifin Corporation, and six other companies that focus on instrumentation in the field of biomechanics.

Looking Back

In the past year, several colleagues from the Washkewicz College of Engineering retired. We thank them for their services, hard work and collegiality, and we whole-heartedly wish them best of luck in their future endeavors.

David Epperly

DAVID EPPERLY, the model maker and machinist of the College, retired in early 2021 after 34 years at CSU. Epperly considers his position at CSU "a blessing," in that he used his talents to help others solve problems they encountered in their research and teaching.

"I did everything from oiling a squeaky wheel on someone's chair to helping prepare objects to go into space," Epperly said. "Some of these jobs were highly technical."

For example, he helped create a patented device to create ultra-pure water, even from water of poor quality.

Epperly used lathes, mills, drills, grinders, saws and "all the things you need for the creative process."

"In today's world, everything is computer-controlled. But in the environment that I was in, "everything was done manually," he added.

"Whoever needed my services — professors, students — their needs were all different. You may have three requests for something to be welded, but those objects could all be of different material. So, it was very versatile."

As a child, Epperly had an insatiable curiosity for how mechanical objects work. This evolved into a desire to know how those objects are made. This thirst for knowledge drove him throughout his career.

During his years at Collingwood High School, part of the Cleveland Metropolitan School District, Epperly developed a strong technical preference in math and machine shop. He spent summer break working in a machine shop, which set him, as he said, "on a quest" for how to make things.

"Cleveland was a highly industrious area back in the 60s," Epperly said. "We had the railroads and there was so much machining going on."

On his 17th birthday, July 16, 1969, Apollo 11 launched with three astronauts on board. Epperly excitedly listened to it on a radio at the shop. Four days later, man walked on the moon for the first time.

"Every radio station had it on, but my anxiousness was not to miss it. It was going to be on TV, but I was a kid making $1.65 an hour. This was my job, I had to be there. Work ethic started early," he said.

Following graduation in 1972, he enlisted in the United States Navy for four years, serving two Mediterranean cruises on board the USS Forrestal aircraft carrier. There he was trained to perform structural maintenance on a Grumman A-6 Intruder attack aircraft, such as sheet metal fabrication, hydraulic systems, landing gear and brakes, plastics, honeycomb structures and environmental systems.

One part of his Navy experience which he found "thrilling" was as a flight deck trouble shooter. He performed the aircraft's final inspection during the launch sequence from the carrier.

"As can only be described as an astounding feat of engineering, is when 56,000 pounds of metal, fuel, ordnance and two humans travel down the flight deck of 250 feet, going from a standstill, being held back by a hold back fitting that breaks at a predetermined tensile strength, being propelled by a steam catapult and engine thrust to 150 mph and airborne," said Epperly.

After honorable discharge, he worked for Lear Siegler Incorporated. There, he made some of the same types of aircraft parts he'd worked on in the Navy. He learned numerical control (NC) and computer numerical control (CNC) setup and operation of lathes and machining centers.

He was also cross trained in other material processes, such as heat treating, surface grinding, and gear hobbing and broaching – which continued to feed his appetite for how things are made. He went on to make oil drilling equipment as night shift CNC supervisor at PMC Industries.

"The manufacturing processes are the same, but the size and weight of the product went from pounds to tons," said Epperly.

These work experiences prepared him for the position he held at CSU. But throughout his career, he said "working with people was the greatest experience of all. I just loved it. I can't imagine having another job so fulfilling."

Harry Fox

PROFESSOR HARRY FOX retired from the Department of Engineering Technology, after 20 years at CSU. Professor Fox started his professional career as a project engineer at the NASA Lewis Research Center (now NASA Glenn Research Center) in the late 1960s, working on nuclear rocket cold flow start-up dynamics. Over the next thirty years, he worked in a variety of research and training capacities in private industry and education.

Fox was the director and supervisor of instruction at the Cleveland Institute of Electronics until 1976, then joined the Republic Steel Research Center, serving as a processing technologist and senior processing technologist, and then worked on innovations in energy conservation in steel plants. He then became a senior staff engineer at Picker International until 1991, consulted for TAD Technical Services/Kirk-Meyer, Inc., and then spent five years as a field technical instructor and senior engineer at Rockwell Automation, before joining CSU in 2001.

Fox served as the program coordinator of the Electronics Engineering Technology Program (EET) and as interim department chair from 2005 to 2006. He taught a wide range of courses, from thermodynamics and fluid mechanics to numerous electronics courses, as well as Robotics and Robotics System Design. He also taught the senior design capstone project and several special topics courses.

He developed a web-based version of the Advanced Circuit Analysis course suitable for asynchronous distance learning in 2002, far in advance of the need for distance learning brought about by the COVID-19 pandemic, 18 years later. He also developed a web-based robotics laboratory course and presented and published on using robotics to enhance outreach programs to high school students, as a feature of senior design capstone projects, and robotics applications in engineering technology education.

His research experience includes being a NASA summer faculty fellow from 2004 until 2006.

Professor Fox received a B.S. in electrical engineering from Case Institute of Technology (now Case Western Reserve University) and an M.S. in electrical engineering from the University of Southern California.

Rolf Lustig

DR.-ING. HABIL. ROLF LUSTIG received his Diploma from the University of Hannover in 1981 and his doctorate from Ruhr-University Bochum in 1985, both in Mechanical Engineering. After a two-year postdoctoral appointment in the Chemistry Department of Pennsylvania State University, he returned to a faculty position at the Institute of Physical Chemistry at Aachen University of Technology (RWTH Aachen) in Germany.

He successfully finalized his Habilitation in Physical Chemistry in 1994, leading to the highly prestigious Heisenberg Fellowship Award from the German Research Foundation in 1995. The Award came with a five-year sabbatical leave from his faculty position at RWTH.

Dr. Lustig spent this time to deepen his understanding of the fundamentals in his field of expertise, Statistical Thermodynamics. Most of his work during this period was conducted again at Penn State. In 2000, he decided to stay in the United States for family reasons and accepted a faculty position as an Assistant Professor in the Department of Chemical and Biomedical Engineering at Cleveland State University. Dr. Lustig was promoted through the ranks to Professor.

Dr. Lustig's main interests are in the application of his expertise to Molecular Simulation. Over the past decades, this field has evolved from being an academic luxury to serious attempts to replace costly laboratory experiments on the thermophysical properties of matter by numerical experiments on High Performance Computing (HPC) systems.

In this method, a system of about a thousand model molecules are moved around in a virtual box to mimic real molecular behavior.

During his time at CSU, Dr. Lustig has developed novel, rigorous methodologies to measure the entirety of thermodynamic properties simultaneously in a single molecular simulation. As a result, complete equations of state can be simulated in a matter of weeks, as opposed to decades in an actual laboratory.

He takes pride that these methodologies led to the first computer-generated equation of state with an accuracy high enough to serve as scientific standard. This work was done in an international collaboration with two German research groups and was published in the Journal of Physical and Chemical Reference Data in 2016.

There are many by-products of Dr. Lustig's work in the fundamentals of Statistical Thermodynamics. He has published several highly cited papers on pure mathematics. Recently, a highly accurate and purely theoretical equation of state for atomic solids has been derived by him. Sophisticated data correlation methods for thermodynamic properties are another active field of his research.

As a curiosity, Dr. Lustig's research partners in Germany hold the world record for the largest molecular system ever simulated: twenty trillion particles on one of the most powerful HPC systems in the world. Dr. Lustig himself holds the world record for the smallest system ever simulated: Three atoms were shown to undergo a solid-fluid phase transition on his modest computing equipment at CSU.

This was his latest work published before his retirement from higher education. It will certainly not be his last.

Majid Rashidi

MAJID RASHIDI, PH.D. joined the Department of Mechanical Engineering in 1987 as an assistant professor and was promoted through the ranks to professor. Dr. Rashidi held the position of the Betty L. Gordon Distinguished Professor from 2009 until 2014.

The teaching and research areas of Dr. Rashidi include medical device design, renewable energy devices, machine systems and machine component design, dynamics of gear trains, design/analysis of rotating machinery, design for manufacturing (DFM), vibrations of machinery and fluid-solid interactions in machinery.

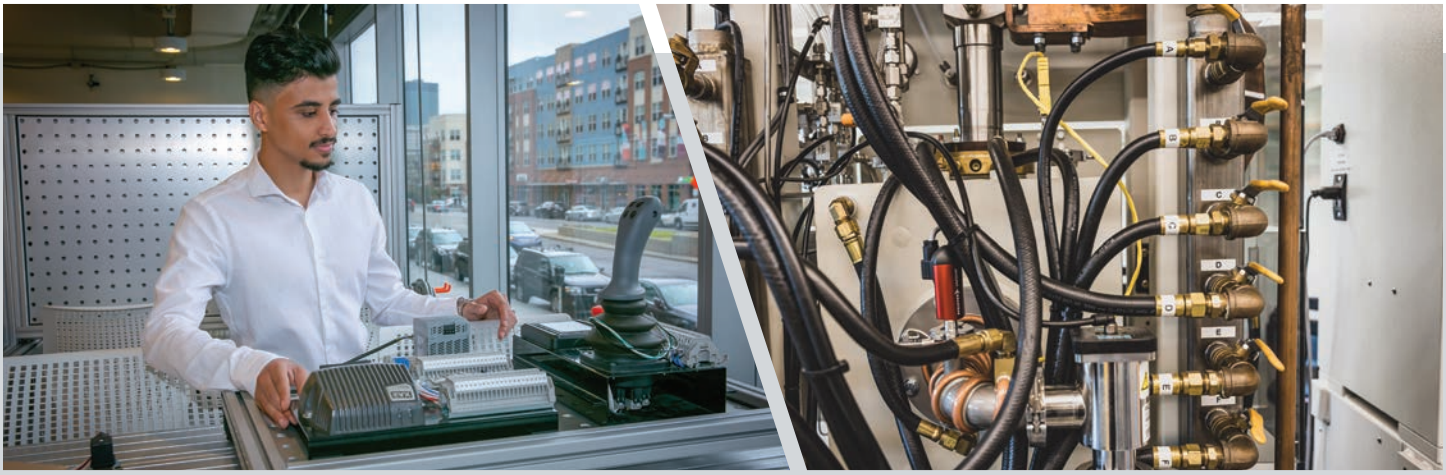
Dr. Rashidi has 34 years of machine design experience related to real-world engineering problem solving. Dr. Rashidi's work on innovative wind harnessing systems, supported by the U.S. Department of Energy and the State of Ohio, was featured in many national and international journals and publications, including *The New York Times*, *Business Week*, *Reuters*, *Popular Mechanics* and *Wind Tech-International*. His research work has resulted in numerous publications and 14 patents, and an additional patent pending in the area of a cardiac pacemaker lead design. His most recent work on a medical device – indicated for the treatment of sleep apnea – has received two U.S. patents.

He was CSU's Principal Investigator of a 3-year grant from the NSF, collaborating with Cuyahoga Community College, to develop a curriculum for STEM education for high school students to prepare them for university engineering programs. He developed a course called "Math-in- Motion" during this NSF Project.

In his tenure at CSU, Dr. Rashidi has taught all the courses related to machine design and solid mechanics offered by the Mechanical Engineering Department at CSU. He also developed and taught a course in the Mechanics of Living Tissues.

On July 19, 2019, the "Dr. Majid Rashidi Endowed Scholarship" fund was created by friends, family, and colleagues of Dr. Majid Rashidi to honor his commitment to student education over the past three decades. Dr. Rashidi's scholarship is intended to support graduate student(s) in the Department of Mechanical Engineering of the Washkewicz College of Engineering of CSU.

He is an alumnus of Case Western Reserve University, where he received his Ph.D., M.S., and B.S., all from the Mechanical and Aerospace Engineering Department. Before joining CSU, he spent a year at NASA Glenn Research Center.



Dan Simon

DAN SIMON, PH.D. joined the Department of Electrical Engineering and Computer Science at CSU in 1999 as an assistant professor. Prior to joining CSU and early in his career, he worked for Boeing Aerospace to design and test satellite control software, which, at the time, ran on a computer with 8 KB of memory and was the size of a suitcase.

Dr. Simon worked in a variety of industrial positions: analyzing guidance and navigation systems for missiles at TRW; designing computer intelligence algorithms for air bag analysis at TRW Vehicle Safety Systems; designing guidance and navigation systems for self-piloted agricultural vehicles with Satloc Precision GPS; designing software for infrared-based blood sugar detection for Instrumentation Metrics; and designing software for process control at Factory Automation.

He also provided consulting to companies through Innovatia Software, his own company, and taught at the University of Akron as an adjunct professor.

At CSU, Dr. Simon's first grant was for surgical mattress pressure control from the Cleveland Clinic Foundation in 2000. Since then, his research has been supported by NASA, the National Science Foundation, Cleveland Clinic, Ford Motor Company and several industrial organizations.

For several summers, Dr. Simon worked at the NASA Glenn Research Center as a summer faculty fellow. This work involved state estimation for aircraft turbofan engine health diagnosis and indirectly led to his first book, Optimal State Estimation, published in 2008.

Dr. Simon has since published two other textbooks: Evolutionary Optimization Algorithms (2013), and Evolutionary Computation with Biogeography-Based Optimization, written with Haiping Ma (2017).

He served as the Associate Vice President for Research from 2015 to 2020, organizing internal research funding programs, monthly research newsletters, annual research magazines, undergraduate poster sessions, faculty seminars, and proposal writing courses.

Dr. Simon taught courses at CSU on electric circuits, digital electronics, control theory, computer intelligence, embedded systems and technical writing. He also taught short courses for the Applied Technology Institute, which specializes in professional training for scientists and engineers. Dr. Simon supervised seven Ph.D. dissertations and 33 master's theses and has three Ph.D. students who are in the process of graduating.

In addition to his three textbooks, Dr. Simon has written over 200 peer-reviewed journal and conference papers, and which have been cited almost 20,000 times.

He is especially proud of his CSU students, particularly those who conducted research and published with him. One of his Ph.D. students, Saman Khademi, won the CSU Research and Creative Scholarship Award in 2018; another Ph.D. student, Hanieh Mohammadi, won the same award in 2019; and his current Ph.D. student, Mohamed Abdelhady, won the CSU Excellence Achievement Award in Research this year.

"The thing that's really inspiring to me about engineering is that it boils down to the surprising fact that the world can be described and improved using the primary tool of mathematics," says Dr. Simon.

"Engineering is essentially applied math. It doesn't make sense that everything in the universe, from the smallest subatomic particle to the largest galaxy, can be described using math," he added. "But it can, and so we use math to study the world, understand it, and even improve it."

He received a B.S. in electrical engineering from Arizona State University, a M.S. from the University of Washington, and a Ph.D. degree from Syracuse University.

After retiring from CSU, Dr. Simon and his wife are beginning a new career in humanitarian work and religious ministry in Brazil, building on several years of their work with orphanages and missions.

Orhan Talu

ORHAN TALU, PH.D. joined Cleveland State University as a tenure-track assistant professor in the Chemical and Biomedical Engineering Department in 1986 and was promoted through the ranks.

He served as Department Chairman of the Department of Chemical and Biomedical Engineering, Director of the Doctor of Engineering program, and Associate Director of Industrial Services and Contracts at the Fenn Research and Development Institute.

In addition, he served as Director of Applied Biomedical Engineering, where he established the collaboration between the College of Engineering of CSU and the Cleveland Clinic Foundation.

Dr. Talu received many awards and recognitions at CSU, including the Distinguished Faculty Award for research, and students voted him Most Outstanding Faculty Member three times.

He maintained a record of excellence as a scholar at CSU, including 56 publications and 2,574 citations, and received over $5M in total research funding. These grants helped establish a well-equipped, state-of-the-art solid-fluid interfacial phenomena laboratory at CSU.

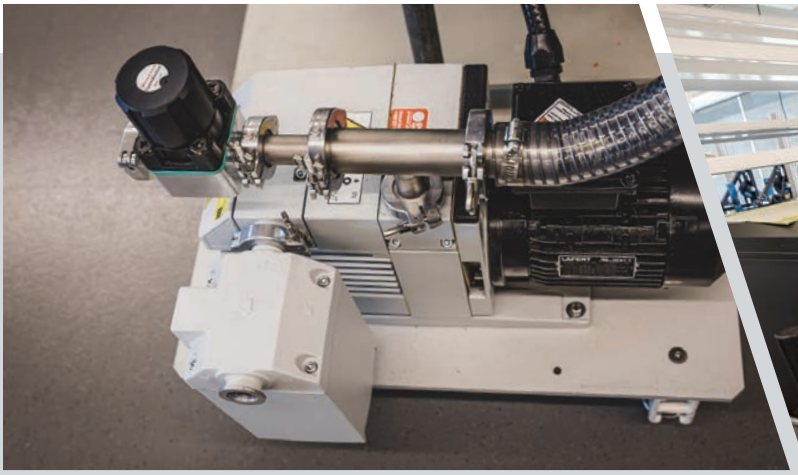
He was advisor to 43 graduate students, many supported by his research funds. Through this research, he became an internationally recognized scholar in solid-fluid interfaces (adsorption phenomenon).

Dr. Talu also served as a chair or member in 39 CSU committees at the department, college and university levels. He performed numerous roles in scientific societies, most notably as president of the International Adsorption Society which features members from 130 countries.

He also was chair for the international Fundamentals of Adsorption conference in 2004, which was attended by 330 scientists from 41 countries. He participated in programming committees for 10 conferences and meetings and organized 23 symposia.

Dr. Talu is also a charter member of the National Academy of Inventors.

Dr. Talu earned his Ph.D. and M.S. in Chemical Engineering from Arizona State University. He earned his B.S. in Chemical Engineering from Middle East Technical University in Ankara, Turkey.



Geyou Ao Receives NSF Grant for Generating Crystals of Boron Nitride Nanotubes

Geyou Ao, Ph.D., assistant professor in the Department of Chemical and Biomedical Engineering, has received a three-year, $353,903 grant from the National Science Foundation for *Establishing Liquid Crystals of Boron Nitride Nanotubes for Aligned Assemblies*. Dr. Ao will collaborate with Brian Davis, Ph.D. from the Washkewicz College of Engineering for STEM outreach and Geoff Wehmeyer, Ph.D. from Rice University for the thermal conductivity measurements. The research involves several disciplines including manufacturing, liquid crystal science, nanotechnology and engineering. The multidisciplinary project will also provide research opportunities and skillsets to CSU students.

The NSF grant supports fundamental research to provide the framework for establishing liquid crystals of boron nitride nanotubes – a lightweight nanomaterial with excellent thermal conductivity while being an electrical insulator. These material properties meet the critical need for manufacturing electrically insulating thermal interface materials (TIMs) for the next generation electronics as well as high strength fibers for protective textiles.

The objective of this research is to test the broad hypothesis that lyotropic, chiral nematic liquid crystals can be obtained from the cellulose nanocrystal-templated nanotube system and the ordered liquid crystalline structures can be translated into solid assemblies for property enhancement. This can establish the structure-processing-property relationships of the new nanomaterial system. The cellulose nanocrystal matrix – a renewable and low-cost nanomaterial that is known to form chiral nematic liquid crystals – will be utilized as a structural template for forming liquid crystals of boron nitride nanotubes.

The long-term goal is to establish a rational framework for the advanced manufacturing of nanomaterial assemblies with tunable structures and properties for developing high-performance TIMs for electronics and high-strength protective fabrics against elevated temperature, radiation and hazardous chemicals in many settings from medical to defense applications.

Tushar Borkar Receives Grant from Advanced Technology International to Evaluate Oxidation-Resistant Coatings

Tushar Borkar, Ph.D., associate professor in the Department of Mechanical Engineering, has received $699,397 from Advanced Technology International for the three-year project titled *Evaluation of Oxidation-Resistant Coatings on Forging Billet*. Forged steel parts are used extensively within the Defense Logistics Agency (DLA), the U.S. Department of Defense (especially in ground-based systems and armaments) and commercial marketplaces. Oxidation and decarburization of steel billets is a critical challenge particularly in forging industries especially during the heating of steel to elevated temperatures. This is a major concern for the steel industry because decarburization and oxidation result in problems for forging companies.

This project will develop a cost-effective and efficient method for applying commercial coatings on forging billets to prevent the oxidation and decarburization that occur during pre-heating. Identifying such a method will be a truly innovative aspect of this project. In order for the coating to be implemented in a production environment, the application method will need to be efficient and cost effective. The project will explore automated and robotic application methods to reduce the cost of application, improve cycle times and provide additional safety to the operator.

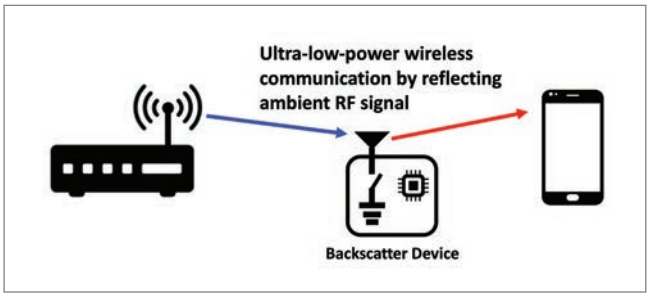
The benefits of this project will extend well beyond the forging industry and will involve other steel manufacturing operations that face quality problems due to oxidation, and scaling during processing at high temperatures.

Zicheng Chi Receives NSF Grant to Improve Spectrum Use of IoT Devices

Dr. Zicheng Chi, assistant professor in the department of electrical engineering and computer science, has received a $349,999 National Science Foundation grant for a three-year project titled *Effective Spectrum Utilization for Coexisting Active, Semi-passive and Passive IoT Systems*.

The number of Internet of Things (IoT) devices has been exponentially increased. By connecting billions of sensors, actuators, and various smart objects to the Internet, IoT will produce an unprecedented amount of information for making more informed decisions in numerous public and private sectors. IoT devices are connected via different types of communication networks (i.e. LTE, WiFi, ZigBee). To support future IoT devices, backscatter provides high spectrum efficiency by reusing existing RF signal; it can lead to energy-efficient communication; and is low cost.

The goal of this project is to design a frequency agnostic backscatter system that can operate across different wireless protocols and frequency bands and has the potential to be deployed at different locations. A holistic solution has been proposed to address the challenges of spectrum utilization and coexistence among active, semi-passive, and passive IoT devices across different frequency bands. Specifically, hardware solutions, cross-layer designs, and networking technologies to address these challenges will be developed.

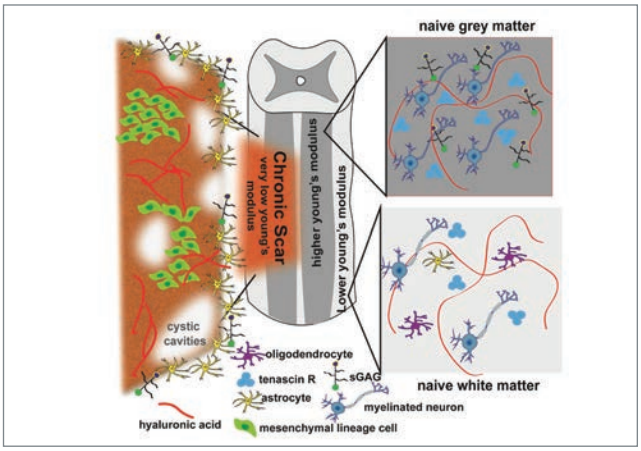


Chandra Kothapalli Receives NSF Grant to Study Spinal Cord Injuries

Chandra Kothapalli, Ph.D., associate professor in the Department of Chemical and Biomedical Engineering, has been awarded $299,996 from the National Science Foundation for the project *Glial scar morphology informed tunable biomimetic platforms for spinal cord injury*. The motivation for this project has been that spinal cord injury (SCI) results in loss of cells and blood supply, disruption of brain connectivity to various tissues, and formation of a dense scar around the injury site. This ultimately results in permanent loss of mobility and other cognitive functions. There are no proven clinical solutions or pharmaceutical interventions to reverse SCI.

Dr. Kothapalli will be collaborating with Nic Leipzig, Ph.D. from The University of Akron to first understand the physical, chemical and biological changes occurring over time in the injured spinal cord tissues. The investigators will use that information to develop improved mimics of such injured tissues, combining important structural, mechanical and inflammatory aspects. Finally, they will test the response of various cells resident to the spinal cord, and evaluate the efficacy of pharmaceutical drugs in promoting spinal tissue regeneration.

The research goals will lead to the development and validation of biomimetic systems that improves our fundamental understanding of SCI, enables new testing platforms, and generates new insights into how nerve cell outgrowth and targeting is inhibited in an inflammatory injured tissue. The significance of this work is linked to the potential of cellular engineering technology to enable injured spinal tissue repair, specifically for thousands of Americans who suffer from such injuries every year. In addition, many opportunities will be available for the scientific education and research training of high school, undergraduate and graduate students, as well as summer internship and outreach programs.



Eric Schearer and Associates Receive Grants from NSF

Physical Rehabilitation Engineering

A transdisciplinary team from the CSU Center for Human-Machine Systems was awarded a three-year, $450,022 Research Experiences for Undergraduates site program from NSF. The team includes faculty from mechanical engineering (Dr. Brian Davis, Dr. Hanz Richter, Dr. Eric Schearer, and Dr. Antonie van den Bogert), health sciences (Dr. Debbie Espy and Dr. Ann Reinthal), and health and human performance (Dr. Douglas Wajda). The program, *Rehabilitation Engineering at Cleveland State University (RE@CSU)*, offers an immersive experience in rehabilitation research that will help motivate and prepare a diverse group of students to pursue careers in rehabilitation engineering and assistive technology.

The number of people with disabilities will increase in the United States in the coming decades due to an aging population and advances in medicine that extend the lives of people with chronic diseases and victims of traumatic accidents, such as car crashes. Despite the national need for rehabilitation technology, opportunities to enter the field of rehabilitation engineering are limited for many students and there is a critical need to increase and diversify the population of students equipped to pursue careers in rehabilitation engineering and assistive technology. Therefore, the overall objectives of this project are to immerse a diverse group of undergraduate engineering and computer science students in the challenges of developing technology to restore daily function to people who have limited ability to move their arms and legs; motivate students to pursue future opportunities in rehabilitation and assistive technology; and empower students to succeed in careers in rehabilitation and assistive technology.

Over the three-year period, the RE@CSU program will engage undergraduate students in a 10-week intensive, original and creative hands-on summer research and professional development/training experience centered around integrated learning communities that surround students with their peers, mentors, medical professionals and people with disabilities. This program has a special emphasis on participation of students with disabilities and scholarship focused on understanding best practices in facilitating participation. More info on RE@CSU can be found at engineering.csuohio.edu/recsu

Assistive Robotics

People who are paralyzed from the shoulders down rely on 24-hour care to complete basic daily activities. Restoring arm and hand function would greatly increase their independence. Assistive robotics and functional electrical stimulation can potentially restore arm and hand function, but each has significant drawbacks. The objective of this $305,986 NSF-funded project is to develop a cooperative control strategy for functional elbow and wrist movements in people with high cervical spinal cord injuries using functional electrical stimulation and a robotic exoskeleton. The results of the project will help move functional electrical stimulation and upper limb robotics from laboratory assistive technologies to wearable devices used for everyday tasks by people with full-arm paralysis.

The complementary strengths of functional electrical stimulation (FES) and assistive robotics can potentially enable people with high tetraplegia to independently feed and groom themselves. FES provides free power using a person's own muscles but cannot sufficiently control all joints simultaneously due to permanent denervation of some muscles. Assistive robots can provide additional power and control, but can be rigid, bulky and heavy. This project's objective is to develop a cooperative control strategy that demonstrates functional elbow and wrist movements in people with high tetraplegia using a hybrid FES+rigid support robot.

By maximizing the utility of muscles activated by FES, the proposed hybrid strategy will reduce the need for robot power and size, paving the way for using FES with soft wearable robotics. This project will use a rigid robot as the testbed for developing cooperative control strategies, allowing for exploration of the entire design space for future development of soft wearable exosuits coupled with FES. FES+robot assisted muscle-induced torques will be measured in real time during elbow and wrist movements. This information will feed into a coordinated FES+robot control scheme that aims to decrease robot work while maintaining tracking accuracy. Performance and robustness of the control scheme will be benchmarked for varying robot capabilities during a self-feeding task.

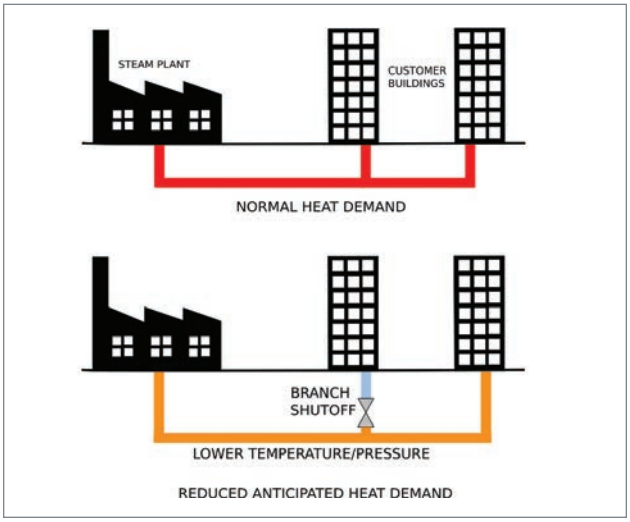
The outcome will be a model, mapping robot capabilities to task completion success, to be used to design future wearable hybrid FES-robotic systems for upper limb movement restoration. These advances will open up new research horizons in commanding and controlling hybrid neuroprostheses that could not otherwise be achieved.

Yong Tao Receives U.S. Department of Energy Grant for Efficient Energy Control Systems

Yong Tao, Ph.D., the Betty L. Gordon endowed chair and distinguished professor and chair of the Department of Mechanical Engineering, received $256,905, as part of $1.2 million grant from U.S. Department of Energy for a research project entitled *Advanced District Energy Controls for Improved Efficiency and Resilience*. The goal of the project is to investigate the advanced system control strategies that would increase the district and city-level system efficiency for more cost-effective ways of providing heat and cooling to building customers.

District energy systems have provided efficient heat and cooling to buildings in the United States for well over a century. To further expand its potential of providing customers with higher efficiencies, the research team at CSU will develop a physics-cased model to predict system efficiency under time-dependent energy demand load and discover an optimal control scheme. Sensors and surveys will be deployed to collect customer data to validate the developed model. The model analytical tool will lay a foundation for incorporating remote combined heat and power (CHP) equipment, low temperature conversions, renewable generation, and electricity microgrids with district energy systems when optimizing control.

Dr. Tao collaborates with the PI institution, Paragon Robotics, a Cleveland-based technology service company; Cleveland Thermal, a district energy company; and Andrew Thomas, an energy policy expert and director of the Energy Institute in the College of Urban Affairs at CSU. Dr. Tao's team also work closely with CSU's Office of Facilities Management on retrieving critical energy data used for modeling and analysis.



Chansu Yu Receives NSF Grant for Cybersecurity Education

Cleveland State University was awarded a $397,826 National Science Foundation grant to support an interdisciplinary initiative in which CSU's engineering, law and education colleges will collaborate to provide course instruction on legalities and legal policies for CSU students studying cybersecurity.

The need for cybersecurity – across all industries and even for our national security – is increasing every day. It is urgent that we train students in computer science and electrical engineering who are studying in areas of cybersecurity on the legal guidelines and legal compliance that are an integral part of their work. Knowing these legal parameters is critical in developing and implementing successful and effective use of cybersecurity safety nets.

At the same time, it will also help law students understand the technical aspects regarding cybersecurity issues and give them a broader perspective of the subject.

Chansu Yu, Ph.D., professor, electrical engineering and computer science at CSU and principal investigator on the grant initiative, will collaborate with three co-principal investigators, Sathish Kumar, Ph.D., associate professor, electrical engineering and computer science, Debbie K. Jackson, Ed.D., department chair of teacher education, and Brian Ray, JD, Leon M. and Gloria Plevin professor of law and director of the Center for Cybersecurity and Privacy Protection at CSU Cleveland -Marshall College of Law.

This project highlights the strong interdisciplinary relationships faculty at CSU have developed in critical technology areas like cybersecurity and data privacy and the unique approach we're taking to training students from all disciplines. CSU is becoming a leader in interdisciplinary approach to innovation and research in course instruction. The real world doesn't operate in silos, so it would make sense that educational institutions mirror that interconnectedness that exists in the real world.

DONATIONS

Thank You

A HEARTFELT THANK YOU to the 348 donors who gave $2,167,668 in gifts and pledges to the Washkewicz College of Engineering during the Fiscal Year 2021 (July 1, 2020–June 30, 2021).

Your generous support allows the College to continue providing a high-quality, affordable engineering education, along with innovative programming that helps our students succeed.

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