2019 - 2020

A Year in Review

SMART Scholar Protects Soldiers in the Field

Since beginning college, UNT student Kelly Jacques wanted to use her engineering talents to minimize the need for soldiers on the battlefield. And now, thanks to a scholarship from the U.S. Department of Defense, she is getting her chance.

"I know people in the military risking their lives every day and I've always felt that I should give something back to help them," Jacques said. "That's why I am interested in research that focuses on improving drones reliability to be used in military applications. I believe the more drones we use, the fewer soldiers will be on the ground. I want to protect people."

Jacques recently graduated from UNT's College of Engineering with a B.S. in Materials Science and Engineering. She is the 2020 recipient of the DOD's SMART (Science, Mathematics and Research for Transformation) scholarship that will cover the cost of tuition, books and living expenses as she pursues her Ph.D. She also will participate in summer internships at DOD facilities across the U.S. and, upon graduation, be employed by the DOD.

Jacques specializes in the field of tribology, the study of friction. Throughout her undergraduate career, she has conducted research into developing protective coatings that can be incorporated into the internal mechanics of a drone's fuel injection system to reduce friction in the system, especially when using a lower quality fuel. Through this research, Jacques will make drones more efficient. She wants them to stay in the air longer, go farther and fly faster.

"I am focused exclusively on the fuel injection system," she said. "In a battlefield situation, the types of fuel available for the drones can be inconsistent, which causes a lack of efficiency and increased wear and tear."

Jacques plans to complete her Ph.D. in Materials Science and Engineering in four years after which she can begin employment with the DOD.

Jim Rogers

$1M to Focus on Fundamental Bonding in Metallic Alloys

A UNT Engineering research team is working to better understand how metal alloys function at the atomic level with a $1 million grant from the Department of Defense, under the U.S. Air Force Office of Scientific Research.

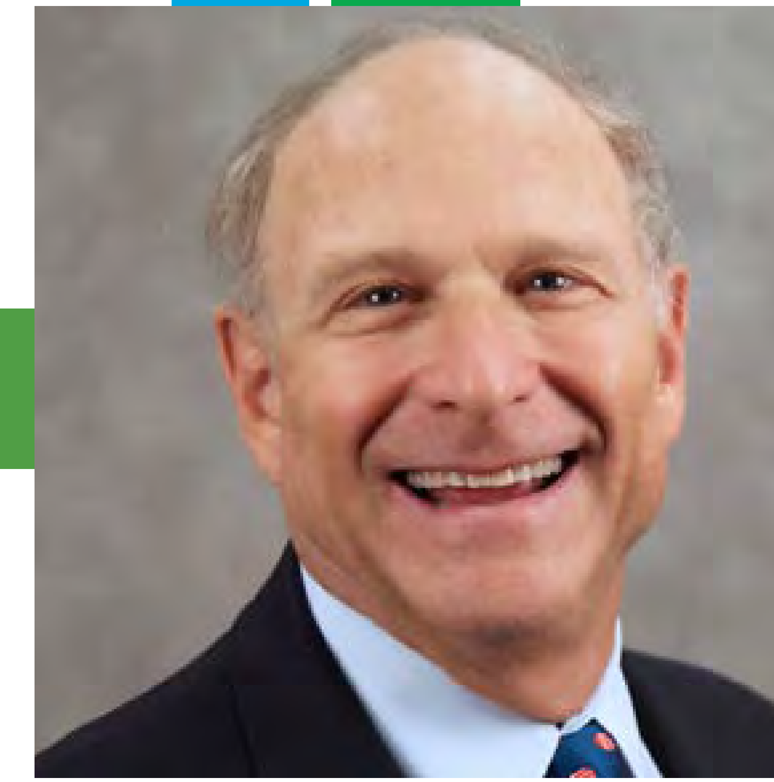
The team consists of three experts from the Department of Materials Science and Engineering: Principal investigator professor Srinivasan Srivilliputhur and co-PIs Rajarshi Banerjee, a Presidential and Regents Professor and University Distinguished Research Professor Michael Baskes, a member of the U.S. National Academy of Engineering.

Srivilliputhur, Banerjee and Baskes hope to give scientists better insight on how certain metal alloys used by the military and aerospace industries deform under stress. While engineers take stress factors into account when determining the tolerances of a material, their methods of finding the breaking point often takes place at the macro level. This could involve everything from applying pressure to a metal bar and bending it until it breaks to applying extreme temperatures.

"We are going to look at the underlying principles in metallurgy and into the atomic level," Srivilliputhur said. "Scientists have observed that when one metal is added to another, there can be a change in the properties of the resulting alloy. What we are trying to understand is why this occurs by looking at the atoms involved and how they interact rather than looking at the alloy overall."

Banerjee added that each different type of atom has a different electron shell that interacts with the electron shells of the atoms around it. When a material is made up of all the same atoms, like titanium, they all line up neatly forming a perfect lattice. But, he said, when a solute atom is added, such as an aluminum atom, the electron shells of all the atoms involved will change to a new configuration.

"The electron shells are the glue that holds the atoms together and when the glue changes, the properties change," he said.



"We know that the new configurations of atoms will change the alloy's properties," Baskes explained. "But, will the change be beneficial? Will it increase or decrease the strength or toughness of the material? We want to understand the material involved so we can predict and avoid catastrophic failure of the alloy." Baskes also added that getting such a significant grant from DOD to study a fundamental problem indicates a recognition of UNT's reputation in advanced materials research.

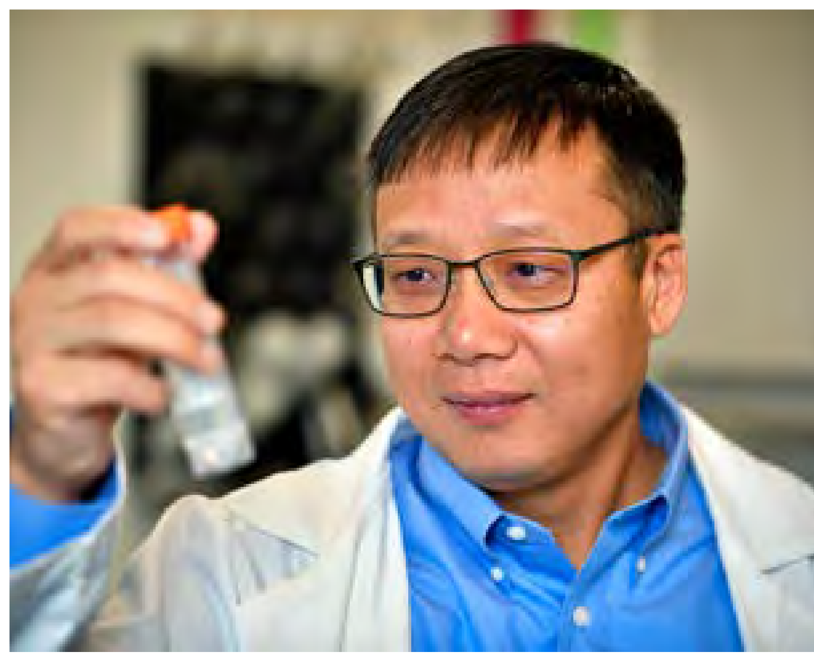
The UNT team will create a model using physical experimentation and advanced computer simulations that will allow scientists to understand exactly what properties and tolerances will result from mixing different kinds of atoms. At this time, metallurgists use a more empirical method that requires time and guesswork. This team hopes to develop a generalized model useful to predict strengths of alloys.

"Our model will allow scientists to determine which atoms and in what amounts will result in the needed properties," Srivilliputhur said. "This will remove the need for long and expensive trial and error search for new alloys."

Jim Rogers

Outstanding Faculty in their Fields

Three College of Engineering faculty have been named Fellows of their respective societies for their outstanding contributions to the fields of materials science and engineering and mechanical engineering.



Jincheng Du, a professor in the Department of Materials Science and Engineering, has been named a Fellow of the American Ceramic Society (ACerS) for having demonstrated outstanding contributions to the ceramic arts or sciences, broad and productive scholarship in ceramic science and technology and outstanding service to the society.

"Dr. Du is a dedicated leader as well as an excellent scientist in ceramic and glass science fields, and has made significant contributions to ACerS by leading ACerS Glass and Optical Materials Division, organizing many ACerS conferences, and serving as an editor of the 'Journal of the American Ceramic Society,'" said ACerS President Tatsuki Ohji.

Du has been a longstanding expert in the field of ceramics, and particularly, within the study of glass materials. His research focuses on advancing and understanding the structure and properties of glass materials, defects and interfaces in ceramics, by using state-of-the-art atomistic computer simulations and advanced characterizations.

Thomas Scharf, also a professor in materials science and engineering, was elected Fellow of ASM International for significant contributions in materials tribology and surface engineering, pioneering work on solid lubricant materials and mechanisms, and distinguished service to the materials science community.

Scharf received the designation for his expertise and contributions to the field of tribology along with his years of mentorship and service to the society's summer camps and local North Texas chapter.

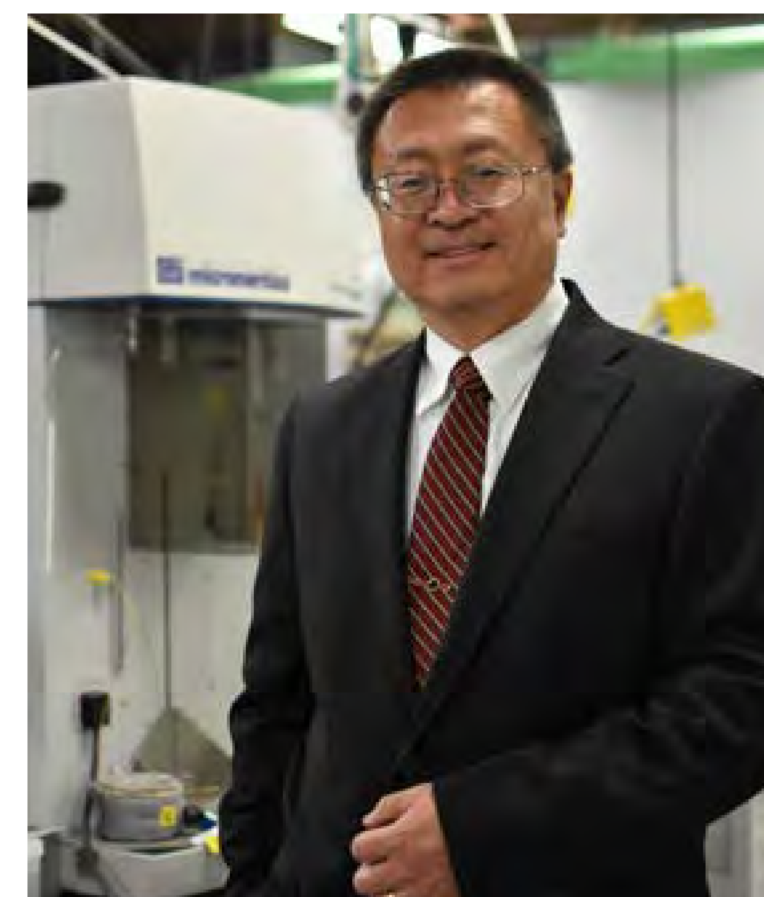
"Tom has been one of the foremost leaders in the study of tribology and has been a great educator and mentor for our undergraduate and graduate students," said Nigel Shepherd, interim chair of the Department of Materials Science and Engineering. "We are so fortunate to have Tom here at UNT."

Mechanical engineering professor Sheldon Shi was named Fellow by the International Society of Wood Science and Technology (SWST), an internationally-recognized professional organization of wood scientists, engineers and other professionals concerned with raw materials used in the production of biofuels.

Nominated for his expertise within the field of bioproducts and his contributions to the society, Shi has been extensively involved in multiple committees within SWST, including serving successively on the executive board as executive director, vice president, president-elect and president of the society. He also chaired the membership committee and scholarship committee.

"It's truly a great honor to be named a Fellow of SWST, and to be recognized by my peers within the field," said Shi. "I'm very humbled, and I very much appreciate it."

Kayla Green



CAREER Could Change Chronic Pain and Stroke Recovery

Ifana Mahbub, an assistant professor in the Department of Electrical Engineering, is developing a wireless recording, stimulation and power system that will allow medical researchers to study and possibly treat brain diseases such as chronic neuropathic pain and post-stroke paralysis.

"My goal is to develop a microscopic, wirelessly powered, wireless system that will record neural signals from electrodes inside the brain and provide stimulation in the form of visible light from tiny LEDs," said Mahbub. "This will allow researchers to study genetically modified neurons in the brain. Scientists will actually be able to monitor neural signals in real time and see responses throughout the brain when the neurons are exposed to light."

Today, scientists are limited to external electrodes or wires running directly from the brain for data recording, stimulation and power. By eliminating the need for wires, test subjects will not have to wear bulky recorders and batteries. Power will be delivered through inductive coupling, the same technique used to wirelessly charge mobile devices.

Mahbub's research is funded through a $500,000 National Science Foundation Faculty Early Career Development Program grant. The CAREER grant is one of the NSF's most prestigious awards. It supports early-career faculty who have the potential to serve as academic role models in research and education.

As part of the grant, Mahbub also will design a learning curriculum for pre-college, undergraduate and graduate students.

"I am developing an interactive circuit design module that will teach fundamental concepts of engineering and neuroscience to students in sixth through 12th grade," she said. "I also will be mentoring students at the Northwest ISD STEM Academy and underrepresented students in STEM from UNT's own Texas Academy of Mathematics and Science."

Jim Rogers

Protecting Protective Mechcanical Surfaces

Materials science and engineering Assistant Professor Diana Berman has received a $290,000 National Science Foundation grant to help mechanical systems, like combustion engines and turbines, last longer and go farther by changing how their protective surface coatings are designed.

“Current approaches to protecting the surfaces of these mechanical systems with coatings provide only temporary solutions as eventually the surface coatings degrade and wear off,” said Berman. “Our goal is to look at the fundamental mechanism of the material wear and learn how we can manipulate and reconstruct the coating.”

Currently, coatings are deposited into a mechanical system where they will eventually wear and tear down due to interaction with water, fuel or other hydrocarbons. Once this happens, the system will need to be completely disassembled so the coatings could once again be deposited into the system. Berman’s approach will allow the damaged surfaces to be repaired without having to disassemble the entire mechanical system, saving time, energy and resources.

“Once we’ve gained a fundamental understanding of these coatings and how they are damaged, we’ll be able to create coatings that could not only stop the damage caused locally, but also replenish itself,” she said.
Berman’s work on surface coatings will have a large impact on aerospace, automobile, or other industries that use mechanical systems or other machinery by significantly improving overall system reliability and reducing energy losses.

“Tribology is pretty much everywhere; wherever there is movement, there is tribology,” she said. “What excites me most about this field is that you can directly see the impact you’re making.”

Kayla Green

A New Way to Diagnose Cancer

Doctors soon will have a new way to determine if a cell is cancerous by measuring its thermal properties, thanks to Tae-Youl Choi, a professor and associate chair in the Department of Mechanical Engineering.

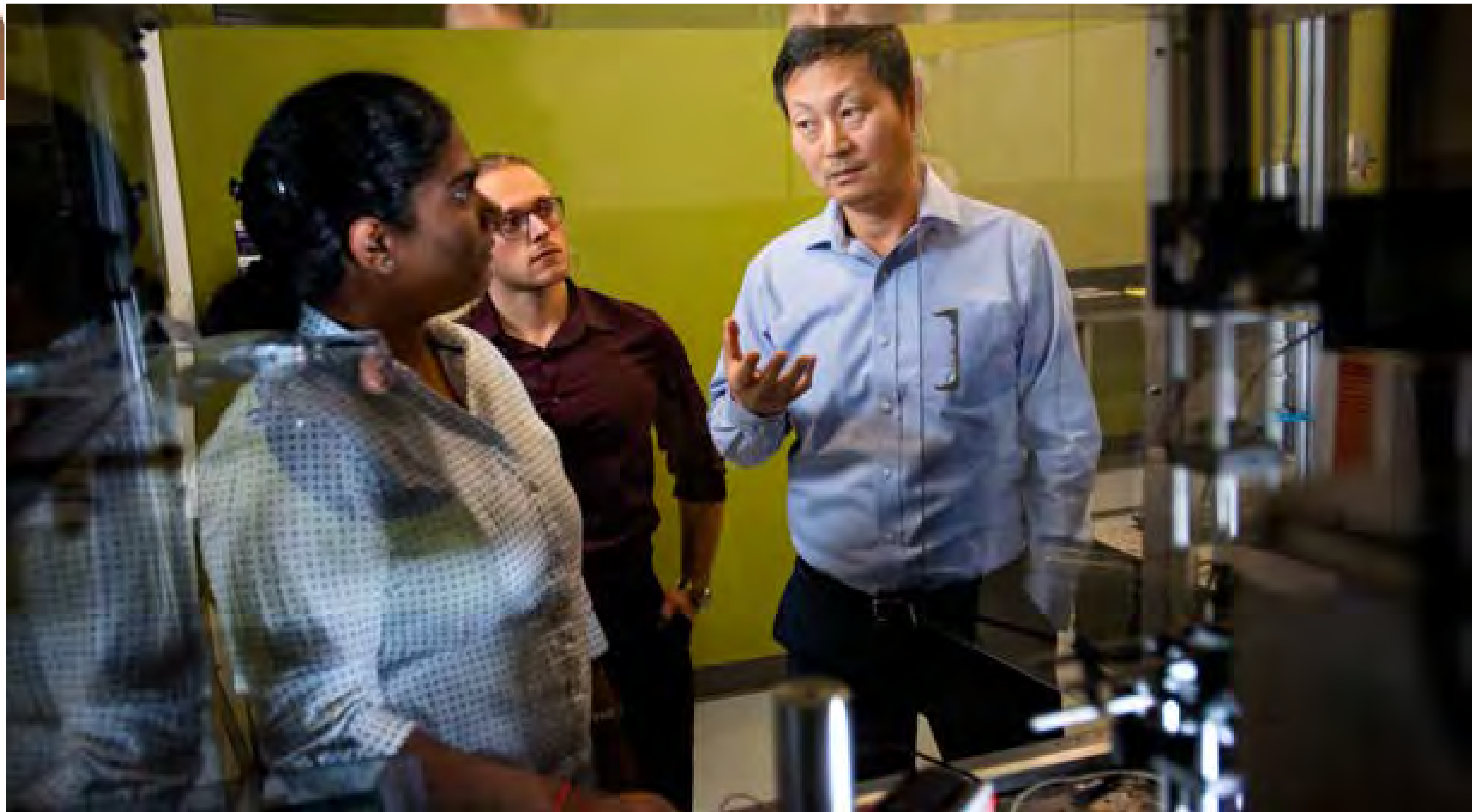
Choi has developed a micropipette sensor technology that will allow for a quicker and more reliable diagnosis of cancerous or precancerous cells. Doctors also should be able to determine the boundary between cancerous and healthy tissue in real time during surgery rather than having to remove tissue from around a tumor for testing in a lab.

“Instead of taking the temperature of the patient, I am sort of taking the temperature of their cells,” said Choi. “Thermal properties of healthy cells change as they become cancerous.”

This all started when Choi wondered if modern engineering principles could provide answers to biological medical problems. Specifically, he asked himself if human cells would have similar properties to materials such as water and protein, and if thermodynamic principles would apply. He found that by measuring thermal conductivity, a material’s ability to conduct heat, and thermal diffusivity, the rate of transfer of heat from the hot end to the cold end of a material, he could detect cancer in cells.

Choi’s device was patented in 2010 and UNT’s research and commercial agreements office is looking forward to finding a company willing to move this technology from Choi’s laboratory to doctors’ offices and hospitals so patients can begin benefiting from this new tool.

Jim Rogers



5 Five New Degrees Designed to Tackle Emerging Demand

As demand rises and new technologies further ingrain in life, there's a growing need for more experts in the field. UNT Engineering is helping solve that need with five new programs designed to better prepare undergraduate and graduate students for the future of engineering in artificial intelligence, cybersecurity, engineering management and geographic information systems + computer science.

M.S. in Artificial Intelligence

As the only standalone program in the state of Texas and one of few nationwide, UNT's unique program offers students the opportunity to enhance their skillset in the growing field of AI.

Intentionally designed to be interdisciplinary, the M.S. in Artificial Intelligence allows students to choose one of the three concentrations: machine learning, autonomous systems and biomedical engineering, with new concentrations to be added. The degree welcomes applicants with degrees in engineering, computer science, mathematics, and science-related fields.

Students take bridging courses, core courses related to AI, and courses that specifically relate to their chosen concentration, allowing students to specialize in AI as it relates to their interests. All students leave the program with a solid understanding of the fundamentals in AI, feature driven and learning driven methods, and their applications. Students coming out of UNT's degree will have skillsets in AI technology anchored deeply in a program domain as well as marketable skills in data analysis, problem solving, and communication.

"We're very excited to launch this degree. The new degree will help to educate an AI-ready workforce," said Yan Huang, senior associate dean for the College of Engineering and interim chair of the Department of Computer Science and Engineering. "Artificial Intelligence is a game-changing technology for endless domains. We really hope that students looking for a rewarding career in engineering will see that AI could be a great fit for them."

B.S. & M.S. in Cybersecurity

Depending on where they are in their career, students choose to earn either their bachelor's or master's degrees in cybersecurity from UNT Engineering. Both programs emphasize skills such as critical thinking, creativity and problem solving in an active learning environment. UNT's goal is to produce professionals who are highly skilled, are technically savvy and will think critically about cybersecurity challenges.

For the bachelor of science degree in cybersecurity, students learn about all aspects of defensive and offensive cybersecurity beginning with the initial design and development of the system to be protected. The master of science program delves deeper, giving students a complementary competency skillset that includes artificial intelligence-based security analysis, machine learning, data security, vulnerability analysis and activities in evaluating the trustworthiness of systems.

Both programs were designed by faculty in the UNT Center for Information and Cyber Security, which is designated as a National Center of Academic Excellence in Cyber Defense Education and Research by the National Security Agency and Department of Homeland Security. As a center for excellence, students learn from experts in the field and gain knowledge and skills that have practical applications in industry post-graduation.

"We want to equip our students to become leaders in the rapidly changing and often unchartered environment that cybersecurity operates in. That means not only giving them the knowledge they need to thrive today, but also instilling a valuable skillset that encourages innovative thinking for solving the needs of tomorrow," UNT Provost Jennifer Cowley said.

M.S. in Engineering Management

This new degree offering will give students the knowledge and skills needed to advance their career and become pioneering leaders in the engineering field. UNT already offered a graduate concentration in engineering management, but students in this program will work towards completing a master of science degree in the field.

This newly elevated program focuses on teaching students how to strategically manage people, projects, organizations and processes. Students choose a concentration in either construction management or energy management to expand their knowledge in a field they enjoy or use the degree as an opportunity to move their career in a new direction. Upon completion, graduates will be able to manage the development of engineering projects and their human and societal impacts, develop the design of experiment for six sigma and associated cost and quality of a product, as well as engage in strategic and entrepreneurship activities.

B.S. in Geographic Information Systems + Computer Science

A new bachelor of science in geographic information systems + computer science debuted in Fall 2021 was designed to respond to a growing industry need is a good fit for students looking to meld their interests in geography and computer science.

Cloud computing, big data and the Internet of Things has dramatically impacted how organizations view and use geospatial data to develop analytics and gain insights into their business processes. Increasingly, businesses are looking for professionals who understand the complexities of geospatial data and are able to leverage modern computing techniques to convert such data into meaningful information.

This program teaches students how to apply geographical perspectives to complex data-related geospatial processes, understand computing principles, program using various languages including C++ and Python and use complex databases effectively. Additionally, specializations such as remote sensing, enterprise geographic information systems, computer networks, security, data mining, graphics and artificial intelligence are available.

Heather Noel + Kayla Green

For Love of Glass

rofessor Jincheng Du's glass research is a labor of love that has resulted in a Fulbright U.S. Scholar Award, sponsored by the Department of State, the International Commission on Glass's W.E.S. Turner Award and Corning's 2019 Gordon S. Fulcher Distinguished Scholar Award.

"Jincheng's awards shine a spotlight on the world-renowned faculty we have here in our Materials Science and Engineering department," said Hanchen Huang, dean of the College of Engineering. "As a member of our faculty since 2007, he has invented glass to contain radioactive waste and has received both national and international accolades for his work. He's also published 150 journal papers and co-authored a book about computer simulations of how glass materials interact at the molecular level. He does all this and teaches classes and advises students, too."

Through the Fulbright U.S. Scholar Award, Du will conduct fundamental glass research at the Federal University of São Carlos in Brazil, home to the Center for Research, Technology and Education in Vitreous Materials – one of the top research centers on glass materials in the world.

The International Commission on Glass is the largest organization in the field of glass science and technology. For the last eight years, Du has served as the chair of an ICG technical committee. The W.E.S. Turner Award recognizes the notable contributions he made through his work to grow the committee and promote the modeling and simulation of glass at the atomic level among the scientific community.

Corning, an internationally-recognized innovator in materials science, selected Du for its Gordon S. Fulcher Sabbatical Program. Du will spend three months working with Corning scientists to pursue two separate research paths that have potential applications in photonics and optical devices, as well as the surface treatment of glasses for display and other applications.

Jim Rogers

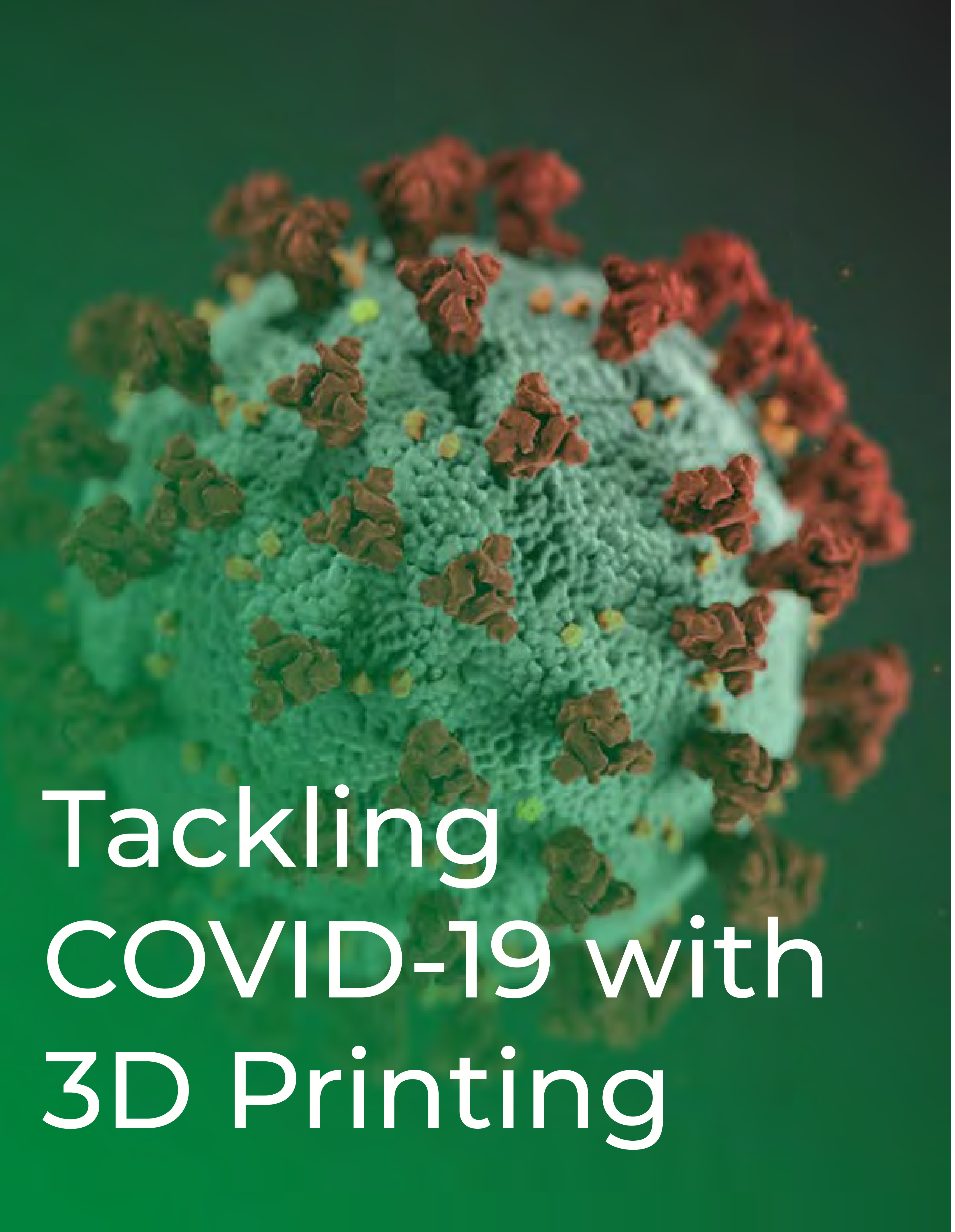
Huang Distinguished in Computing Field

Yan Huang, senior associate dean of the College of Engineering and interim chair of the Department of Computer Science and Engineering, was named a distinguished member of the Association for Computing Machinery for her scientific contributions to the field of computing.

"My work focuses on organizing, making best use of and finding interesting patterns in large amounts of data. For example, a navigation system used to mean only a driver's GPS location on a map with a static route to their destination. But, today massive amounts of data can be collected by navigation systems and road sensors in real time allowing for routes to be adjusted based on conditions," said Huang. "Now, we can take advantage of all the new data to detect movement patterns, schedule ride sharing and predict and circumvent traffic problems."

Huang's research forms core technologies for modern spatial databases and spatial data mining – the process of discovering interesting and previously unknown, but potentially useful patterns from large spatial datasets.

Kayla Green



Tackling COVID-19 with 3D Printing

When the pandemic hit, everyone felt it. Locally, nationally and globally – it was unavoidable.

And like many of its peers, UNT Engineering sought to tackle the world's most pressing problem and provide practical solutions safely and efficiently.

In one collaboration, engineers and artists worked together to create face shields for faculty and students to use once laboratories on campus reopened. To do this, the hard plastic part that fits around the head was created using additive manufacturing techniques at both UNT Engineering and the College of Visual Arts and Design (CVAD). colleges. CVAD specialists then laser-cut transparent plastic for the shield front and assemble the final product.

"Our students and faculty follow strict safety protocols in our laboratories, which means they must use safety equipment such as masks, gloves, face shields, etc.," said Mark McLellan, vice president for research and innovation. "But, as everyone knows, there is a shortage of certain equipment due to COVID-19. Fortunately, we have the tools and the talent to make our own."

The plans for the face shields were found online and were converted for 3-D printing. UNT Engineering doctoral student Cesar Chavez added design improvements to the headpiece portion of the shield. Working with Bobby Grimes, the Department of Engineering Technology lab manager, they were able to begin fabricating the parts.

"We are a Tier One research university because we have the expertise, equipment and capability of tackling world-sized problems," said McLellan. "I believe these and other efforts across campus to address problems resulting from COVID-19 show our researchers' talents."

UNT engineers also used 3D printing technology to make ventilator splitters that would allow doctors to use a single ventilator to treat two patients.

Using biocompatible materials that can be sterilized for medical applications, the team adapted a design and manufactured ventilator splitters and flow limiter inserts using the college's digital manufacturing lab.

"Hector Siller, our manufacturing engineering technology department program coordinator, received the design and worked with Cesar Chavez and Bobby Grimes, to generate files for 3D printing, print the first prototype and test the model immediately," said Andrey Voevodin, associate dean for research at the college. "After the splitter model was tested on a hospital ventilator, the team made design modifications and had it ready for production in just two days. That is impressive."

Another researcher, Yijie Jiang, and his students developed open source codes for a new mask and nose plug that used smart technology to respond to a wearer's breathing.

The masks and nose plugs are designed with an array of channels that include curved micropillars in each channel that move inward or outward as a person breathes. The fully customizable masks and nose plugs can be printed with at-home 3D printers from commercially available materials, like silicone.

"The objective of the project was to develop 3D printable smart masks and nose plugs to prevent onward transmission of coronavirus from patients," said Jiang, assistant professor in the Department of Mechanical Engineering. "The 'smartness' of the technology derives from the designed curved micropillars, whose curvatures will change in response to a person's respiration."

UNT undergradute student Sophia Zoch developed the designs for the masks and nose plugs in addition to running simulations and analysis on the microstructures.

"This has been a really great experience for me, because I've been able to do real-world research," said Zoch.

Kayla Green

Early Career Award for Alumnus

UNT Engineering alumnus Arun Devaraj is one of 76 recipients nationwide to receive a 2020 Early Career Research Program award from the Department of Energy. The award comes with five years of research support for Devaraj, totaling to about $2.5 million.

While at UNT, Devaraj studied experimental and computational material science under the advisement of University Regents Professor Raj Banerjee and Department of Materials Science and Engineering Associate Professor Srinivasan Srivilliputhur.

"My PhD thesis was focused on understanding titanium alloys, which are high strength, extremely low weight materials of interest for decreasing weight in automobiles," said Devaraj. "I used powerful electron microscopes, atom probe tomography and synchrotron x-ray diffraction to analyze phase transformation of the titanium alloys. I then correlated the experimental results with theoretical computation under my computational research advisor."

Now, at PNNL, Devaraj will use the award funds to explore how hydrogen, combined with stress and oxidation, leads to catastrophic failures of high-strength steels widely used in the nuclear and automotive industries.

"The unique experience of working in both experimental and computational material science during my PhD research at UNT prepared me to efficiently interface between these two complementary areas while working at PNNL," he said. "I also got to use the fundamentals of material science and metallurgy I learned from UNT to continue to pursue advanced research on nationally important problems in PNNL."

Kayla Green

Photo by Scott Butner, PNNL

A Breath of Fresh Air for Astronauts

Alyssa Sarvadi, a recent graduate of UNT Engineering, believes they have found a better way to clean the air aboard space ships. And, NASA agrees.

Sarvadi and their mentor, associate professor of mechanical engineering Huseyin Bostanci, are part of a 10-year-old NASA program that sponsors graduate students and their professors who show significant potential to contribute to the space agency's goal of creating innovative new space technologies.

"NASA has road maps that researchers can use to see where the agency is headed in the next five to 10 years and what sort of technology they will need," Sarvadi said. "It turns out that my research into air revitalization in microgravity environments is one of the many technologies in which NASA is interested."

The NASA Space Technology Graduate Research Opportunities grant provides up to $80,000 a year for two years for Sarvadi and Bostanci's research into the design and development of a "microgravity vortex phase separator for liquid amine CO2 removal system." As part of the grant, Sarvadi also will get to work at NASA facilities during the next two summers. The funding includes tuition, travel expenses, and a living stipend. This project also involves collaboration with Cable Kurwitz, an associate research engineer at Texas A&M University.

"Our vortex phase separator could be described as a type of CO2 scrubber," Sarvadi said. "For astronauts in an enclosed area like a space craft or station, the carbon dioxide they exhale will quickly build up unless removed."

Currently, the CO2 removal system used by NASA in the International Space Station involves a solid, granular sorbent-based system. This system is known to break down over the long term and uses too much energy in an environment where energy is limited. Sarvadi and Bostanci propose to design and build a system using non-gravity-dependent vortex phase separator that could potentially offer a reliable, high-throughput flow and energy efficient CO2 removal technology.

"The thought of building something that might actually be used in space is very exciting," Sarvadi said. "But, the big dream is to actually work at NASA."

Jim Rogers

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