

CORNERSTONE

Fall 2019

Schwartz is
taking research
on an adventure
PAGE 12

T CIVIL & ENVIRONMENTAL ENGINEERING

Smart Technologies • Walking Under the Influence • Strengthening Nuclear Cores

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On the Cover: John Schwartz and Taylor Blackstone gather data from one of his mobile labs in the Great Smoky Mountain National Park.
Photo by Shawn Poynter.

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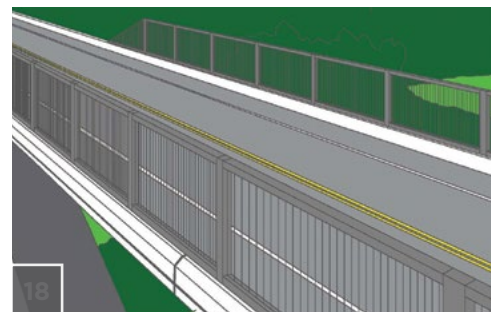
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From the Department Head



As we head into a new academic year, it is worthwhile to look back at the accomplishments of our faculty and students over the last year. The highlight of the year was hosting over 1,000 participants from ASCE student chapters across the region at the 2019 ASCE Southeast Student Conference. By all accounts, the conference was a tremendous success and set the bar for future conferences. I extend my personal thanks to those in the civil and environmental engineering community who supported the conference by volunteering and through financial contributions—we couldn't have done it without you!

We also completed our first year of the expanded two-semester capstone senior design class under the leadership of Senior Lecturer Jenny Retherford. Student teams of four to six tackled real-world civil and environmental engineering problems from the region. The expanded format provided more opportunity for students to interact with and receive feedback from clients and stakeholders, to refine their professional skills in the context of a real-world problem, and to fully define the scope of their project during the first semester, thereby allowing additional time for intensive design during the second semester. A current project focused on suicide prevention on the Natchez Trace Bridge is described in this newsletter. You can learn about other capstone design projects our students have completed at tiny.utk.edu/cee-design.

I encourage you to take a few minutes to read how research conducted by our faculty and students is

extending the frontiers of knowledge in civil and environmental engineering. Our faculty are leading the integration of technology into civil engineering infrastructure, conducting multi-decadal water quality monitoring in the Smoky Mountains, assessing the life of concrete in nuclear energy applications, quantifying a key risk factor to pedestrians, developing fundamental knowledge about the limits to bioremediation of contaminated sites, and discovering the key members of microbial communities essential to waste treatment, to name a few.

It is also my pleasure to welcome two new faculty members that are joining us this fall. Sarah Mobley is a lecturer who will teach many of the undergraduate labs and Nick Zhou is an assistant professor in construction engineering and management. We look forward to their contributions to our program!

I greatly appreciate your interest and support. Let me know how we can continue to improve.

All the best, and Go Vols!

Chris Cox

Robert M. Condra Professor and Department Head,
Civil and Environmental Engineering

Our S M A R T Future

By Élan Young.

Although smart technology continues to completely alter the way humans in the modern world communicate and obtain information, the global web of connected devices, sensors, software, and systems has scarcely scratched the surface of potential for social good. As research plows forward into the Internet of Things and cyberphysical systems with great promise to transform the human-built landscape, civil and environmental engineers are among those helping to shape a more technologically connected future. Meet four CEE faculty members who are advancing research on how to use smart technologies:

Assistant Professor Candace Brakewood

Uncovering behavior of bikeshare riders



Recent research from Brakewood and her collaborators involves mining smartphone app data to better understand bikeshare user behavior. The team's analysis focused on a widely used app known as Transit that provides public transit and shared mobility information in over 175 cities worldwide. This app can also be used to unlock bikeshare bicycles in some cities, including Chicago. The research team developed an algorithm to identify bikeshare users who make a

short trip, return a shared bicycle, and immediately check out another bike, presumably to avoid paying extra usage fees for trips over 30 minutes. The algorithm revealed that 27.3 percent of Transit bikeshare users in Chicago exhibited this cost-saving behavior. The results of this research are important for bikeshare providers to understand the impact of pricing policies, particularly in encouraging the turnover of bicycles.

Read the full study in the May 2019 edition of the *Transportation Research Record: Journal of the Transportation Research Board*.

Assistant Professor Jon Hathaway

Smart stormwater systems

Hathaway is leading the first phase of a collaborative research project funded by the National Science Foundation to identify whether adding technological capabilities to stormwater systems will help cities control flooding and adapt to changing climates. Whereas most cities have some physical form of storm management in place, having a smart stormwater system would give managers greater capability to adjust and respond as needed during storms. His research includes studying 20 bioretention columns housed in an experimental greenhouse. The columns are equipped with water level and soil moisture sensors to better monitor

their performance and provide key insights as to how technology can modify natural biogeochemical processes. Once the first project phase is complete, colleagues at the University of Virginia will begin scaling the lab results to a full-sized bioretention area. Later, researchers at the University of Michigan will use computer modeling to understand how these individual practices can be controlled in concert to achieve watershed-scale benefits.



Beaman Professor Asad Khattak

Testing and certification of autonomous vehicles

Khattak's latest collaborative research with UT Chattanooga, UT Space Institute, and East Tennessee State University aims to take knowledge about the automation of air and space vehicles to see what can be applied to connected and automated vehicles (CAVs) for daily use. While CAVs might be more than a decade away from integrating into the mainstream US transportation system, Khattak is hopeful they can transform the transportation industry to reduce traffic fatalities, which are currently more than 1,000 per year in the state of Tennessee and 38,000 per year in the

US. CAVs can also mitigate traffic congestion, which costs \$1.1 billion annually in Tennessee's four largest cities. In their TDOT-sponsored project, Khattak and his project partners are working toward a testing and certification system to ensure that, as vehicles become more automated and connected, there are proper safeguards in place to protect human life.



Assistant Professor Shuai Li

Mapping subsurface infrastructure

Through a grant from the National Science Foundation, Li is researching how sensor-equipped autonomous vehicles can help map the infrastructure beneath a city and how that map can be used to navigate autonomous vehicles in distressed urban areas during and after natural and man-made disasters. Under city roads exist water pipes, utility cables, and gas lines, so having the ability to digitally map this infrastructure

can vastly improve safety when digging is required. The project involves using multiple CAVs with ground-penetrating radar technology to collect radargrams of subsurface infrastructure along coordinated trajectories.



CEE Hosts 1,000 Participants

for ASCE SE Student Conference

By Élan Young.



CEE was proud to host the 2019 American Society of Civil Engineers (ASCE) Southeast Regional Conference for 28 schools to test their skills in 17 competitions. The theme of Rockin' in the Smokies set the stage for the conference's musical theme that welcomed attendees to Knoxville. UT placed 4th overall, coming first in the GeoWall, Professional Paper, and On Tour competitions and second in the Sight Reading and Concrete Canoe Product Display competitions.

In addition to hosting, the conference engaged more than 75 UT engineering students and more than 40

professional engineers to volunteer, while nearly 40 sponsors contributed \$80,000 to carry out the event.

"The students were having fun applying their civil engineering and professional knowledge in engineering competitions, while expressing their school spirit, developing their leadership skills, and making new friends and memories," said Department Head Chris Cox. "These kinds of formative experiences for young engineers contribute to building their own sense of belonging to the profession and to ASCE."

Faculty conference organizer and CEE Senior Lecturer Jenny Retherford said the student organizers put in many hours over the last two years to make the conference a success.

"UT hosted a conference that sets the standard for efficiency and coordination," she said. "Many participants complimented the venues, our campus, the competition designs, and the overall experience we created for the event."

Special Thanks to the Following Sponsors:

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UT ASCE Chapter Raises Funds through Volstarter

By Harrison Ooi (Senior, Civil Engineering).

As a civil engineering student who just wrapped up his junior year at UT, I have had the pleasure of being the fundraising chair for the ASCE student chapter for the 2018-2019 year.

Through working with great individuals within the executive board and communicating with local companies for donations, it has been a great privilege to watch ASCE grow as a chapter, and to also have the opportunity to watch the UT ASCE Chapter host the 2019 Southeast Student Conference. Through meeting with multiple companies, the chapter was able to successfully raise more money than ever before through their generous offers to take ASCE to the next level.

Additionally, this academic year, the team also decided to take a new, proactive measure to fund more money for the organization by creating a Volstarter campaign. This start-up has given the opportunity for future leaders within the program to get a jump-start on establishing a more secure basis with other civil engineering companies across Knoxville and Tennessee.

It has been a great privilege to partake in an organization where everyone supports each other and contributes to the future generations of civil engineering students. While the campaign to raise funds for the 2019 ASCE Southeast Student Conference is over, people can still donate through the link to help us pay for future expenses, such as making sure students who need financial assistance can still attend the conference and potentially even send every student to future conferences if we receive enough support.

Around the ASCE SE Conference



Student demonstrates UT's doghouse built completely using sustainable solutions. View the build at tiny.utk.edu/doghouse.

Students test their calculations on how to make a rolling stone move on a hydraulic flume.

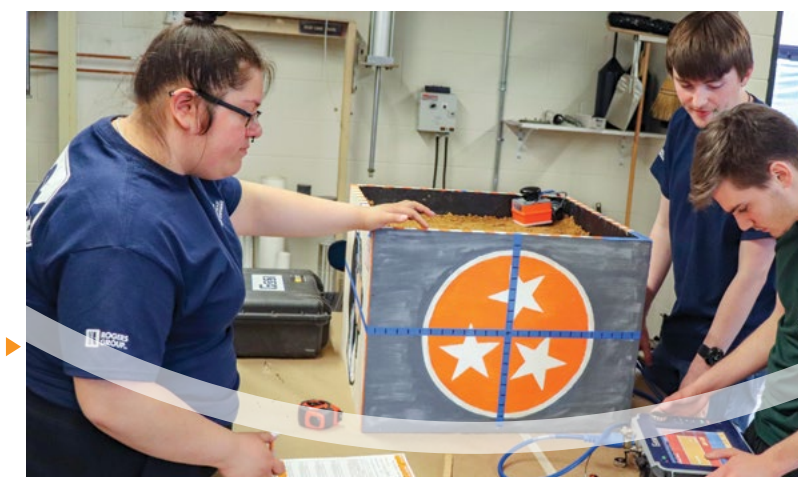


Testing a mechanically stabilized earth wall during the GeoWall competition.



Students from Florida A&M University test their concrete canoe for its ability to take on water.

UT students make final preparations before their structure attempts to remain standing in the Shake it Off competition.



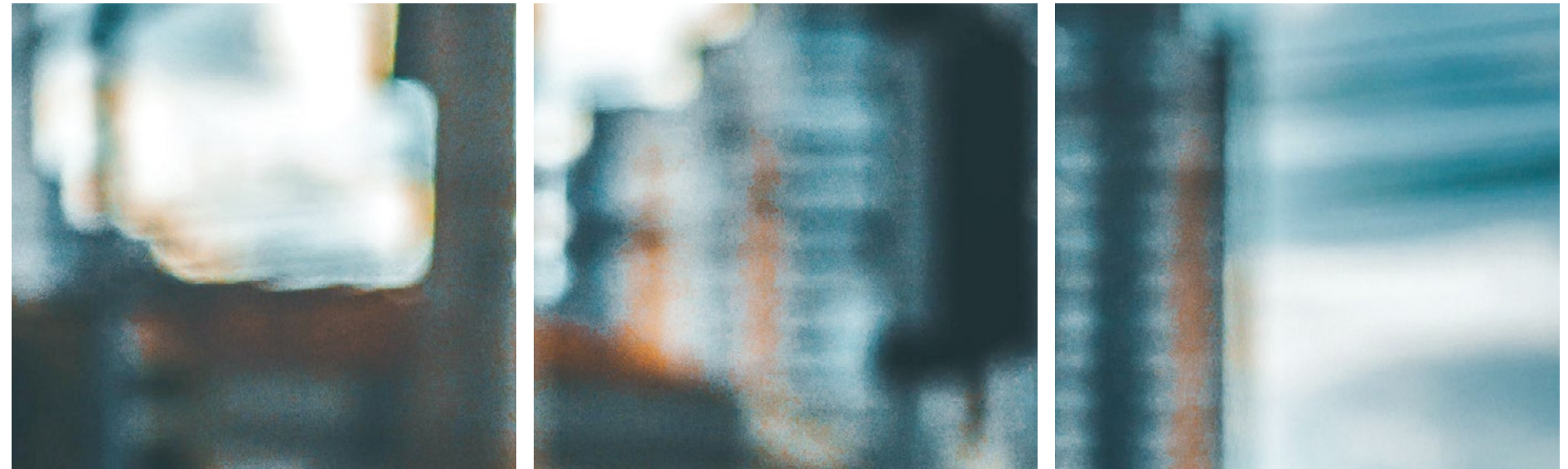
Students design and test improvised water filtration systems.



Testing concrete samples from the Concrete Concerto competition.

Walking Under the Influence

By Élan Young.



How often are pedestrians involved in alcohol-related car crashes? Most might assume pedestrians would be innocent victims in such cases, but Professor Chris Cherry has uncovered data that shows how often pedestrians who are Walking Under the Influence (WUI) are the cause of car accidents that result in their injury or death.

In Tennessee between 2011-2016, 11,309 reported crashes occurred that involved pedestrians. PhD student Amin Mohamadi Hezaveh and Cherry recently explored available data from the Tennessee Integrated Traffic Analysis Network (TITAN) to determine the role of alcohol in crashes involving pedestrians, specifically those who were WUI. His findings were recently published in Volume 121 of *Accident Analysis & Prevention*.

The study aims to identify the share of crashes where WUI was a factor, regardless of injury severity, explore WUI crash characteristics and compare them with non-WUI crashes, identify the groups that have a higher likelihood of involvement in WUI crashes, and finally, explore the association between characteristics of the pedestrian, road, and environment and WUI.

Cherry and Hezaveh discovered a number of interesting details:

- » Approximately 22 percent of pedestrians who died in crashes had alcohol in their system
- » Alcohol was present in 7 percent of pedestrians involved in crashes (but who did not die)

- » Those with alcohol in their system had a high chance of severe crashes
- » Males were 1.9 times more likely to be involved in WUI crashes compared to females
- » Pedestrians aged 40-54 had the highest likelihood of being involved in WUI crashes
- » WUI crashes were 50 percent more likely to happen over the weekend than on weekdays
- » Nighttime crashes without streetlights were a main contributor to WUI crashes compared to other pedestrian crashes

The profile of the WUI crash is in line with other studies that have focused solely on WUI crashes resulting in

fatalities or severe injury. WUI crashes usually occur at night, at non-intersection locations, and locations without traffic control, and are more frequent on Friday night, Saturdays, and Sundays. Additionally, pedestrians involved in these crashes tend to be older and male.

“Since crashes were more likely in straightaway sections than where the driver was turning, road improvements and lighting where drivers are not expecting a pedestrian could help,” said Hezaveh.

Additionally, Cherry suggested that if Tennessee Police record the Blood Alcohol Content more consistently, researchers would be better able to identify a critical threshold for BAC that put pedestrians in danger.





Core Strength

Writing and photography by Elan Young.



The failure of concrete in any form of construction is troubling enough, but add in the ‘failure-is-not-an-option’ component of nuclear energy, and the need for reliable materials increases tenfold.

Professor John Ma is seeking to remedy that problem before it even starts, thanks to a multi-year project now entering its final phase.

“We are hopeful that this project provides the nuclear industry with valuable information for many years to come,” Ma said.

“**There were many people involved in making this project come to life, and together we’ve gathered our expertise to try to provide answers to the nuclear industry.**”

—John Ma

Ma’s study involves the degradation of concrete through the Alkali Silica Reaction (ASR), also known as the “cancer” of concrete. During these reactions, concrete forms a gel that absorbs water. As it expands, it damages concrete over time, both on the surface and within structures. By understanding how ASR works, the strengths of existing reactors and their safety can be monitored and outcomes better predicted.

For the study, Ma rigged a number of samples with different sensors to see which ones worked the best, including acoustic emission, pressure sensors, fiber optics, and transducers that convert physical changes into electrical signals.

Steel reinforcement layers were designed for the top and bottom of each specimen, so as to leave the entire thickness without shear reinforcement. He then set up two samples with different boundaries, allowing one to grow unimpeded while the other was constrained.

ASR was accelerated by maintaining the samples at 95 percent humidity and 100 degrees Fahrenheit. ASR was further accelerated in two of the specimen by adding sodium hydroxide to the mix, while lithium nitrate was used in the control mix formulation.

After years of being subjected to test conditions, the temperature-controlled chamber—specially designed for this study—was removed and the three test structures were cut into both beams and wall elements.

With the chamber gone, the team was able to remove cylinders of concrete, which will help identify the behavior of the concrete in different directions. All of the tests contribute to a greater understanding of concrete’s behavior under different circumstances.

The experiment—thought to be the first of its kind at this scale and with so many monitoring sensors—is hoped to provide a better understanding of the effect of geometrical conditions and preexisting ASR cracks.

The specific purpose of the project is to provide insight for the nuclear industry in managing aging infrastructure, with Oak Ridge National Laboratory and a consortium of other universities including the University of Alabama, the University of South Carolina, and Vanderbilt University, serving as partners.

While this study is focused on the nuclear industry, it will also provide far-reaching understanding into the behavior of concrete across other industries.



A Lab with a View

By Andrea Schneibel. Photography by Shawn Poynter.

In the Great Smoky Mountains National Park, UT engineering professors and students are taking adventurous steps to ensure the quality of our water and air is in check.



Clockwise from left: Schwartz and graduate student Taylor Blackstone taking data from the open site; Taylor Blackstone tests water samples; bottles are connected to sensors that help monitor groundwater.





At first glance, there is nothing particularly striking about John Schwartz's workstation. It's nestled high up on a ridge on the North Carolina side of the park just southeast of Clingmans Dome. In one spot, a few white buckets collect water from the tree canopy. In another area, he manually cleans sediment out of a flume to ensure the quality of water samples.

And yet, the work that he and his students do at the Noland Divide Water Quality Station has implications in the everyday lives of millions of people: they monitor the levels of acids and other contamination present in the water that flows through the park.

Schwartz, director of the Tennessee Water Resources Research Center and professor of civil and environmental engineering, started working on this project 20 years ago when he first arrived at UT, but the project's beginnings can be traced back to 1991. The university, along with Oak Ridge National Laboratory, had begun participating in a federally funded program called the Integrated Forest Study, an international collaboration to explore the "effects of atmospheric deposition on forest nutrient cycles," according to the DoE.

Since then, UT students and professors have been collecting and processing water samples every two weeks, and the research has morphed in a number of ways in an attempt to find answers to new questions.

Located on the line that divides Tennessee from North Carolina, the Noland Divide Trail sits at an altitude of about 4,000 feet. It is this height that makes it an ideal place to capture all sorts of pollutants coming from as far as the Midwest, says Schwartz.

"Imagine all the samples that we have collected for 28 years, every two weeks. That's a wealth of information."

-John Schwartz

"Power plants in Georgia, coal mining... All of these places emit chemicals that need to be checked

periodically to better understand their effects on the diverse and fragile ecosystem that is the Smoky Mountains."

For this purpose, Schwartz and his students manage three collection points in Noland Divide.

The first one is known as the through-fall bucket site. Here, a series of buckets collect the water falling from the tree canopy. This gives researchers an idea of the pollutants that travel in the air and make it to the park.

At the second point, the team collects samples from a stream that travels through a flume, which provides detail on how the pollutants that travel via air are processed on the ground.

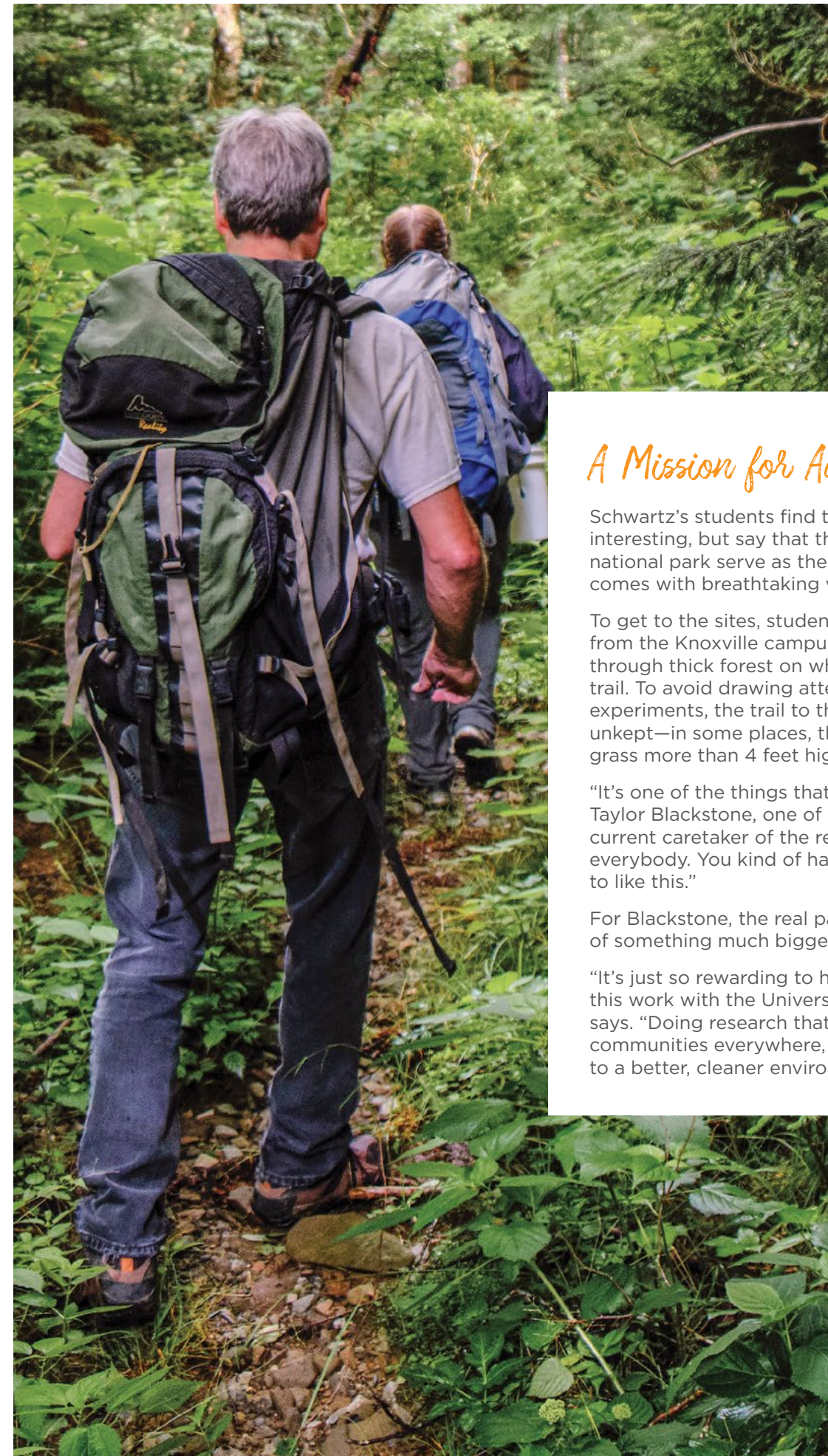
The third station is known as the open site. It's a small platform that holds a weather station in a clearing surrounded by trees. It has an automated water collection bucket with a lid that opens when rain is detected. Because the water doesn't touch tree leaves, the ground, or come from water streams, the information collected here acts as a baseline for the rest of the samples and gives scientists an insight on how much acid deposition clouds can carry.

It might seem like an underwhelming setting, but the data obtained here is very important. The quality of the water found in the park can tell researchers several things about the current state of the environment, including the very air we breathe.

In fact, Schwartz explains that there was an evident decrease in the levels of pollutants present in the park's waters between 2005 and 2008, when the Tennessee Valley Authority started using softer coal to fuel their operations and converted some of their plants to natural gas.

"Documenting these changes and trying to explain how and why they occur is vital," he said.

Very little of this work would be possible without the help of Schwartz's graduate students.



A Mission for Adventure-seekers

Schwartz's students find the research exciting and interesting, but say that the real treat is having the national park serve as their very own office, a perk that comes with breathtaking views.

To get to the sites, students drive about 90 minutes from the Knoxville campus, then hike about a mile through thick forest on what it is mostly an unmarked trail. To avoid drawing attention to equipment and experiments, the trail to the research station is unkept—in some places, the trail is overgrown with grass more than 4 feet high.

"It's one of the things that drew me to this job," said Taylor Blackstone, one of Schwartz's PhD students and current caretaker of the research site. "But it is not for everybody. You kind of have to be a natural explorer to like this."

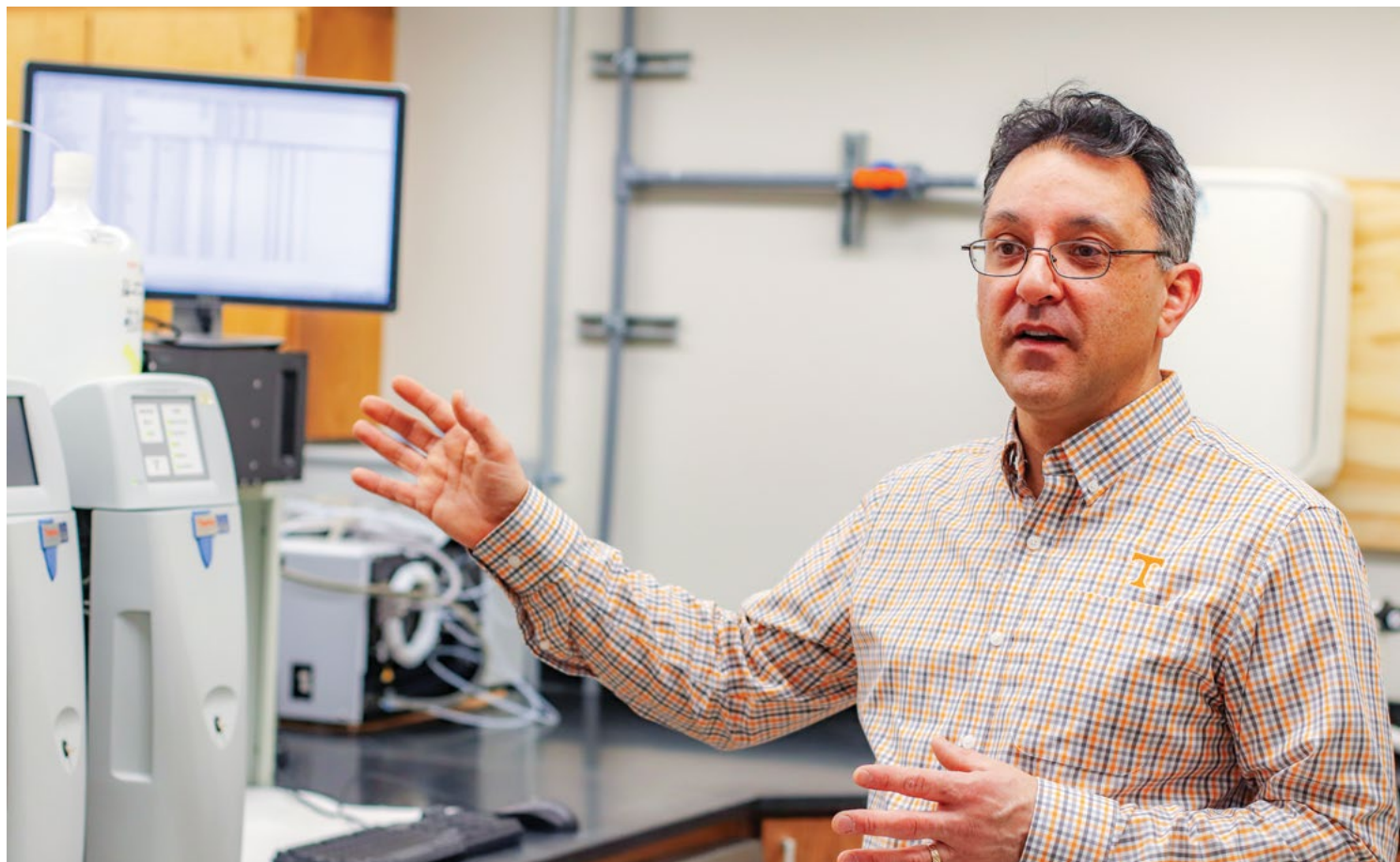
For Blackstone, the real payoff of her work is being part of something much bigger than herself.

"It's just so rewarding to have the opportunity to do this work with the University of Tennessee," Blackstone says. "Doing research that can have such an impact on communities everywhere, and being able to contribute to a better, cleaner environment is a privilege to me."

◀ Clockwise from left: Schwartz checks the collection of water from the through-fall bucket site; Schwartz and Taylor Blackstone hike to the station.

Testing the Waters

By David Goddard. Photography by Randall Brown.



A new laboratory established in 2018 is on its way to becoming a regional leader in water quality analysis. The Water Quality Core Facility (WQCF) already has relationships with some noteworthy clients.

“The Great Smoky Mountains National Park and the Big South Fork National River and Recreation Area are longtime partners with UT,” said lab manager Adrian Gonzalez. “We’ve done water analyses for them since the 1990s to monitor effects from acid rain and climate change, but we are entering a whole new chapter through the establishment of this dedicated lab.”

The lab offers analytical services and expertise to clients such as the US National Laboratories and to other UT departments including microbiology, biosystems engineering and soil science, and earth and planetary sciences.

Housed in the Science and Engineering Research Facility, WQCF was envisioned by Department Head Chris Cox as a natural step forward in the collaborative history between GSMNP and Professor John Schwartz, who also directs UT’s Tennessee Water Resources Research Center.

Gonzalez earned his doctorate under Schwartz last year while serving as manager of the lab that was the precursor to the WQCF. Gonzalez credited the department and Facilities Services for the “Herculean

effort” put forth to quickly transform the space and expand the lab’s client base.

“Water quality is important to more than academic researchers, so our mission is to offer high-quality analytical services to a broad spectrum of clients,” Gonzalez said. “Our combination of facilities, expertise, and experience with long-term partners offers a unique opportunity.”

The lab is seeking national accreditation, which will open partnerships with organizations seeking the most reliable, accurate, and reproducible water quality measurements.

Accreditation will mean the lab meets or exceeds the data quality standards required of many high-budget commercial labs around the country.

“UT researchers know that if they partner with the WQCF, they will have the same or better data quality as anywhere else, but at greatly reduced cost,” said Gonzalez. “Our mission is to promote research and education in the public realm, whereas private labs have a heavier focus on turning profit.”



N₂O Laughing Matter

By Élan Young. Photography by Shawn Poynter.

A new Superfund Research Program (SRP) study led by UT-ORNL Governor’s Chair Frank Loeffler shows that nitrous oxide (N₂O), better known as laughing gas, commonly occurs in groundwater due to agricultural runoff and is responsible for inhibiting bacteria that breakdown toxic contaminants.

Bioremediation, the process of using microorganisms to degrade pollutants found in water and soil, has proven to be effective in detoxifying some chlorinated organic pollutants. Essentially, the microorganisms gain energy for growth and reproduction by breaking the spring-like chemical bonds between atoms and stealing electrons.

However, Loeffler and his team of researchers have recently discovered that reductive dichlorination—the removal of chlorine atoms to turn contaminants into non-toxic substances—can be stalled even when there are low levels of N₂O present.

For the study, the team measured the dechlorination rates of hazardous compounds such as tetrachloroethene (PCE), dichloroethene (cDCE), and vinyl chloride (VC) by bacteria used in bioremediation, specifically *Dehalococcoides mccartyi* and *Geobacter lovleyi*.

They found that even low concentrations of N₂O can interfere with the enzymes that perform the dechlorination process, which can result in incomplete dechlorination. Loeffler and his team are continuing to explore how biological and geochemical conditions at a site can impact the reductive chlorination activity of the bacteria.

“Incomplete biodegradation of toxic chlorinated pollutants is often observed but it was not clear why” said Loeffler. “Our findings imply that N₂O negatively impacts the bacterial detoxification process, and we need better control of agricultural fertilizer runoff to prevent undesirable consequences to precious drinking water resources.”

Since 1987, SRP, which is part of the National Institute of Environmental Health Sciences, has provided practical, scientific solutions to protect health, the environment, and communities. SRP funds grants on basic biological, environmental, and engineering processes to find real solutions to hazardous waste problems.

SRP also works to learn more about ways to protect the public from exposure to hazardous substances found in contaminated water, soil, and air at Superfund waste sites throughout the United States.

A Change for the Better

By David Goddard. Photography by Trish Merelo.



(L-R) Barry Boyd, chief of maintenance of the Natchez Trace, and Sarah Davis, chief ranger; pose with UT students Jay Thota, Connor Campbell, and Meet Patel at the site of the Natchez Trace Bridge.

The Natchez Trace Bridge is famous for its architecture and its views, but a darker reputation has begun to surround it in recent years due to its increasing use in suicides.

The National Park Service (NPS), which has jurisdiction over the bridge and park, doesn't keep official records of the number of suicides, but the Williamson County Sheriff's Office, which serves as de-facto law enforcement for the bridge, says that at least 32 people have died after jumping from the bridge, most recently on New Year's Eve in 2018.

Trish Merelo's son John was one of those, dying in January, 2016. Like most cases, the people he left behind had been given few warning signs; he was a solid student, didn't miss school, and had a scholarship to the University of Alabama awaiting him.

"He had told me he had symptoms of depression, but he'd told me he'd let me know when he was feeling down," Merelo said during a visit to UT. "When I woke up that morning and he wasn't at the house, I knew. I just knew."

Following that turn of events, Merelo learned about the other instances at the bridge, figuring out that the bridge's design played a major role in its grim status.

Since it wasn't intended to carry foot traffic, the sides of the bridge were built only 32 inches high so as to not impede the view from cars traversing it. Although ideal for sightseeing, it has proven far too easy for people to surmount.

"Barriers are the only way to prevent people from jumping from bridges," Merelo said. "The national suicide prevention organization has gone so far as to issue a paper saying as such."

Along with other people who have lost family members at the bridge, Merelo formed the Natchez Trace Bridge Barrier Coalition.

Inspired, she sent out feelers to several major public and private universities around Tennessee, but only UT had the right pieces in place to help. That's where Jenny Retherford, senior lecturer in the Department of Civil and Environmental Engineering, entered the picture.

Retherford answered Merelo's request and told her she'd be glad to help, setting up a senior design project aimed at developing barriers for use on the bridge.

"Civil engineering, at its core, is all about serving for the betterment of humanity," Retherford said. "What could be more perfect for that than quite literally preventing suicides?"

Retherford's team of students face a number of challenges due to the bridge's location in a national park. Any change to the bridge must conform with park rules mandating design, materials, changes to aesthetics, and even the "feeling" it evokes when viewed. The students have spent the spring semester tackling the project.

"We are currently performing a lot of research to create a design that will comply with [NPS] guidelines and regulations while also satisfying the coalition's wishes, so we're taking it a little slow right now," said Nancy Abdo, a CEE senior who has served as liaison for the project's various entities. "Once we settle on a design, we can shift our focus to a more technical engineering scope next semester."

Along those lines, Abdo said the team has decided that any solution will likely be a mix of aluminum and concrete, which would satisfy a key NPS requirement since those materials are already in use on the bridge.

In addition to Abdo, the team includes students with concentrations in structures, construction management, transportation, and water resources, covering all the bases a project such as this requires.

"The great thing about this team is that they all actively chose this project," Retherford said. "It's inspiring because what they are doing will have a very real influence on society."

The team and their project also recently received help from a powerful source, as Tennessee State Representative Sam Whitson, whose district includes the bridge, introduced legislation aimed at loosening NPS rules so the bridge could be altered. That bill unanimously passed its first committee, the first step in the legislative process.



Natchez Trace Bridge Update: Students Submit Designs

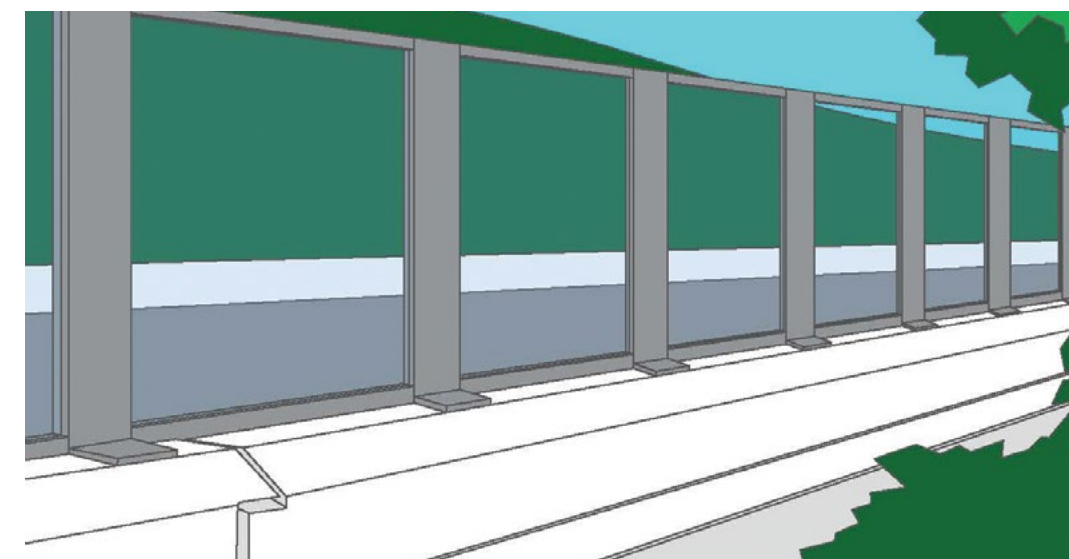
Students from the Department of Civil and Environmental Engineering have submitted four design ideas for consideration as safety improvements to the Natchez Trace Parkway Bridge.

Working in response to a request from the Natchez Trace Bridge Barrier Coalition and under the guidelines of the National Park Service, the designs seek to curb suicide attempts from the bridge while preserving the view and adhering to strict standards related to materials.

Those four designs, all made primarily of metal and featuring fenceposts every few feet, are:

- » **Cable Barrier Concept:** Includes rectangular sections of metal featuring vertical cables along the span
- » **Fence Barrier Concept:** Much like a standard property fence, features metal strips spaced far enough apart to still allow a view of the valley
- » **Plexiglass Barrier Concept:** Instead of spaced metal planks, uses plexiglass to completely cover areas between posts without obscuring any of the view (CAD drawing of this concept pictured below)
- » **Standard Highway Barrier Concept:** Likely the easiest to implement, features the same three-decked barrier seen along many interstates.

Once the fall semester begins, the CEE student team will next seek to incorporate feedback from the coalition and the government, hopefully settling on a final design all sides approve.



UT's He Helping Flush Away Problems with Wastewater

By Élan Young. Photography by Jack Parker.



It has long been understood that microorganisms play a key role in the treatment of wastewater, but what is less well known is how the process is affected by the diversity of such populations of bacteria and microbes.

CEE Associate Professor Qiang He is working with a team of experts from around the world to help solve that riddle by analyzing the global patterns of these microorganisms.

Using a systematic sampling system to evaluate 1,200 activated sludge (or aerated sewage) samples from 269 waste water treatment plants in 23 countries on 6 continents, the team seeks to better understand microorganism diversity and factors controlling it.

Their findings found that, despite the high diversity of approximately 1 billion bacterial phylotypes, the activated sludge had a small global

core bacterial community that were most closely associated with freshwater populations.

With nearly 300 cubic kilometers of wastewater produced globally each year—an amount equal to roughly 15 percent of all the rivers flowing on earth— even a small improvement in treatment methods would have an enormous impact on humanity.

“We use microbes to treat our wastewater,” said He. “But we actually don’t know a lot about the key microbes doing this job. This work helps answer this particular question and makes it possible to target the key populations and improve wastewater treatment.”

The study, entitled “Global diversity and biogeography of bacterial communities in wastewater treatment plants,” has been published in the journal *Nature Microbiology*.

UT Student ITE Chapter Wins Traffic Bowl

By Élan Young.

The annual Tennessee Section Institute of Transportation Engineers (ITE) Traffic Bowl was hosted at Tennessee State University in Nashville on February 27. Three teams competed for the title this year: UT, the University of Memphis, and TSU.

The UT students made a comeback in the final round to beat University of Memphis, making this win the 6th title for UT since 2011. The competition follows the style of the popular television show, Jeopardy! In the first and second round, students are asked 25 questions worth 100 to 500 points each across 5 different categories. During the third and final round, teams answer just one question and can bet up to all the points they have accumulated.

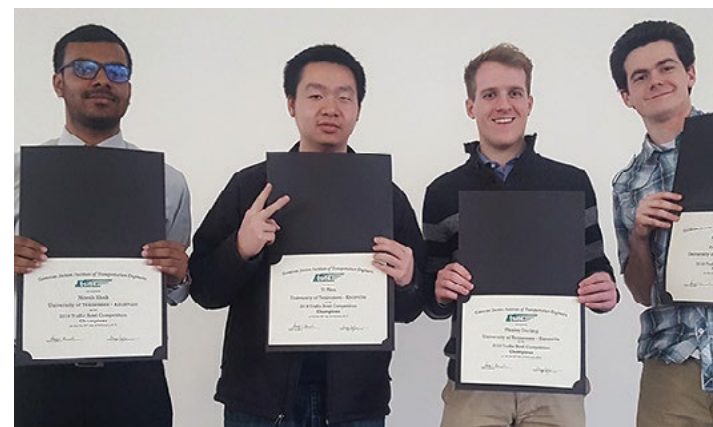
UT had 4,200 points entering the final round, with University of Memphis in the lead with 5,400.

“We bet all of our points and answered the question correctly for a score of 8,400,” said team member Yi Wen. “University of Memphis did not answer the question correctly and lost the points they bet on.”

“The Institute of Transportation Engineers is an organization that provides a community of

transportation experts and researchers to students to help shape their professional future,” said UT ITE chapter President Ramin Arvin.

The four team members, Nitesh Shah, Wen, Wesley Darling, and Zachary Jerome, went on to represent UT in the southern district ITE Traffic Bowl competition in Arlington, Virginia, last March.



From left to right: Nitesh Shah, Yi Wen, Wesley Darling, and Zachary Jerome.

FACULTY NOTES



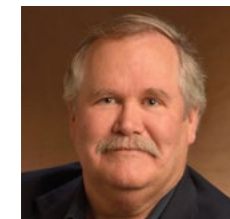
John D. Tickle Professor **Joshua Fu** spoke at the Expert Meeting on Measurement-Model Fusion for Global Total Atmospheric Deposition, held in Geneva, Switzerland, in late February. Fu provided expert advice, input, and guidance during the workshop’s discussion sessions on how to advance the field on a global scale.



Assistant Professor **Jon Hathaway** received the Environmental Leadership Faculty Award from the Office of Sustainability’s Committee on the Campus Environment last spring. He was honored for his previous work with the Green Fee and the dedication he shows to students in bringing them into his work on water resources engineering. The UT Chapter of Phi Eta Sigma National Honor Society also recognized Hathaway for his exceptional contributions as a faculty member with their Outstanding Faculty Award. The award acknowledges a faculty member for going above and beyond in the classroom to make lasting positive impacts on students.



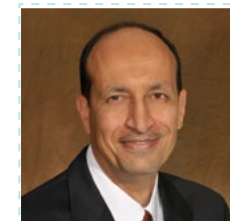
Edwin G. Burdette Professor **Baoshan Huang** received the Research and Creative Achievement Award at the 2019 Chancellor’s Honors Banquet. The honor is bestowed to senior faculty in recognition of excellence in research, scholarship, and creative achievement. Huang is ranked among the most prolific authors in the world on pavement and asphalt, with more than 200 refereed journal articles published.



Terry Hazen, UT-ORNL Governor’s Chair for Environmental Biotechnology, was named one of UT’s top cited researchers for the 2018–19 school year. While the methodology Clarivate uses is fairly complex, it results in a list of the top 1 percent of researchers in a given field.



Professor **John Schwartz** was named director of the Tennessee Water Resources Research Center (TNWRRC), located in UT’s Institute for a Secure and Sustainable Environment (ISSE). Schwartz is also serving on a committee with the National Academies of Sciences, Engineering, and Medicine (NASEM) to comprehensively evaluate the Watershed Protection Plan for New York City’s drinking water supply. Eighteen experts from around the US are serving on this 21-month long assignment.



Professor **Khalid Alshibli** gave a keynote lecture at the IS-Atlanta 2018, an international conference for geotechnical engineers. His lecture, entitled “Particle Level Constitutive Behavior of Sand,” highlights the importance of considering the anisotropic behavior (i.e., different engineering properties when loading a sand grain in different directions) when compressing an individual sand grain.



Senior Fellow of the Howard H. Baker Jr. Center for Public Policy and Research Professor **David Greene** was featured in an article on the future of electric vehicles (EVs) by *Southern Automotive Alliance*. In the article, Greene predicts an increase in EV sales due to a number of factors, including a reduction in the cost of batteries. He also discusses his own EV, a BMW i3 electric, and the ways in which EVs are superior to traditional vehicles.

STUDENT NOTES

Ten CEE students were recognized for their exceptional contributions to UT at the 2019 Chancellor's Honors Banquet. The following undergraduates were recognized for their Extraordinary Academic Achievement: **Rebecca Bennett, Matthew Howard, Katie Lance, and Ryan Marine**. Students who received recognition for Extraordinary Professional Promise included **Ali Boggs, Charles Cianciolo, Nolan Hayes, Abdollah Javidialesaadi, Ryan Johnson, and Jiani Tan**.



Doctoral student **Ali Boggs** was honored by the Collaborative Sciences Center for Road Safety at the Council of University Transportation Center's (CUTC) 28th Annual Outstanding Student of the Year Awards Ceremony. Boggs's research includes examining self-driving vehicle

crashes and disengagements and commercial vehicle parking shortage. The award came with a \$1,000 scholarship, a certificate from the US Department of Transportation, and registration to the CUTC Awards Banquet in Washington, DC.

Mohmad Mohsin Thakur competed at the Geo-Poster Challenge of the Geo-Congress 2019 earlier this year. Thakur's presentation, entitled "Capillary Suction Measurements in Granular Materials from Experiments and Direct Numerical Simulations Using X-ray Computed Tomography Microstructure," is based on his research that aims to improve the fundamental understanding of multiphase flow behavior in granular materials at pore scale.



The Graduate School awarded a Student/Faculty Research Award to John D. Tickle Professor **Joshua Fu** and his doctoral student **Jiani Tan**. The award provides up to \$5,000 to student/faculty pairs to further their research goals. Fu and Tan's research aims to study the effectiveness of current and past emission control strategies on alleviating the excess of atmospheric deposition over the terrestrial ecosystems of the US.

The Knoxville Chapter of the Tennessee Society of Professional Engineers awarded six students with scholarships at its All Engineers Banquet in conjunction with Engineer's Week. The students included current seniors **Luke Edwards and Lauren Meffe, Zachary Jerome, Katie Lance, Cameron Neary, and Jonathan West**. The banquet was a celebration of STEM educators, engineers, and their impact on society.



UT placed fourth at the 2019 Southeast Regional Steel Bridge Competition, held in March. Student teams from across the southeast were challenged to design, fabricate, construct, and load test a roughly 1:10-scale model steel bridge that must be 20 feet long and be able to withstand a load of 2,500 pounds. Team members included **Andrew Shahan, John Stanford, Peyton Mize, James Hegedus, and Francisco Lemus**. Professors Tim Truster and Mark Denavit served as faculty advisors.



Graduate students **Numan Ahmad, Mojdeh Azad, Amin Mohamadi Hezaveh, Nitesh Shah, and Zhihua Zhang** were named 2019 Traffic Safety Scholars and each received a \$1,000 scholarship at the 37th Annual National Lifesavers Conference on Highway Safety Priorities. The students were among 50 to be selected through a competitive essay application process where they explained how their study could help countries move closer to achieving the goal of zero fatalities on roadways.

ALUMNI NOTES

Five recent 2018 graduates were recognized last fall for their aesthetic design of a timber transmission tower in a competition hosted by Aesthetic Competition Series. **Morgan Jenkins, Williams Kin, Matthew Livesay, Liliana Porras, and Trenton Wiles** teamed up to engineer an aesthetically-pleasing design for the built environment. Their design was selected over other submissions by industry professionals. The prize came with \$10,000, \$1,000 of which the team donated to the 2019 SE-ASCE Conference UT hosted this past March.



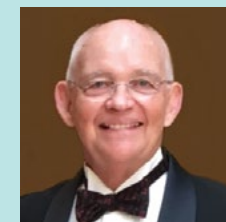
Trenton Wiles and Jennifer Retherford, senior lecturer, accept check from Aesthetic Competition Series officials for their timber transmission tower.



Morgan Jenkins, Williams Kin, Matthew Livesay, Liliana Porras, and Trenton Wiles on site at the timber transmission tower site.

In Memoriam

The Department of Civil and Environmental Engineering extends its deepest sympathies to the families of two friends of the department who passed away earlier this year.



Edwin A. McDougale Jr. passed away on January 23, 2019. He completed his MS degree under Professor Emeritus Ed Burdette, who passed away in 2018. McDougale had a distinguished career at Ross Bryan and Associates, culminating in him serving as president of the firm. He was a former member of the CEE and TCE Boards of Advisors and a great friend of the department.



Curtis Saufley Allin Jr. of Louisville, Tennessee, passed away at age 90 on January 15, 2019. Allin was a proud US Army veteran who served in the Korean War. He attended Jefferson City Missouri Junior College and the University of New Hampshire before training with Casagrande Consultants at Harvard University. He served the department as a lab supervisor for 40 years.

Join Caroline.
Join the Journey.

“As a research assistant in the Hydraulics and Sedimentation Laboratory, I have studied the effects of natural and man-made structures in flowing canals and used rare earth elements to tag soil and determine erosion patterns. I am sincerely grateful to Volunteer donors because financial aid has helped me continue my education, which I hope to use to make the world a better place.”

—Caroline Stephens,
TCE Ambassador,
FY20 Lawrence Barker Scholar



Invest in our journey to help other students like Caroline explore their passions. Call **865-974-8890** or visit giving.utk.edu/cee.

Find us on Instagram

Follow the department on Instagram @cee_utk.



cee_utk On #InternationalWomensDay, we want to acknowledge two of our student leaders. Kendra Jackson, left, is president of @nsbeutk, & Laura Ferrer is president of @utkshpe. Their leadership definitely makes TCE a stronger program!



cee_utk It's graduation day! Congratulations to all our graduating seniors. Thanks to Dr. Retherford for sharing photos of Senior Design teams. Commencement begins at 9am at Thompson-Boling. #engineeringVols #commencement #graduation



cee_utk Meet CEE graduate student Elina Geut. She is a rising star in the department, helping Dr. Truster with his CAREER award research. She intends to design skyscrapers one day. Read more about her at the link in our bio. #EngineeringVols



cee_utk We are so proud of CEE Business Manager Samantha Allen and Financial Specialist I Amber Mathes! Both have earned their MBA degrees from @utmartin while holding down full time jobs running the CEE office. Way to go, ladies! 🙌

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big orange. big ideas.



Check out photos from the ASCE SE Conference.