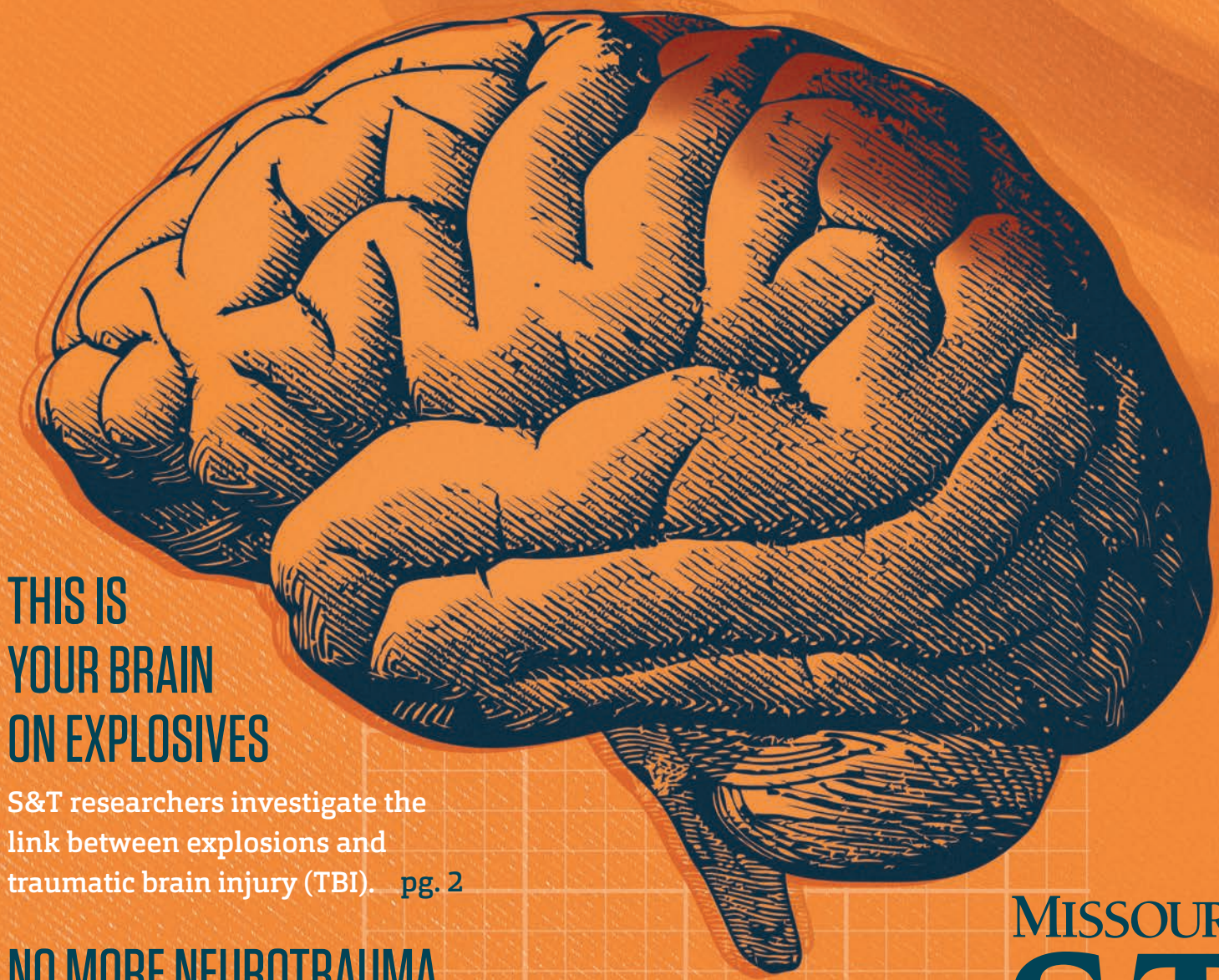


Fall 2018

# re:search

An inside look at innovation and discovery at Missouri University of Science and Technology



## THIS IS YOUR BRAIN ON EXPLOSIVES

S&T researchers investigate the link between explosions and traumatic brain injury (TBI). [pg. 2](#)

## NO MORE NEUROTRAUMA

S&T partners to prevent, detect and treat TBI. [pg. 3](#)

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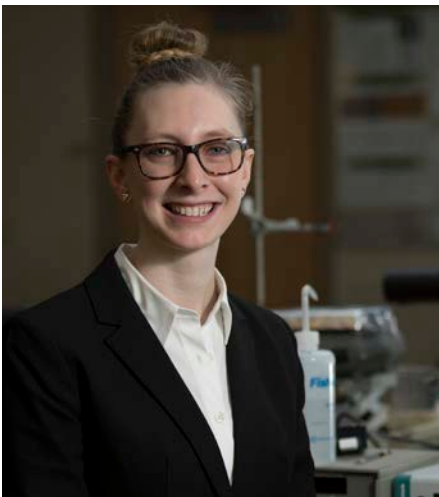
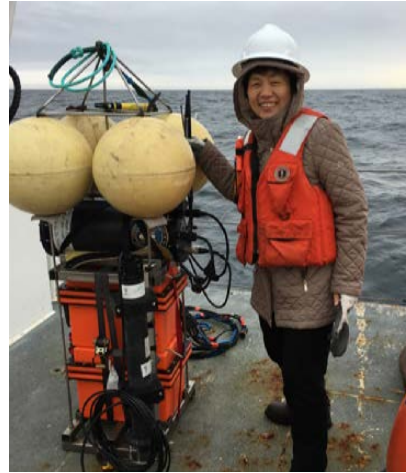


## MURAL MYSTERY SOLVED

When a prominent St. Louis politician objected to Thomas Hart Benton's portrayal of blacks in his Missouri State Capitol mural, Benton invited the man described as the "most important black voter 'getouter' in the city" to model for the mural.

For years, the identity of the man in a white hat leaning against a tree in Benton's mural was a mystery, but **James J. Bogan Jr.**, a Missouri S&T professor emeritus of art history and film and creator of the documentary *Tom Benton's Missouri*, believes he solved it.

Bogan combed through historical photos and archives to identify him. An inquiry to the *St. Louis Post-Dispatch* yielded an obituary of Jordan Chambers, who fit the description. "The obituary calls him the 'Negro mayor of St. Louis,' and candidates at all levels of government wanted his support," Bogan says. "Also, he was noted for wearing a 'signature' white Stetson hat, just like the fellow in the mural."



## NEW LEADER AT THE HELM OF S&T'S RESEARCH, GRADUATE PROGRAMS

An expert in multi-agent systems and artificial intelligence is now leading Missouri S&T's research efforts. **Costas Tsatsoulis**, former dean of the College of Engineering at the University of North Texas, joined S&T as vice chancellor for research and dean of graduate studies on Sept. 4.

"In Missouri S&T, I see all the necessary ingredients that will allow us to rise to new levels of excellence," says Tsatsoulis.

An electrical engineer, Tsatsoulis became UNT's engineering dean in 2008 following a 20-year career at the University of Kansas. At KU, he served as chair of electrical engineering and computer science from 2004 to 2008 and director of the Intelligent Systems and Information Management Laboratory from 1997 to 2003.

Tsatsoulis' research focuses on multi-agent systems, case-based reasoning, machine learning and intelligent image analysis. He is the author of 25 journal articles and 79 published conference and workshop papers and is co-editor of the textbook *Analysis of SAR Data of the Polar Oceans* (Springer Verlag, 1998). He holds one U.S. patent for an automated data entry system.

Tsatsoulis holds a Ph.D. in electrical engineering from Purdue University in Lafayette, Indiana.

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THIS IS  
YOUR  
BRAIN ON

# EXPLOSIVES

While in the Marine Corps, **Barbara Rutter** witnessed the effects of traumatic brain injury (TBI) on her fellow soldiers' lives. Now a Ph.D. student in explosives engineering at Missouri S&T, Rutter studies the relationship between physical building damage and TBI occurrence so that the military can more easily determine if an improvised explosive device (IED) explosion has caused a TBI.

"It's really difficult to quickly assess people's injuries in combat after an IED has gone off," says Rutter. "Being able to give the military an easy guide to identify the severity of the TBI right away allows them to start preventative treatments immediately."

With funds from a Department of Defense grant, Rutter is working with **Catherine Johnson**, assistant professor of explosives engineering, to investigate how exposure to explosions affects the brain. They're mapping blast waves that reflect off the ground and damage structures in an explosion.

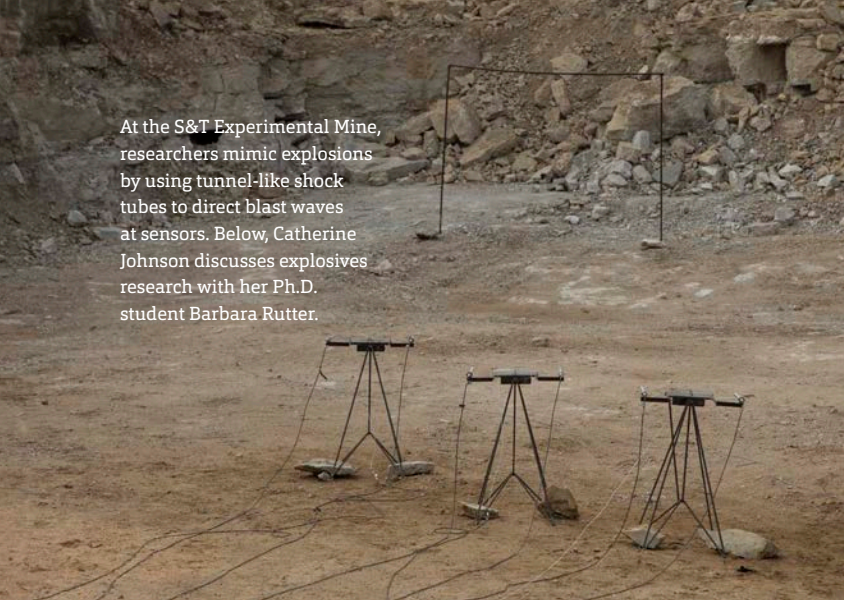
"Experimental models can provide insights into the basic mechanisms underlying what for many remains an 'invisible' injury."

A partnership with the University of Missouri-Columbia School of Medicine and the Department of Veterans Affairs allows Johnson and Rutter to use the blast model to better understand behavioral and neuropathological changes to people with blast-induced TBIs. Johnson says the ultimate goal of the research is to eventually improve the quality of life for anyone with a traumatic brain injury, from athletes to car crash victims.

"This sort of brain trauma is extremely difficult to diagnose," Johnson says. "Experimental models can provide insights into the basic mechanisms underlying what for many remains an 'invisible' injury."

Much of the related research on explosives and brain trauma is conducted using shock tubes, a tunnel-like device in which blast waves can be directed at sensors to mimic explosions, using compressed gas rather than detonation.

At the S&T Experimental Mine, researchers mimic explosions by using tunnel-like shock tubes to direct blast waves at sensors. Below, Catherine Johnson discusses explosives research with her Ph.D. student Barbara Rutter.



S&T's Experimental Mine, though, offers enough open space above ground to perform open-field blasting, which can more effectively replicate battlefield explosions by enabling the blast waves to bounce off buildings, the ground, military vehicles and other objects.

The research also provides a window into a better understanding of the physics behind explosives.

"What we're also trying to create are damage curves for TBI based on pressure and impulse," Johnson says. Damage curves refer to building damage and are a simple graphical representation to aid with building design and minimum distance to explosions.

"If you've got shock wave reflections off of walls, the duration is going to last longer, affecting the impulse rather than the peak pressure, so the relationship between the two is important."

Johnson's research is one of several S&T projects associated with the Acute Effects of Neurotrauma Consortium (see story at right).

With funding from the U.S. Army Research Office, Johnson is also working with S&T chemists and ceramic engineers on research aimed at understanding how nanomaterials are made with explosives and creating new kinds of nanomaterials for practical applications, such as silicon carbide for more durable brakes in cars and better bullet-proof vests. Missouri S&T is the only U.S. institution that can make detonation nanodiamonds. □



## NO MORE NEUROTRAUMA

According to the U.S. Centers for Disease Control and Prevention, traumatic brain injury (TBI) was a factor in the deaths of more than 50,000 people in the United States in 2010, and 2.2 million people visited an emergency room that year with symptoms of TBI.

It is also a significant health issue for the military due to blast-related concussions and other injuries, according to the Defense and Veterans Brain Injury Center, a division of the Defense Health Agency.

Through the Acute Effects of Neurotrauma Consortium, Missouri S&T is partnering with Phelps County Regional Medical Center, the U.S. Army at Fort Leonard Wood and the Army's Leonard Wood Institute to prevent, detect and treat TBI.

S&T researchers are examining TBI from a variety of angles. Current projects include developing a urine test to detect the presence of "biomarkers" that could indicate TBI or concussions; studies at S&T's Experimental Mine to determine the potential impact of blasting (see story at left); data analysis of medical records to determine TBI-related patterns; and research on the biochemistry of brains affected by TBI.

# CHIRALITY = RIGHT HAND + LEFT HAND



In the early 1960s, the Thalidomide drug scare caused thousands of worldwide infant deaths and birth defects from a morning sickness medicine for expectant mothers.

The disaster transformed drug regulation systems and changed the pharmaceutical industry's understanding of chiral properties: the notion that molecules with otherwise identical properties are in fact mirror images.

Missouri S&T materials science and engineering doctoral student **Meagan Kelso** wasn't even close to being born when the chiral consequences of Thalidomide first became apparent. But the drug industry's continued efforts to fine-tune how it first identifies and then separates chiral compounds is driving her Ph.D. research.

"Chirality is just like your right and left hand," explains Kelso. "Two molecules that have exactly the same chemical compositions — like you have the same five fingers on your hand — but they're arranged differently.

"The molecules, like your hands, are mirror images of each other, and they're not superimposable. So if you put one

on top of the other, no matter how much you rotate them, they'll never line up.

"One hand of a molecule is arranged just right to resolve your headache, while the other may do nothing, or cause harmful side effects."

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**"The molecules, like your hands, are mirror images of each other, and they're not superimposable."**

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A process known as chiral chromatography is now used to separate the mirror-image molecules known as enantiomers. But that process is pretty costly and time-consuming, Kelso says.

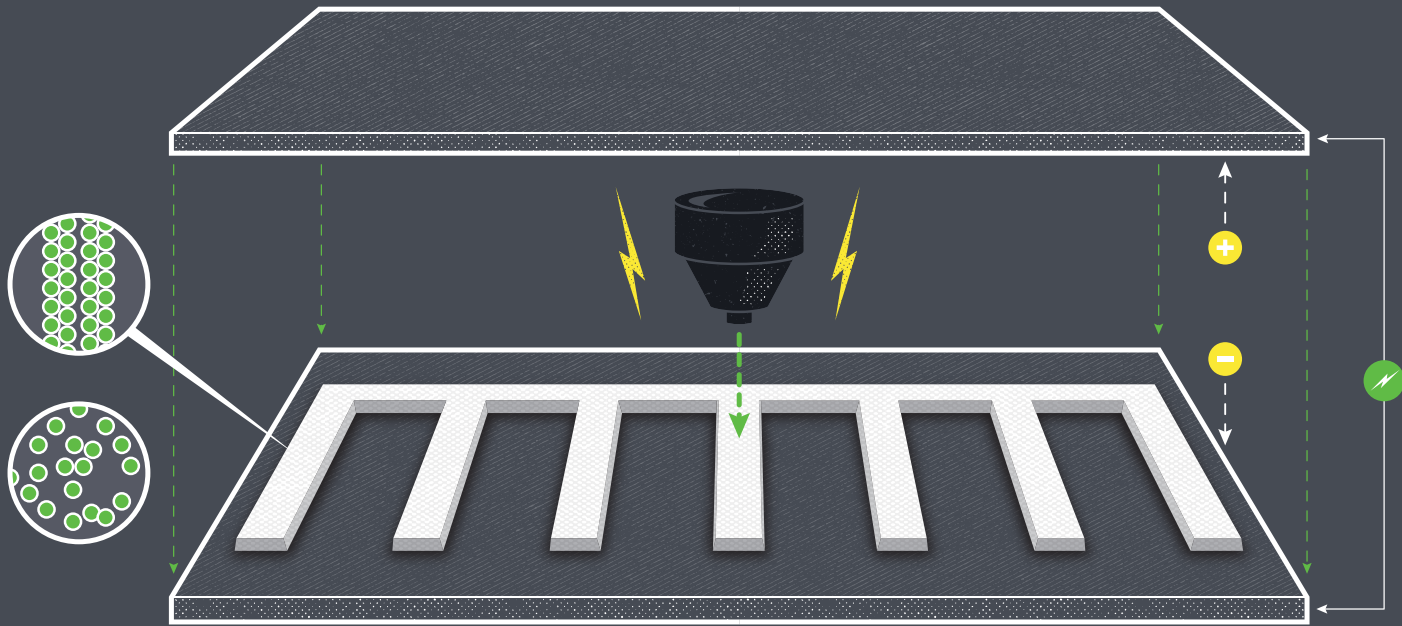
Kelso's research relies on the simpler and less costly process of adsorption — the adhesion of a substance, in an extremely thin layer, to a solid surface — using the combination of thin layers of gold, silver and other materials electrodeposited atop silicon. Silicon(643) is a variation of the common semiconductor that has a two-dimensional chiral surface capable of sensing 3-D chiral molecules.

The initial results are promising, say Kelso and her advisor, **Jay Switzer**.

"When epitaxial gold is electrodeposited on silicon, surface chirality is maintained," she says. "This can be used as the base to obtain many other desired chiral surfaces.

"Because each chemical compound is so different, you need to revise the traditional techniques to separate them for each compound. So that's where it gets more complicated, and time-consuming and expensive," Kelso notes.

"Our goal is to produce a surface that will allow for the selective chiral crystallization of important pharmaceuticals," adds Switzer, the Donald L. Castleman/FCR Endowed Professor of Discovery in Chemistry at S&T and a senior investigator at the university's Materials Research Center. "I'm sure this would be a disruptive technique to isolate the 'right' hand of a chiral drug."



# PRINTING BATTERIES

Your cell phone may one day charge faster and hold a charge longer thanks to Missouri S&T researchers who are working to develop a new processing method for manufacturing battery electrodes. Their work, which uses additive manufacturing to essentially 3-D print electrodes, could lead to transformational enhancements in battery capacity, energy density and life cycle.

Although significant advances have been made in lithium-ion batteries, higher energy and power densities are still required for portable devices, transportation and stationary applications. The amount of materials in an electrode determines the energy and power of the battery — so the requirement for a high-tap density is of considerable importance.

Conventional strategy for increasing density involves adding more material, but that isn't always desirable. Increasing the volume fraction of an active material improves the transport of lithium ions and electrons in the solid phase, but it impedes the transport of lithium ions in the electrolyte.

An alternative strategy is to increase the thickness of the electrodes. This approach, however, limits the transport of ions and electrons, resulting in poor power performance and inefficient utilization of materials.

**Jonghyun Park**, an S&T assistant professor of mechanical engineering, and doctoral student **Jie Li** instead turned to additive manufacturing to increase tap density.

Park and Li developed a new manufacturing technique for fabricating battery electrodes that simultaneously controls the patterning of the macro- and micro-structures to increase tap density, helping address current energy storage technology gaps and future energy storage requirements.

Modern batteries are fabricated in the form of laminated structures composed of randomly mixed constituent materials. This randomness provides the possibility of developing new breakthrough processing techniques to build well-organized structures that can improve battery performance.

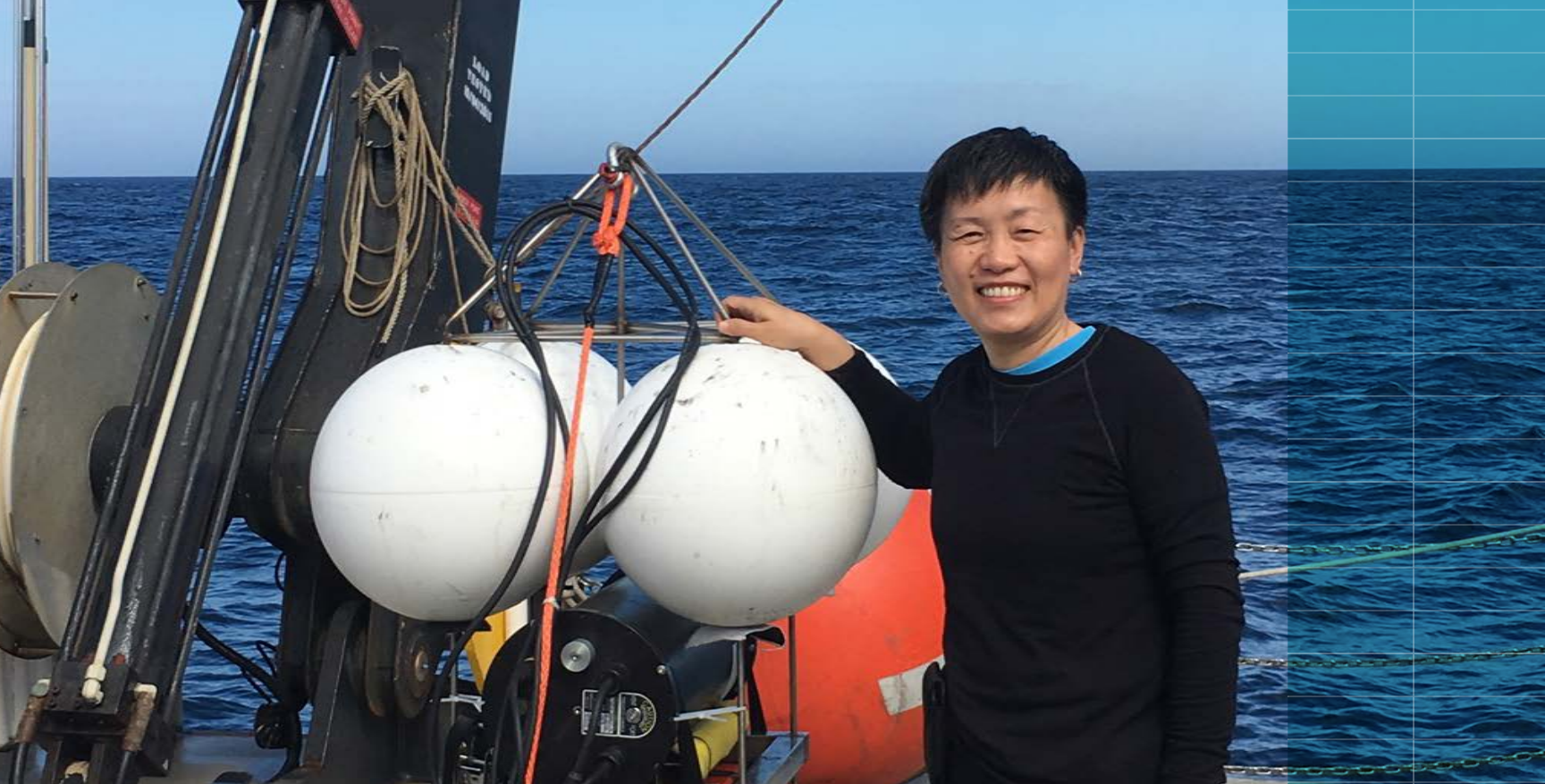
“Well-organized, 3-D electrode structures that cannot be achieved from conventional fabrication methods are possible with this new manufacturing method.”

The new technique consists of an electric field process that controls the microstructure pattern of manganese-based electrodes, and an additive manufacturing process that controls the macro-3-D structures and the integration of both scales. Electrochemical tests show that these new electrodes exhibit superior performance in specific capacity, areal capacity and cycle life.

“Well-organized, 3-D electrode structures that cannot be achieved from conventional fabrication methods are possible with this new manufacturing method,” Park says. “That opens the possibility to significantly improve battery performance.”

The researchers' work was published in the January 2018 issue of the journal *Nature: Scientific Reports*.

**Xinhua Liang**, associate professor of chemical and biochemical engineering, and **Frank Liou**, professor of mechanical engineering, assisted with data analysis and are co-authors of the journal article.



Submitted photo

## COMMUNICATING

# UNDERWATER

Imagine diving into a swimming pool and then trying to talk to someone underwater. In order to communicate, the underwater voice would have to be loud and clear, and the other person would have to be close enough to hear.

That's the challenge facing Missouri S&T researcher and Wilkens Missouri Telecommunications Professor **Rosa Zheng** — to wirelessly transmit and receive data underwater.

"Your cell phone doesn't work underwater," says Zheng. "Radio frequency — called RF — is used in your cell phone. They use antennas and cell phone towers with antennas. If you go even one meter underwater, all of those signals are gone."

Zheng's research is testing several methods for underwater communications, including ultrasound, coils as transmitters with receivers, and optical approaches in an effort to improve current methods.

### **Bridge foundation monitoring**

Underwater communication can be used to monitor the foundations of bridges with support structures in streams and rivers to keep motorists and pedestrians safe.

"In the past 45 years in the U.S., about 1,500 bridges have collapsed and about 60 percent were attributed to hydraulic effect," says **Genda Chen**, the Robert W. Abnett Distinguished Chair of Civil Engineering at Missouri S&T. "Scour is the most critical factor leading to bridge collapse."

Bridge scour is the engineering term for the erosion of soil around bridge foundations. It's caused by swiftly moving water that can create scour holes in the structure and compromise its supports.

Working with Chen, Zheng developed smart rocks that flow with the rushing river waters and embed into scour holes. Zheng developed nodes that are set up on a riverbed to create a local tracking system that will allow engineers to map the bridge scour. This gives engineers a better understanding of the bridge's health and could prevent bridge collapse from water damage.



# “RIGHT NOW WIRELESS COMMUNICATION IS A BOTTLENECK FOR MANY OCEAN TECHNOLOGIES.”

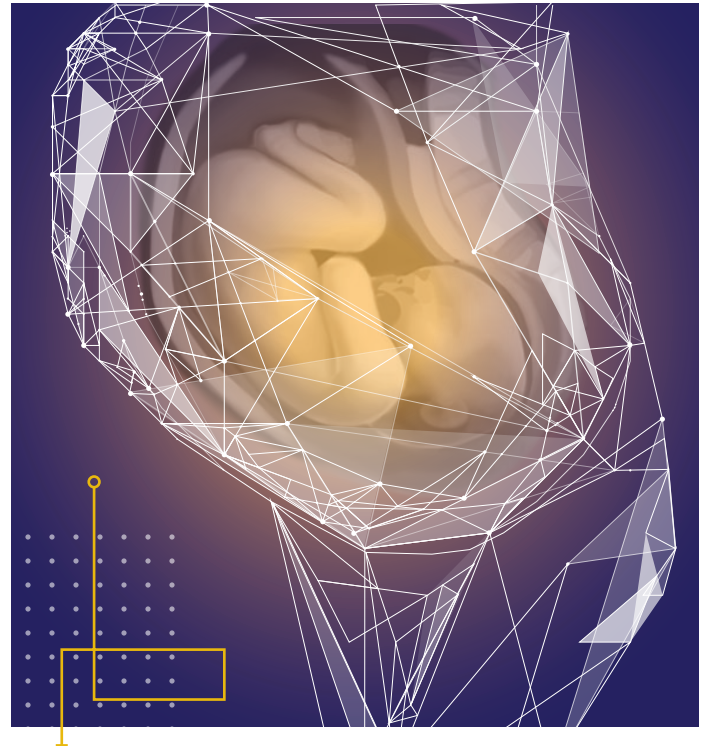
## Oil and gas exploration

The oil and gas industry uses underwater wireless communication to monitor pipes and drilling equipment used for oil rigs and oil and gas exploration. For example, in the Gulf of Mexico, engineers use underwater autonomous vehicles (UAVs) and robots to explore oil reservoirs underneath the ocean floors to depths of up to 30,000 feet.

“Submarines, torpedoes, UAVs all need communications down there. Otherwise, they have to surface and talk to the satellites and then return to the water,” says Zheng. “They have a lot of data, and they want to send it fast. But right now wireless communication is a bottleneck for many ocean technologies.”

Zheng is testing using ultrasound to communicate in the ocean — similar to how dolphins and whales communicate underwater. Using ultrasound, Zheng says messages can travel over long distances and still have a good data rate.

Zheng and her research team have increased the data rate and improved the robustness of underwater wireless communications methods in the last 10 years, participating in more than 20 ocean and river experiments using their advanced receiver technology. She hopes to soon take her research innovations to develop the next generation of underwater communication devices. □



## USING BIG DATA TO REDUCE CHILDBIRTH RISKS

According to the Centers for Disease Control and Prevention, complications during pregnancy or childbirth affect more than 50,000 women annually, and about 700 of them die every year.

**Steve Corns**, associate professor of engineering management and systems engineering, is working with researchers from Phelps County Regional Medical Center through the Ozarks Biomedical Initiative to reduce that number.

Corns is studying fetal heart rate patterns to develop a computational model that can predict the risk of dangerous conditions like fetal hypoxia and acidosis after a mother is in labor.

“The goal is to look at the heart rate to try to predict what those conditions are (that cause oxygen deprivation during birth),” Corns says. “And then before we get to the situation where the baby is highly acidotic, go in and do an intervention.”

Corns says that in the early stages of labor, doctors typically rely on cardiotocography, also known as electronic fetal monitoring, to record fetal heartbeat and uterine contractions, usually reviewing the results every 10 to 20 minutes.

Corns instead wants to analyze tens of thousands of discrete data points that could more accurately predict patterns — and pitfalls to arm physicians and nurses with more informed decision-making tools.

Early results are promising. In a research paper presented at the 2017 IEEE International Conference on Computational Intelligence in Bioinformatics and Computational Biology, the researchers found two types of algorithms that demonstrated a 96 percent accuracy rate in predicting outcomes in the three fetal heart rate classifications: normal, indeterminate and abnormal.

The team hopes to compile data representing over 100,000 live births by collaborating with medical scholars in Columbia, St. Louis and Kansas City, Missouri.



# CITIZEN SCIENTISTS

Picture teams of smartphone-toting citizen scientists, poised to collect water samples and test for contaminants thanks to a user-friendly app that can crowdsource rapid responders to mobilize the next time a public water system is at risk.

Researchers from Missouri S&T and the University of South Florida are tapping National Science Foundation seed money set aside for “potentially transformative research” to advance the technology and hone the social mobilization efforts needed to summon trained, trusted teams of everyday water watchers.

“The overarching goal is to improve water resource knowledge of our citizenry and decision-makers at critical junctures when most needed for the greatest impact,” says principal investigator **Joel Burken**, Curators’ Distinguished Professor and chair of civil, architectural and environmental engineering. “Our health, economy and social well-being are tightly interwoven with our water cycles.”

The project brings together the water quality expertise of environmental, electrical and computer engineers to develop gauges and sensors to link wireless devices to user cell phones, computer scientists for application development, and psychologists to gauge behavioral outcomes toward water quality management.

Look no further than the recent catastrophic hurricanes Harvey and Irma, when public awareness and interest in such issues tend to escalate, says **Denise Baker**, a Missouri S&T assistant professor of psychological science and a co-principal investigator.

“One goal is to engage the broad citizenry with knowledge and data on our most important water issues, while they remain in the news or what is known as the ‘window of crisis,’” she says.

Another novel component of the project is the development of a cellphone-based program to use video of water flows to estimate the total discharge.

“Particularly in flooding situations, we desire to know the flow rates in rivers and streams, but the rapid rise of water does not usually allow deployment of the equipment and personnel needed,” says **Zhaozheng Yin**, associate professor of computer science. “But people with cellphones are everywhere.”

“The overarching goal is to improve water resource knowledge of our citizenry and decision-makers at critical junctures when most needed for the greatest impact.”

Other S&T researchers working on the project are co-PI **Chang-Soo Kim**, professor of electrical and computer engineering, and **Cesar Mendoza**, associate professor of water resources engineering. Also participating is **Sriram Chellappan**, an associate professor of computer science and engineering at the University of South Florida and an adjunct professor at Missouri S&T.



# RESEARCH ON THE FLY

From U.S. Navy laboratories to battlefields in Afghanistan, researchers are lining up to explore the use of unmanned aerial vehicles to detect unexploded landmines.

At Missouri S&T, civil engineering doctoral student **Paul Manley** is using plant health to see if drones can be used to more safely locate such weapons of destruction.

Since mine casings can degrade, leaching chemical compounds into the subsurface, those changes in soil properties can also be linked to the presence of unexploded landmines.

Using a hyperspectral camera mounted on a UAV, Manley collects images across hundreds of bands that can detect subtle changes in how plants such as corn and sorghum gain or lose water and nutrients, or how they biochemically respond to stress.

"As drought increases, so does the relative temperature around that area," says Manley. "So we can use thermal imaging to see how plants are responding to drought stress. When you add in those hundreds of bands, you can really 'see' how the plants are responding."

Existing landmine detection methods are far from ideal, Manley says.

"Currently, you have people walking around the minefields, leading animals on leashes, tilling up the surface to just detonate the mines and get it over with, or they are using ground-penetrating radar to detect these in the subsurface," he says. Another device, constructed from plastic, iron and bamboo, and powered by wind, has to be replaced each time it detects a mine. And there are over 100 million unexploded landmines across the world.

"These detection methods are really slow, and they're expensive, and they all involve people out in the minefields doing this work, so it's dangerous," Manley says.

His research, part of a project called "Missouri Transect: Climate, Plants and Community," is funded in part through S&T's share of a five-year, \$20 million National Science Foundation grant awarded to nine institutions across the state.



## PARTNERSHIP FOR PETROLEUM PRODUCTION

An estimated 7 billion barrels of light, sweet crude oil lie in the Tuscaloosa Marine Shale, a 90-million-year-old sedimentary rock formation across the Gulf Coast region of the U.S. But the preponderance of rich clay in the shale makes extracting the oil a challenge.

Missouri S&T geologist **David Borrok**, chair and professor of geosciences and geological and petroleum engineering, is part of a four-campus research team that received \$9.7 million from the U.S. Department of Energy and several energy companies to boost unconventional oil and gas recovery in the region.

The research group also includes engineers, geologists and geophysicists from the University of Oklahoma, the University of Southern Mississippi and Los Alamos National Laboratory.

In industry parlance, the Tuscaloosa play — a term referring to an area where oil and gas exist — is considered "unconventional" based on both geological factors and geographic size.

"Challenges with the types, conditions and continuity of mineralogy and organic matter have made the Tuscaloosa play a tough nut to crack," Borrok says. "Through this research project, we hope to identify ways to overcome these challenges and help increase production."

"This project offers tremendous potential for new knowledge and innovation for unconventional energy production in the U.S.," Borrok says.



## FILLING THE SCIENCE COMMUNICATION GAP

Science communication can be hard to define, and even harder to teach.

At most universities, science writing is taught by English or communication faculty, not science faculty. And these instructors often have minimal experience in science disciplines.

To make the subject easier for instructors to teach and their students to learn, **Kathryn Northcut**, professor and co-director of technical communication programs at Missouri S&T, co-edited *Scientific Communication: Practices, Theories, and Pedagogies* with a colleague from Kansas State University. The book is a collection of case studies and real-life examples from experts in technical and science communication fields that demonstrate the various types of science writing.

Scientists often have to explain their work to their peers, Northcut says, but they also have to explain their research to people who aren't specialists in their field.

"It's writing about science topics in a few different ways for a few different audiences," she says.



Photo courtesy of the Oriental Institute of the University of Chicago

# UNCOVERING AMERICA'S FIRST FEMALE EGYPTOLOGIST

Historian **Kathleen Sheppard** wondered why there was so little mention of the scholarly work of Caroline Ransom Williams (middle row, left), America's first university-trained female Egyptologist, in archaeology's published history.

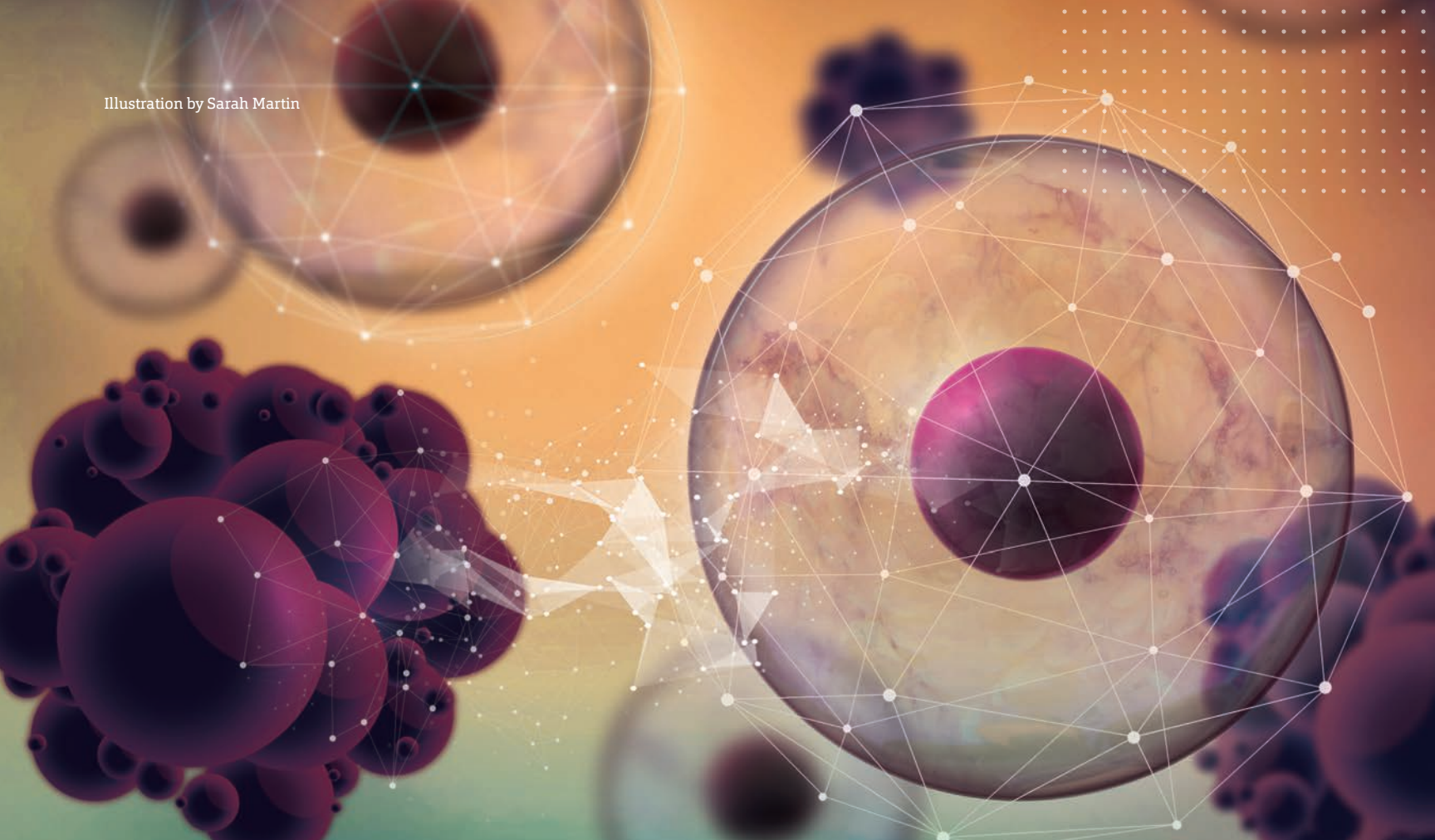
So Sheppard, an associate professor of history and political science at Missouri S&T, spent two years researching, transcribing and editing 240 letters between Ransom Williams and her mentor, James Henry Breasted, the first American Egyptologist and founder of the Oriental Institute of the University of Chicago.

She recently published the collection of correspondence in the first book-length discussion of Ransom Williams' life and career, *My dear Miss Ransom: Letters between Caroline Ransom Williams and James Henry Breasted, 1898–1935*.

Sheppard's research focuses on the history of Egyptology in the U.S. and the U.K., and especially women's roles in the discipline. She says that telling the life stories of women in Egyptology is crucial to fully understanding the whole story of the discipline.

"In the history of archaeology, it was the men who went out into the exotic fields to dig in the dirt and make exciting discoveries; women usually stayed back in the institutions to do the maintenance work of curating the collections and performing administrative duties," says Sheppard. "Although this work was essential to preserving the early stages of Egyptology, it has largely been ignored. Through the letters in this volume, we see a woman's life that is unique while at the same time, similar to the lives of other professional women of that period."

Sheppard is also the author of *The Life of Margaret Alice Murray: A Woman's Work in Archaeology*, about one of the first women to practice archaeology and the first woman to unwrap a mummy.



# ‘CLOAK OF INVISIBILITY’ SNEAKS DRUGS INTO CANCER CELLS

Doxorubicin, or DOX, is one of the most effective and widely used drugs in chemotherapy, but its current delivery mode presents challenges like drug resistance by cancer cells, lack of selective delivery to the right cells and adverse side effects.

In a recent study, a group of S&T researchers led by **Risheng Wang**, assistant professor of chemistry at S&T, found that changing the shape of the DNA nanostructures that deliver the drug could improve its effectiveness.

“Shapes matter,” says Wang. “The optimization of the shape and size of self-assembled DNA nanostructures loaded with anti-cancer drugs may allow them to carry a greater quantity of the drugs, rendering them more effective.”

“These self-assembled DNA nanostructures could serve as a ‘cloak of invisibility’ to sneak drugs into cancer cells without being detected and pumped out by cells that have already created drug resistance,” Wang says. “Compared with synthetic materials for drug delivery, DNA nanostructures are biodegradable and biocompatible, and their size, shape and rigidity can be easily manipulated, which are the features nanocarriers need.”

To test their self-assembled DNA origami, the researchers used long-term single cell imaging, an advanced technique that shows molecular interaction, and observed the efficiency of drug delivery in breast cancer cells over a 72-hour period.

“Our results clearly show that efficient drug delivery depends on the shape of DNA nanostructures,” Wang says, “and a rigid 3-D DNA origami triangle transported more DOX in the breast cancer cell nuclei compared to the flexible 2-D DNA structures.”

Wang’s study could also lead to safer bio-tools to diagnose and treat disease.

“With proper modification, this system may also be suitable for delivery of non-drug systems, such as bioprobes for imaging and small interfering RNA (siRNA) molecules for gene therapy,” Wang says.



# BREAKING

# BIAS

Women make up less than 25 percent of the STEM workforce. **Jessica Cundiff**, assistant professor of psychological science at S&T, says that's because women who consider careers in STEM fields are deterred by stereotypes that impose barriers on their recruitment, retention and advancement.

It may seem that women are freely choosing to opt out of math-intensive STEM careers, but Cundiff says the choice is affected by implicit STEM-male stereotypes that may have been unconsciously ingrained since childhood.

She discusses these stereotypes and recommends ways to remove them in "Subtle Barriers and Bias in STEM: How Stereotypes Constrain Women's STEM Participation and Career Progress," her chapter in the February 2018 essay collection *The War on Women in the United States: Beliefs, Tactics and the Best Defenses*. The book examines gender roles and inequity and the impact of unintentional and purposeful efforts to undermine women's equality in the U.S.

Cundiff says educators and practitioners can help break these stereotypes and broaden the appeal of STEM by using diverse images to represent the fields and adapting course projects to include communal goals.

"Even when bias is unconscious, that does not absolve us of responsibility," Cundiff says. "We have a responsibility to interrupt unconscious bias and minimize its effects on our behavior."

## THE HUMAN SIDE OF MEDICINE

Recent studies suggest that the more medical students are exposed to courses in the humanities, the more likely they are to possess empathy, wisdom and emotional intelligence.

Because scientists and humanists often learn and work differently, the field of biomedical humanities examines the human side of healthcare through disciplines like literature, history and philosophy.

This past spring two new research centers, the Center for Science, Technology and Society (CSTS) and the Center for Biomedical Research (CBR), co-presented the first Biomedical Humanities Symposium at S&T.

"Through this holistic approach, students, health professionals and other researchers consider how to use ethical judgment, compassionate communication and sound decision-making along with their scientific expertise," says **Kate Drowne**, CSTS director, associate dean of academic affairs for the College of Arts, Sciences, and Business, and a professor of English.

The CSTS was formed to give S&T humanists, scientists and engineers a chance to collaborate on research that addresses how science and technology shape, and are shaped by, society, culture, politics and the environment.

The CBR is a multidisciplinary center for research and development of advanced biomaterials, devices and therapeutics for applications in the biomedical industry with an emphasis on biomedical engineering.



A VIEW  
TOWARD THE  
FUTURE OF

# AMORPHOUS MATERIALS

Because of their unusual and often superior mechanical, optical, electrical and thermal properties, amorphous oxide materials are already in use in display panels from iPads to smart TVs. Yet we still don't know much about these materials.

**Julia Medvedeva**, a professor of physics, hopes to illuminate our understanding thanks to a \$1.6 million National Science Foundation grant shared by S&T and Northwestern University researchers.

The oxide semiconductors Medvedeva studies demonstrate seemingly contradictory properties, such as optical transparency and electrical conductivity. These properties make the semiconductors ideal for use in flat-panel displays that consume less power while creating brighter images.

They also allow electrons to transmit much more rapidly than through silicon — as high as 50 times the electron mobility of “amorphous” silicon, Medvedeva says. That allows for

higher pixel density, which in turn leads to better screen resolution.

And because the amorphous form of these oxides can be grown at room temperature and on a variety of substrate materials, they can be produced at larger scales and at lower costs than silicon or other crystalline materials, Medvedeva says.

“This is very fundamental research,” she says, but adds that the results could enable advances in flexible-panel displays and wearable electronics, smart windows for homes and cars, and solar panels that could wrap around a surface to capture as much sunlight as possible.

Through the NSF grant, Medvedeva is developing computer models to show

how amorphous oxides act under certain conditions at the atomic level. She will then develop simulations of structures under various conditions and record how those conditions affect the material’s properties.

“We want to start by looking at the way atoms are put together,” she says, “because structure determines everything.”

From these simulations, she will create an open-source software she calls the Amorphous Materials Analysis Database that other scientists worldwide could use and contribute to. Her hope is that this approach will “bring computer-aided design of amorphous materials to a new level.”

“We want to start by looking at the way atoms are put together because structure determines everything.”



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## TECHNOLOGY? NO, 'FASHNOLOGY'

For wearable devices like fitness bands and smart watches to succeed in the marketplace, they must be designed with fashion and aesthetics — the look and feel — in mind.

That's because "wearable technology, unlike traditional technology, is a 'fashnology' because they are both fashion accessories as well as functional technology," says **Fiona Fui-Hoon Nah**, Missouri S&T professor of business and information technology.

A study by Nah and fellow S&T researchers on factors that influence the adoption of wearable technology was published in the *International Journal of Human-Computer Interaction*. They found users also look at brand, common values, image and value.

"Understanding factors influencing the adoption of wearable devices is critical to improving their design and development," says fellow researcher **Keng Siau**, chair and professor of business and information technology.