Innovations

Basic and Applied Sciences Magazine

Fall 2018 Vol. 5, No. 1

The Changing Faces of STEM

Seven CBAS female faculty members among rising research stars

Rachel Leander

MIDDLE TENNESSEE STATE UNIVERSITY

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Fall 2018, Vol. 5, No. 1

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2,000 copies printed at Lithographics, Nashville, Tennessee
Designed by MTSU Creative and Visual Services

MIDDLE TENNESSEE STATE UNIVERSITY

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Words and **Actions**

I am proud, honored, and humbled to continue to lead the College of Basic and Applied Sciences.

At almost 5,200 students and 150 faculty, our college is the largest at the University. In a typical year, we are responsible for one in every five degrees granted by MTSU. Our students represent about 24 percent of the total student body, yet frequently account for 30 to 50 percent of academic honor society memberships, national award and fellowship winners, and student government officers.

But numbers alone don't tell the whole story. We are a diverse college in terms of gender, race, and ethnicity, and the number of female students, faculty, and alumnae is growing. In this issue of *Innovations*, you'll see several stories on many of our successful female graduates, faculty, staff, and students. We are lucky to have such strong and accomplished women in the college family.

I also want to draw your attention to the important and impactful work of our faculty and students, some of which is featured in this issue. Research conducted at the college tackles the most pressing issues facing Tennessee, the nation, and the world, including curbing pollution and its ill effects; using byproducts in construction materials; developing new herbal medicinal products; and discovering new ways to monitor acetaminophen to prevent overdoses resulting in liver damage, as examples.

To continue making all these great advances in research and student success, we rely on a strong connection to alumni and friends who share with our outstanding faculty and dedicated staff a deep commitment to the college and experiential learning. We seek to provide opportunities for students both inside and outside of the classroom, and your time, talent, and treasures are important to this effort. I hope you will join me in this endeavor and support our students through professional connections, student mentoring, internship/job opportunities, and financial contributions in support of the college and your home program.

One of the college's goals is to continue to bolster the reputation of the programs as valuable and timely sources of insight and leadership on the challenges facing our world today. Here again, you can help us by thinking back to your days at MTSU and sharing the profound ways the college shaped your life and career. Feel free to pass this magazine on to friends, colleagues, and other MTSU alumni, as well as potential students and supporters, to show them our accomplishments as a college.

I hope that during the next year you have a chance to visit MTSU. Be sure to stop by the dean's office in the Science Building to say hello. I also would encourage you to reconnect with your department or program and to join us at one of our many lectures and social events held at the college. While this magazine gives you a sense of the energy and drive of our college, there is no substitute for seeing us in action.

Bud Fischer, Dean

MTSU's Science Building

Got Milk?

MTSU does—but the School of Agriculture also boasts items ranging from drones to "Fitbits for cows" to keep the University's historical dairy farm "moo-ving"

by Skip Anderson

MTSU was among the first to carry the Tennessee Milk logo on dairy products sold publicly. The logo indicates products come from Tennessee dairy farms.

Days start early on MTSU's 750 acres of farmland scattered across Rutherford County. And at the farm laboratory of MTSU's Experiential Learning and Research Center at Guy James Farm, the University's flagship agricultural outpost, the cows need milking, the livestock need care, the crops need tending, and even the drone may need recharging before taking flight.

In some ways, life down on the farms owned and operated by MTSU hasn't changed much since the first dairy cow came to campus in 1920. Back in the day, the lone campus-owned cow would have been milked daily using the time-tested "grip-and-tug" method, and the milk likely would have been served to students that very day.

Today, modern technology changes the way the milk gets to the students. And today, there continue to be bragging rights as the MTSU Creamery brand of chocolate milk maintains its impressive streak as a Best in Show award-winner that began in the mid-20th century.

Understandably, the champion chocolate milk is the pride of the farm.

"Chocolate is by far our largest seller on a 9:1 ratio, compared to white milk," said Matthew Wade, director of the farm lab. "I can tell our chocolate milk from the others. It has a heavier chocolate than most brands, and I can pick it out of a crowd."

Wade is also an MTSU alumnus, graduating in December 1993 with a B.S. in Agriculture Business and a minor in Marketing. Fourteen years later, he completed an M.B.A. at MTSU.

"I had a younger family then," Wade said, laughing. "I encourage all of our students to try to get their master's immediately."

Obviously, Wade puts his agriculture degree to work daily. Less obvious but equally important is how he uses his minor in Marketing. MTSU Creamery milk products are not only available at on-campus dining facilities, but also in retail markets throughout the region now.


MTSU CREAMERY

And, a few years back, Wade saw expectations in the marketplace changing and wisely saw an opportunity for the farm to rejuvenate its products' images—rebrand, even.

"We came up with a logo that would set MTSU milk apart from the others and changed the name from the Milk Plant to MTSU Creamery, because that's what folks identify with local milk," Wade said. "Even some of the larger plants are going back to that term."

Wade had the University's alumni base in mind, too, when considering the new image.

> ***"The farm has a lot of open space and rolling hills, so it's a good resource for Aerospace students to learn to fly unmanned aircraft systems."***

"Our new logo is the dairy barn from the 1920s with the silo that formerly sat behind the Stark agriculture building," Wade said. "Many alumni remember that barn, so that's why it's on our logo. That really brought it full circle, and we thought that was neat."

Something else that's neat are the half-million or so workers Wade and the agriculture students have helping them with the crops each spring. The Guy James Farm includes nine apiaries, which combined houses nearly a half-million drone bees.

"We've had bees here on and off since the 1970s," Wade said. "But we've had apiaries in earnest since 2012. The first batches of honey go to the alumni office, which makes it available to individuals and sponsors who support our programming."

But the honeybees aren't the only things buzzing overhead. Drone aircraft buzz almost imperceptibly above to help the farmers inspect the crops much more efficiently than previously. The farm partners with other University departments, including Aerospace, which brings the unmanned aircraft to its fields.

"The farm has a lot of open space and rolling hills, so it's a good resource for Aerospace students to learn to fly unmanned aircraft systems," Wade said.

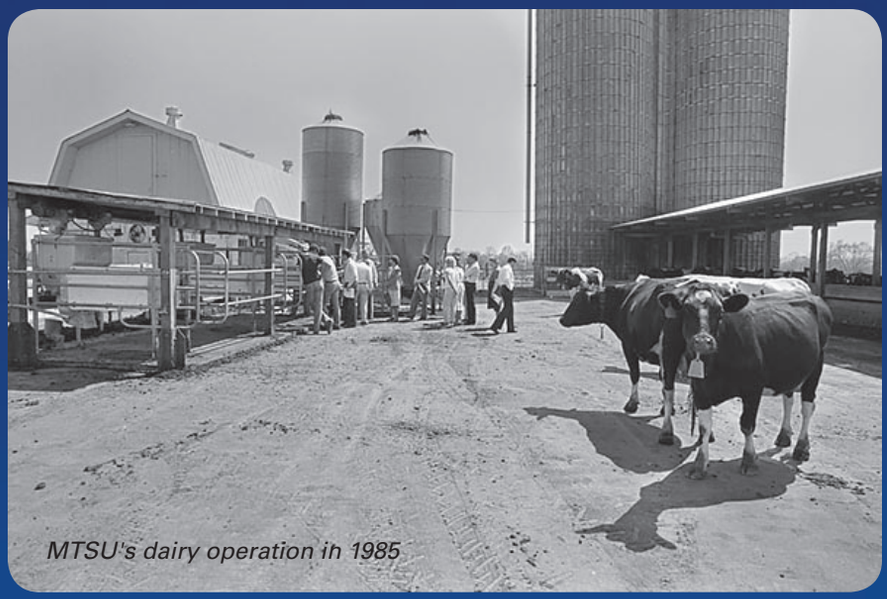
But the interdisciplinary relationship is far more symbiotic than Aerospace students flying drones over and around middle Tennessee farmland and outdoor working labs. While the Aerospace students learn to operate unmanned aircraft, the aggies can inspect crops, inventory livestock, and gather data relevant to running a farm as efficiently as possible with the drones.

"Students from both departments learn about different data-gathering platforms, whether over a crop or forage

Wesley Merrill, senior Global Studies major, and Daniel Troup, senior Plant and Soil Science major

field," Wade said. "Our agriculture students can quickly learn whether these crops are stressed or perhaps subject to some type of disease. The sooner we learn that, we can figure out what type of management needs to be done. This saves hundreds of hours where folks used to have to walk for miles through crops and visually access the crops and grounds."

As the drones buzz overhead, livestock wander in and out of the barns wearing ankle tracking devices that contain a computer chip to record data.



MTSU's dairy operation in 1985

"The barn is computerized, so when the cows walk in to be milked, their information is automatically downloaded," Wade said. The data is "available to our students and faculty for papers and studies. It also tracks how much milk they've produced, the density of the milk, and how many steps they've taken since they were last milked. I tell children who visit that it's like a Fitbit for cows."

And children, Wade is happy to report, visit often.

> ***"The barn is computerized, so when the cows walk in to be milked, their information is automatically downloaded."***

"Last week, we toured 300 students through here," Wade said recently. "Our barn is always clean, not so much for the tours but for sanitation purposes. The dairy industry is the most highly-regulated farm operation."

Wade also offers sage advice from a wise and learned farmer when it comes to the expiration date on dairy products.

"The dates are on there just to assure folks the average time it will taste most fresh," Wade said. "Just look at and smell the milk. If it has a good rich color and a good fluid consistency and smells normal, it's still fresh. However, if you're unsure, feed it to the cat and get you another gallon because that supports these guys and gals who work so hard to get it for you."

One thing is for sure these days after a visit to MTSU's Experiential Learning and Research Center at the University's Guy James Farm: This ain't your daddy's farm laboratory!

Ariel Herrin, equestrian programs director, with her horse, Forbes, at MTSU's Horse Science Center

BACK IN THE SADDLE

MTSU's Horse Science program, which is the only one of its kind in the state, boasts about 200 students, five instructors, 10 graduate students, and about 50 University-owned horses. The judging and equestrian teams have consistently placed in the top five in national competitions through the years, and perhaps more importantly, continue to teach life skills beneficial to any career.

In 1994, a bequest of more than $20 million from the John and Mary Miller Foundation led to construction of the Tennessee Miller Coliseum, completed in 2003. The gift also enabled the University to match funds necessary to claim a U.S. Department of Agriculture grant (previously secured by Congressman Bart Gordon) to build the Horse Science Center and create more faculty positions. The gift catapulted MTSU and the horse program forward.

The coliseum is a top-notch facility and sits right in the middle of the country, making MTSU the perfect candidate to regularly host events, including the Intercollegiate Horse Show Association (IHSA) nationals. The University has already hosted the event four times—more times than any of the other 380 colleges that are part of IHSA.

Miller Coliseum and the Horse Science Center—which, seven miles from campus, comes complete with classrooms, faculty offices, an equine reproduction laboratory, a heated barn with 65 climate-controlled stalls, and a teaching arena—represent a significant draw for prospective students wishing to translate their love of horses and/or thirst for competitive riding into a professional career.

FOR THE FIRST TIME IN FIVE YEARS, BLUE RAIDER RIDERS QUALIFY FOR NATIONALS AS A TEAM IN THE WESTERN CATEGORY

by Randy Weiler and Katie Porterfield

STAYING ON TOP

The MTSU equestrian team recently finished in a tie for third place at the 2018 IHSA National Championships in Harrisburg, Pennsylvania. The performance capped off an outstanding first season for Ariel Herrin ('15, '17) as coach.

"Our riders rode great—everything we had practiced for," said Herrin, a former world championship rider during her time as an MTSU student, whose accolades include being an American Quarter Horse Association (AQHA) world and reserve world champion, AQHA Congress champion, and IHSA national champion during her show career. She also has been a clinician for the AQHA International Horsemanship Camps twice, representing MTSU.

The 2018 IHSA nationals was the culmination of the season for nine MTSU riders. It marked the first time in five years the Blue Raider riders qualified as a team in the Western (horsemanship and reining) category, allowing riders of all levels and abilities—from beginner with no show experience, to ones having success at a high level—to compete as a team.

MTSU took four individuals and six Western team riders to the nationals, which involved more than 400 teams and nearly 9,000 competitors. To advance, MTSU had placed in the top three in the regional. Individual riders included seniors **Kelsey Sloan** (Hunter Seat rider) of Olive Branch, Mississippi; **Julia Rhyne** (novice fences) of Brentwood; and **Steven Todd** (individual novice horsemanship) of Meridian, Mississippi. Alumna **Emily Kopko** ('14) of College Grove competed in alumni horsemanship reining. Todd was joined in the Western team event by **Mary Catherine Wade** of Germantown; **Jenna Seal** of Meridian, Mississippi; **Patricia Wingate** of Woodbury; **Lucas Brock** of Franklin; and **Sarah Kozuszek** of Scheller, Illinois.

Herrin, who replaced longtime MTSU coach Anne Brzezicki, called the nationals "a really big deal to make it. Everyone on the team who qualified did it in style."

MTSU also carried five horses to be used at the 2018 IHSA competition—with Harley (whose official name is Hotroddin' in Chrome) named the Most Popular Western Horse at the event. At least 10 other schools' competitors rode Harley during the four-day event.

MTSU Western team members at a practice at the Horse Science Center's Anne Brzezicki Arena on West Thompson Lane, including (l–r) Patricia Wingate, Sarah Kozuszek, Steven Todd, Lucas Brock, Jenna Seal, and Mary Catherine Wade

GIFT HORSES

A second $10,000 donation in a year's time from Grammy Award-nominated 3 Doors Down's Better Life Foundation will continue to benefit MTSU students and faculty working in equine therapy with veterans from the Murfreesboro-based Veterans Recovery Center.

The money is earmarked for an outdoor training area and meeting space needed for the program, which began in 2013. The Mississippi rock band's foundation also gave a $10,000 donation in 2017. The Center of Equine Recovery for Veterans (CERV) is a partnership between the Veterans Recovery Center (VRC), a psychosocial rehabilitation center, and MTSU Horse Science. CERV offers military veterans from the VRC an opportunity to ride and benefit from interacting with horses, while MTSU students gain valuable experience in helping facilitate the sessions.

"We are so grateful for another donation," said Andrea Rego, an MTSU Horse Science instructor. "We hope to build a fantastic permanent outdoor trail obstacle course, along with a meeting area for goal sessions. We believe this will enhance the veterans' time at Horse Science."

Rego said one of the veterans told her he was "in my own little bubble that I couldn't get out of. This (therapy) has rocked my world, and I can't thank everyone enough."

Along with veterans in the program, among those attending the recent donation luncheon at the MTSU Foundation House were 3 Doors Down singer Brad Arnold; his wife, Jen Arnold, a noted barrel race competitor; Brian McSpadden, recreation therapist with the Tennessee Valley Healthcare System's Alvin C. York Veterans Affairs campus; and MTSU Horse Science faculty members Holly Spooner, Rhonda Hoffman, Ariel Herrin, and Rego. The gathering also included MTSU graduate students and Equine Assisted Activities and Therapies class students.

Equestrian Team rider Patricia Wingate bathing Izzie

LIVING LEGEND

Longtime MTSU equestrian team coach Anne Brzezicki knew all about a retirement celebration dinner planned for her in the James Union Building. She was totally unaware, however, that friends planned a surprise that remained a secret for weeks and months: The large Horse Science Center indoor facility would bear her name—the Anne Brzezicki Arena.

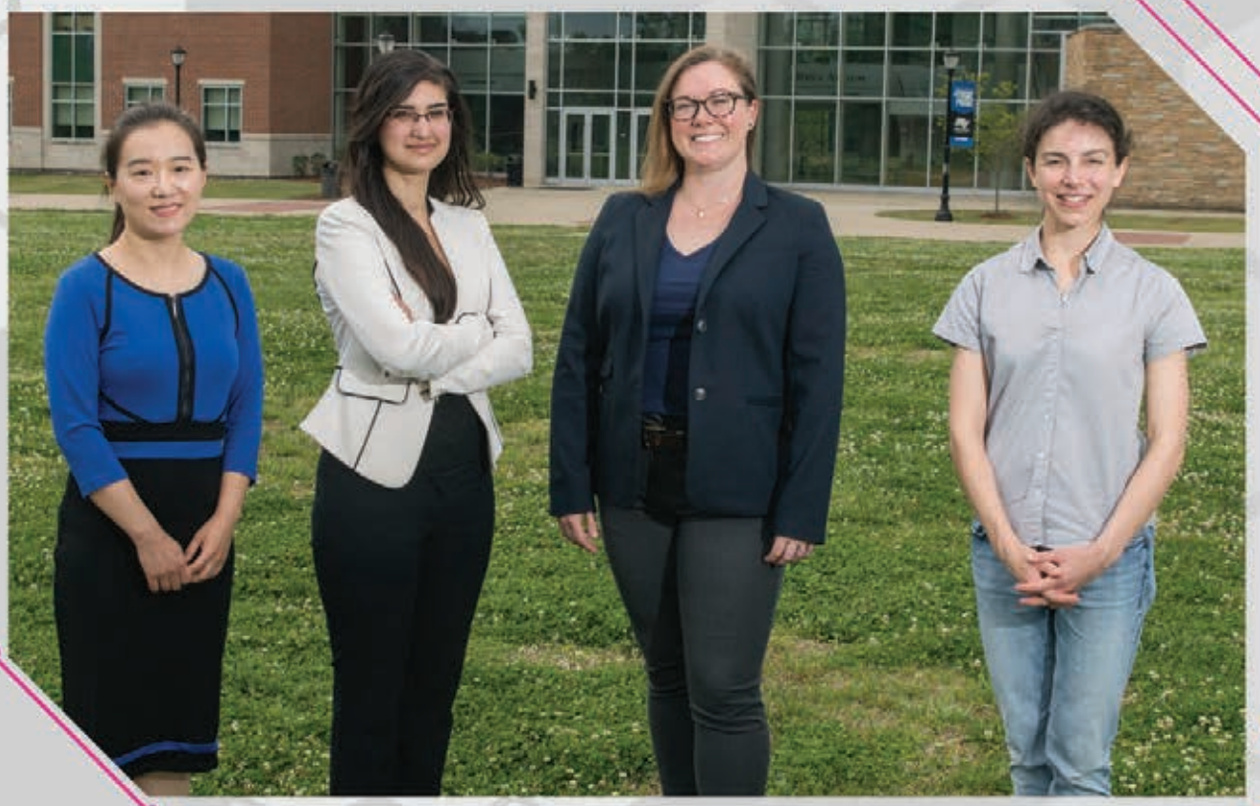
MTSU alumni Lanas and Julie Smith, of Boulder, Colorado, who are longtime friends of both the program and Brzezicki, retained the naming rights for the indoor arena through their generous gift to the MTSU Foundation to enclose the area. When Brzezicki retired earlier this year after a successful 35-year career, there was only one individual's name the Smiths wanted on the building.

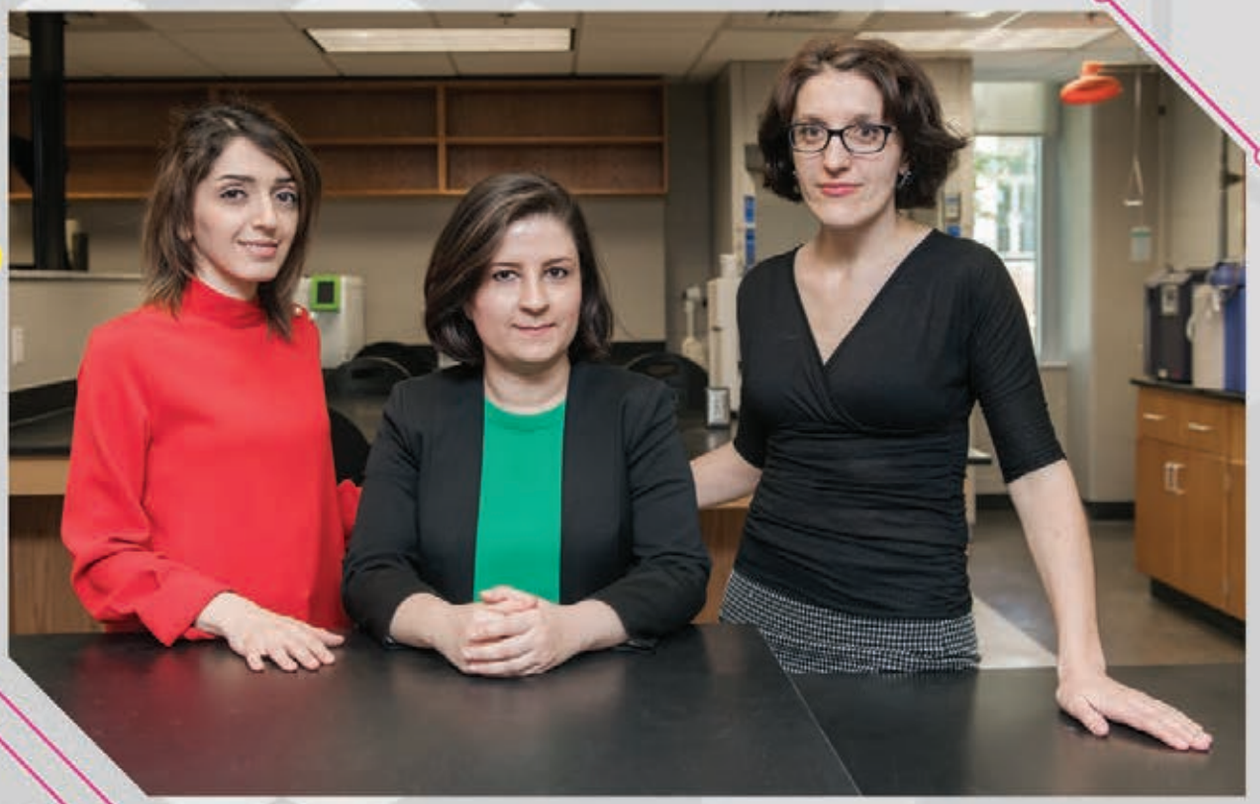
Anne Brzezicki teaching a riding class

"After all the years of putting my heart and soul into the program, a permanent piece of me is now there—and that means a lot," Brzezicki said.

Jared Bryson, development director for the College of Basic and Applied Sciences, said there's an opportunity in Brzezicki's retirement for the public "to support the work she holds dear" by giving to the Anne Brzezicki Equestrian Endowment. Donors can complete giving online at **mtsu.edu/supportag**, then direct their gifts to the Brzezicki endowment in the comments section.

"The funds will support broader student experiences through the purchase of critical new equipment and enable travel to competitions across the country," Bryson added. "In order to stay on the forefront of equestrian education and produce graduates that are highly competitive, we need the ability to secure student learning experiences and enhance existing facilities."





The Changing Faces of STEM

A look at seven female faculty members in the College of Basic and Applied Sciences working to make the world a better place

by Allison Gorman

For students wanting to major in science, math, engineering, or technology, their prospects at MTSU have never been brighter. In addition to almost $150 million in new and renovated facilities making up MTSU's Science Corridor of Innovation, a new generation of faculty in the College of Basic and Applied Sciences is raising the bar for STEM education—not just in the classroom, but also in the laboratory and out in the field.

The fact that so many of these young researchers happen to be women reflects the changing face of STEM. Thanks to their talents and influence, the STEM programs at MTSU are becoming both less and more rarified: offering learning and research opportunities to an increasingly diverse student population, while also producing more groundbreaking research that takes on our world's greatest challenges.

The seven faculty members profiled here are just a few of those new faces. Under their mentorship, Blue Raiders are helping address the rising cost of health care, the toxic byproducts of industry and energy, the environmental effects of climate change, cruel diseases like cancer, and even inadequacies in STEM education.

While their research subjects vary, these women share a common sense of altruism that shines through in their work as researchers and teachers. Ultimately, their goal is to make the world a better place.

The Change Agent

Medicine has saved countless lives, but manufacturing it can have serious side effects. Pharmaceutical processes often involve catalysts made from precious metals like ruthenium or iridium, whose byproducts are toxic and expensive to remove. **Keying Ding**, an assistant professor of Chemistry, hopes to make these processes safer and cheaper. Supported by National Science Foundation (NSF) grants, she is developing a new family of catalysts using cobalt, an earth-abundant metal, for organic synthesis with water and hydrogen as the only byproducts, which are environmentally benign.

Ding's focus is "green chemistry," and catalysis is integral to her research. Because they accelerate chemical reactions without being consumed themselves, catalysts are critical to many industrial processes. Cleaner alternatives could have applications in the pharmaceutical industry and beyond.

"Currently, some chemical and pharmaceutical processes are not selective and energy-effective, and often they generate a lot of hazardous wastes," Ding said. "We hope to develop new catalysts for a number of organic transformations using sustainable methods."

Ding's cobalt-based catalysts also could make it easier to use hydrogen as a green energy source, she says. While hydrogen is clean and abundant, it's also a gas, which is hard to transport. She hopes to develop a more portable option: a liquid carrier that would release hydrogen gas upon introduction of the catalyst.

"Currently, we also are developing catalysts on other base metals such as iron and manganese, which are even more appealing," she said.

Ding has made chemistry itself more appealing in her five years at MTSU. She has mentored numerous graduate and undergraduate students and recruited them to work in her state-of-the-art lab, which she has enhanced through NSF grants. She's also tapping the potential of low-income and first-generation students, a population often underrepresented in STEM fields. In collaboration with colleague Andrienne Friedli, Ding launched a pilot program to encourage these students' engagement and success, supported by the Tennessee Board of Regents. And for the past two summers, she has extended her outreach to economically disadvantaged high school students in Rutherford County, organizing summer educational programs funded by the American Chemical Society Project SEED.

"Education studies have shown that this mentor-student relationship and lab research can really increase the retention rate, as it offers hands-on experience to deepen students' understanding of chemistry concepts and helps them feel more confident working in STEM fields," she said.

As an ambassador for the Department of Chemistry, Ding has become something of a catalyst herself.

"Education studies have shown that this mentor-student relationship and lab research can really increase the retention rate, as it offers hands-on experience to deepen students' understanding of chemistry concepts."

—Keying Ding

Outstanding in Her Field

When **Racha El Kadiri** says she's going on a field trip, she means it. An assistant professor in the Department of Geosciences, she has explored fields (and creeks and riverbanks) in the United States and abroad to witness the impact of droughts, floods, and other water-related natural hazards. The outdoors often serves as her lab and her classroom.

"Field trips are part of my research but also part of my classes," she said. "We'll go and camp, for instance, in the Smoky Mountains for three days, collecting water samples, taking some stream morphology measurements, and just hiking and making observations about the water cycle."

But when El Kadiri needs to understand the big picture, she works in her computer lab. Using satellite data, machine learning, geographical information, and other technologies, she sees how landslides, erosion, and similar events are shifting regional landscapes over time. Then she uses modeling to predict when and where such events might happen in the future, especially as climate change makes the weather more extreme.

"There is a scientific consensus on global temperature increase, but we don't know exactly how the increasing temperatures are going to affect different aspects of life," El Kadiri said. "How is climate change going to affect, for instance, natural hazards, transportation or agriculture?"

Currently, she and her departmental colleague, Henrique Momm, are collaborating with scientists from other universities to project how warming temperatures will impact farming in the Lower Mississippi River Basin. "We are trying to estimate what we should expect in the next hundred years, using climate change scenarios ranging from the least to the most optimistic," she said.

> "There is a scientific consensus on global temperature increase, but we don't know exactly how the increasing temperatures are going to affect different aspects of life."
>
> —Racha El Kadiri

Although the basin is one of the nation's biggest producers of biofuel crops, it is understudied relative to other farming areas, like the Midwest, she says. This current project is being funded by the U.S. Department of Agriculture.

After completing a pilot study of the Sunflower watershed, El Kadiri and the research team will present their preliminary findings in a workshop for farmers, graduate students, and other stakeholders in the community. Ultimately, they will expand their study to the entire Lower Mississippi River Basin, she says.

As global temperatures rise, the weather is getting less predictable. But, by helping predict the long-term consequences of climate change, scientists like El Kadiri are giving farmers a better opportunity to prepare for weather events.

The Model Teacher

The exorbitant cost of American health care is a problem that has confounded political attempts to solve it. **Misa Faezipour**, an assistant professor of Engineering Technology, is tackling the problem from a mathematical angle. The numbers she evaluates don't represent dollars and cents, but rather the many interrelated factors that determine the quality of the hospital/patient experience. If she can reduce the cost of some factors while maintaining patient satisfaction, she says, the savings will benefit providers and patients alike.

Some of those factors, like the number of trained staff at a particular hospital, are obviously quantifiable. Others, like effectiveness of the service there, are not. Constructing a mathematical framework based on these diverse factors seems like an impossible task.

But, as an expert in system dynamics, Faezipour does just that. Right now she's working with Saint Thomas Rutherford Hospital to create a causal model of those interrelated factors, underlain by complex mathematical equations that can predict how changing factors would affect patient satisfaction. At Saint Thomas, the model will be tried, validated, tweaked, and then validated again, until an optimal model is found for guiding hospital policy.

System dynamics is a way to quantify the unquantifiable—and it doesn't just apply to health care. This form of engineering has endless applications, Faezipour says. "You could choose any process or problem or organization and apply the methods and the modeling to that system."

That's the beauty of system dynamics. It can be a gateway to engineering for students who had never considered it.

Faezipour recalls one of her students, a double major in Biology and Japanese, who had studied abroad and was keenly interested in international relations. She wanted to switch to engineering but was worried that her academic experience wouldn't apply. Faezipour reassured her that her background and interests would serve her well—that she could use system dynamics to model the cultural differences between two countries and predict how they might respond to the same problem.

"I think those of us in engineering should try to help students like this, so they won't think that it's really hard, and they don't want to come near it," Faezipour said.

By being quick to encourage, teachers like Faezipour are attracting new students to engineering—students who might someday take their own STEM approach to fixing our broken health care system. Who knows? That might be just what the doctor ordered.

The Learning Lab

In the movies, the college lecture is often a punch line: droning professor versus dozing students. In the real world, great teaching can happen from behind a podium. Still, most educators would agree that a large lecture hall isn't always the best forum for learning, especially in the sciences.

Anna Grinath, an assistant professor of Biology, wants to change the dynamics of how that subject is taught in higher education. Unlike most of her departmental peers, she studies a human-constructed ecosystem, the college classroom, in order to understand how certain variables help or hinder student learning. Based on that research, she's developing new learning experiences that can be used in any undergraduate biology classroom—although first she'll test them in her own.

> "The classroom environment should create opportunities for students to have a voice in the classroom and to engage in the discursive interactions that scientists engage in."
>
> —Anna Grinath

Since Grinath can't scale down the size of her large lecture classes, she's scaling up the methods of Ambitious Science Teaching, a learn-by-doing pedagogy that was originally designed for smaller K–12 settings.

With her Ambitious approach, students in college biology lectures wouldn't just sit and listen (or sleep or text). Instead, they would be expected to engage with the instructor and each other—asking questions, posing answers, and suggesting ways to test those answers. And, instead of merely following a set of instructions, students in biology labs would work together to design and execute their own experiments and analyze the resulting data.

It's all about allowing students to shape their own learning experience, Grinath says. "The classroom environment should create opportunities for students to have a voice in the classroom and to engage in the discursive interactions that scientists engage in."

This fall, working with a colleague in the Department of Education, Grinath will run an Ambitious-style pilot program in a section or two of freshman-level biology at MTSU. So, rather than telling 80 students how to measure the natural variations in a biological population, as she would have last year, she'll let them do it themselves, using 3D models of sea sponges printed at the Makerspace in Walker Library.

"We don't want a disconnect between what it looks and feels like to do science, and what it looks and feels like to learn about science," Grinath explained.

In other words, students understand biology best when they are encouraged to act like biologists.

An Absolute Puzzle

From the earliest age, **Rachel Leander** loved biology. Then she got to college and discovered that she loved math, especially writing proofs, even more. "There's this absoluteness to it," she said. "And when it's time to prove something, it's like solving a puzzle—it's just fun."

As an assistant professor of Mathematics, Leander enjoys the best of both worlds. She's using equations to try to solve one of the most fundamental puzzles in biology: why, all else being equal, some cells choose to die while identical ones divide.

Understanding cells' random decision-making has profound implications in the world of medical science. Although Leander works at a theoretical level, what she learns about cell death and division—and the interdependence between the two processes—could ultimately help inform cancer research. "You can imagine, for example, that if we have a better characterization of how variable cell-cycle division

times are, then we can get a better idea of how effective drug treatments are," Leander said.

But the scientific method doesn't offer a way to model and test the complex, interrelated biochemical networks inside a cell that determine whether a cell will divide or die. That's where math can help, she says.

"What we do as mathematicians is make these hypotheses really precise and, in a sense, quantitative," Leander said. "That makes it possible to derive predictions that you couldn't make otherwise."

Her research is open-ended; every answer leads to another question. And that's half the fun, Leander says, since every new question means another puzzle to solve. But she gets a different kind of enjoyment—instant gratification—from teaching, particularly undergraduate courses. She considers it a personal challenge to kindle enthusiasm for math in a student who hadn't expected to enjoy it.

"There are definitely 'Aha!' moments in science, but those are few and far between as opposed to just asking questions and taking baby steps," Leander said. "What I like about teaching is that I feel like I can make a little difference in people's lives every single day."

A Natural Ambassador

Forget the euphemism: For **Mina Mohebbi**, the call of nature is a powerful urge to protect the environment. It's what compelled her to volunteer for river cleanups as a graduate student in Iran and to switch her master's focus from civil to environmental engineering. Mohebbi earned her bachelor's in Civil Engineering, but her research interest always seemed to stray from traditional infrastructure—roads, bridges, and dams—to the broader infrastructure of industry and its impact on air, land, and water.

"It was a good feeling when I found that I can be involved in saving the environment for the next generation, helping people enjoy it now but also preserving it for other people to enjoy," she said. "That was a big motivation for me."

Mohebbi hopes to continue the environmental research she started as a doctoral student at Penn State University, where she collaborated with a local power company that was exploring new ways to recycle some of the toxic waste that coal-fired power plants generate by the ton. Coal byproducts like fly ash and gypsum are already being reused in innovative applications, such

"It was a good feeling when I found that I can be involved in saving the environment for the next generation."

—Mina Mohebbi

as concrete construction and soil stabilization, Mohebbi says. In this case, she was assessing the potential benefits and environmental impacts of depositing ash in a dead mine near the power plant.

Now that she's in her second year as an assistant professor of Engineering Technology at MTSU, she's looking for similar opportunities to collaborate with industries in middle Tennessee. "There are a variety of industrial byproducts that can be beneficially reused, and I think all of them are worth evaluating," Mohebbi said.

She's also tackling environmental issues even closer to home. As landfill space is increasingly scarce, Mohebbi plans to launch a composting program on campus, and she's been talking with the Murfreesboro Solid Waste Management Department about enhancing the recycling programs at MTSU and area schools.

Much of that work is contingent on her winning a grant from the Environmental Protection Agency, historically a major funder of environmental programs and studies. As the agency's profile has diminished, Mohebbi notes, so has its investment in research like hers.

"There are still some opportunities—the EPA had some plans for clean power plants . . . and that was a really good idea—but unfortunately it's not on the table anymore, and opportunities for us as faculty and researchers have shrunk," she said.

Mohebbi hopes the environment will regain its place as a national priority. For now, she's placed her hope in children. If we can get them in the habit of thinking and acting sustainably, she says, they could be nature's greatest ambassadors.

Charged with Changing Lives

To most people, quantum mechanics might as well be rocket science—just another way to say unfathomable. **Hanna Terletska** was lucky. In her native Ukraine, she had a Physics professor whose enthusiasm for the subject was contagious. "He was crazily in love with it," she recalled with a laugh. "He would go up to the board and say, 'This is so beautiful!' And at some point I thought, 'Okay, maybe this is beautiful. Let's look at this.' "

Terletska, an assistant professor of Physics, admits that quantum mechanics can be counterintuitive, as it characterizes matter in terms of waves and particles. "When you can't see it or touch it, it's kind of hard to imagine," she says.

Understanding how natural objects behave at the atomic and subatomic levels is key to her research, which involves studying the potential of certain materials to transmit or store energy. Both fossil-fueled and nuclear energy come with well-known hazards, so finding safer, cleaner ways to power our world is critical work.

Both fossil-fueled and nuclear energy come with well-known hazards, so finding safer, cleaner ways to power our world is critical work.

It didn't take long for Terletska's research on the subject to grab national attention. Last year, her first at MTSU, she was one of eight winners of the prestigious Scholar Award from the Kavli Institute for Theoretical Physics. Given to faculty at teaching-intensive U.S. colleges, the three-year award allows recipients paid opportunities to travel and focus on their research, which can be hard to balance with classroom responsibilities.

But, to Terletska, her students are as important as her research. She's worked especially hard to encourage and mentor female Physics majors—a group that's underrepresented in the United States, she says. As the mother of a preschooler, Terletska knows from experience that women often face unique challenges in predominantly male fields, especially if they are juggling family obligations too. "I need to show female students that this is possible, that they can do this, that it's fun and interesting," she said.

Terletska beams when she mentions that three of her undergraduate students, including two women, have been accepted into graduate school. "This is the best part of my work, when you can change somebody's life," she said.

Like her former professor, Terletska has a contagious enthusiasm for her subject—and in her case, the effects are apparent not just in her students, but also in her 4-year-old son. She says she's been contemplating Andrew's future career ever since he started playing with computer mice and sleeping with a power cord. They're unplugged, of course, but Terletska clearly has a knack for plugging others into the science of energy.

Basic Highlights

A look at recent awards, events, and accomplishments in CBAS

Top **Hawk**

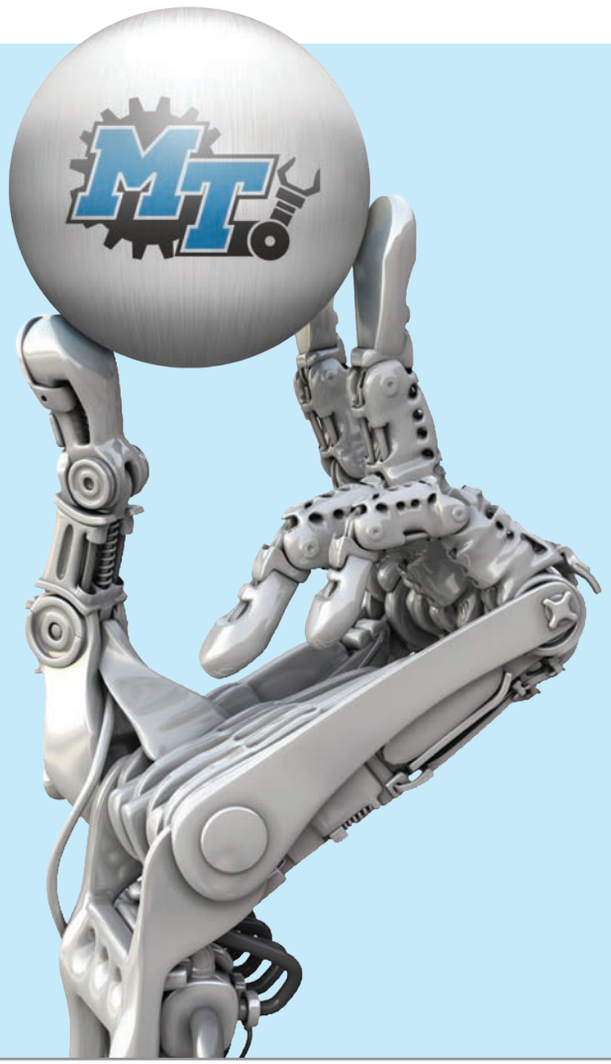
MTSU Aerospace students claimed their prize—use of a new, custom-branded Cessna Skyhawk 172—as part of Textron Aviation's 2018 Top Hawk program. Six student flight instructors and Department of Aerospace administrators accepted delivery of the plane in April during a ceremony in the Flight Operations building at Textron headquarters at Dwight D. Eisenhower National Airport in Wichita, Kansas. **Elizabeth Keller** and **Harry Arcamuzi**, two of the flight instructors, submitted MTSU's application, which was one of five chosen by Textron Aviation. Under the Top Hawk program, MTSU utilized the plane until late September to support flight training, recruiting efforts, and promotional activities throughout the spring and summer.

I, **Robot**

For the second consecutive year, members of the MTSU Robotics Club (a student chapter in Engineering Technology) shined at the National Robotics Challenge in Marion, Ohio. This year, MTSU emerged with gold and silver awards in the Mini-Sumo Robot competition, silver and bronze in Combat Robot competition, and a bronze in the Autonomous Vehicles Challenge. With approximately 450 robots participating, more than 1,300 students and 80 schools from eight states competed.

MTSU's winners included:

- **Wenbo Dong**, a Computational Sciences Ph.D. student from Beijing, who earned first place in the Mini-Sumo robot competition and second place in the Combat Robot event
- **Jacob Pawelski**, senior and team captain from Elmwood; junior **Sarah Zakaria** of Thompson's Station; and sophomore **Michael Boyte** of Frederick, Maryland—all Mechatronics Engineering majors—for a third-place showing in Combat Robot
- **Corey Gamache**, junior and team captain, and juniors **Nick Bledsoe** and **Alex Davis-Snow**, all from Murfreesboro and all Mechatronics majors, who captured third place in the Autonomous Vehicles Challenge



Honing Their Craft

Attendees of the Brewers Association's national 2018 Craft Brewing Conference in Nashville got a sneak peek in May of MTSU's Fermentation Sciences laboratory under construction at the Hop Springs agritourism destination being built by Steel Barrel Brewery in Murfreesboro. Conference-goers were offered bus rides from Nashville's Music City Center to the Hop Springs site, where they sampled Steel Barrel beers and reviewed plans for the facility. Also attending the event was then-state Sen. Bill Ketron, new mayor of Rutherford County, who sponsored legislation that enabled MTSU to create the Fermentation Science program that began in Fall 2017.

Down on the Farm

Sixty young people from seven states received two full days of all things lamb and goat at the annual Massey Show Lamb Camp in the MTSU Tennessee Livestock Center. The youngsters, ages 5 to 18, gained a new or better understanding of how to care for their animals and to prepare them to be shown in competitions in their respective states. The Massey family—patriarch J.B. Massey, daughters Rachel Boyd and Sarah Clause, and granddaughter Emma Boyd, all from Arkansas, and agriculture teacher Pete Dempsey of Lawton, Oklahoma—covered selection, feeding, clipping, grooming, showmanship, and more during the nearly 20 hours of classroom and show ring sessions. Campers from Arkansas, West Virginia, Mississippi, Alabama, Florida, and Georgia joined those from Tennessee at the event.

A Fulbright Future

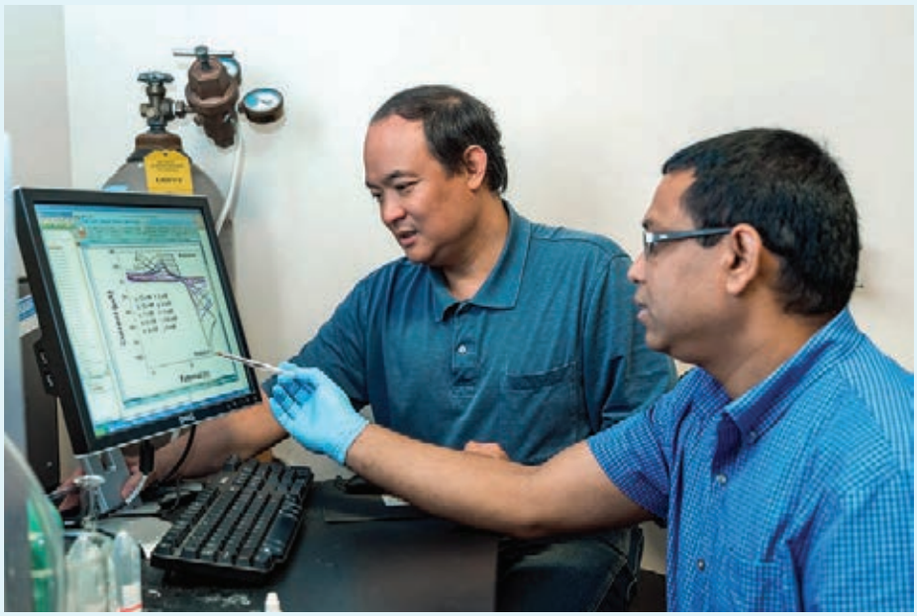
Pel Doski was among the latest MTSU students to earn Fulbright Fellowships to teach or conduct research abroad. Doski, a Biology major, left in July for her assignment to teach English in South Korea for 12 months. The U.S. State Department sponsors the Fulbright program to increase mutual understanding between people in the United States and other countries by placing U.S. students in other nations to teach or conduct research for eight to 10 months. Doski, who was born in Guam after her parents fled persecution in Iraq, was to undergo intensive sessions for six weeks before being placed with high school or middle school students. "I was in utter shock," Doski said of learning about her award, adding she "felt intimidated" by previous recipients from Ivy League schools and those who have majored in Asian studies.

Head of **the Class**

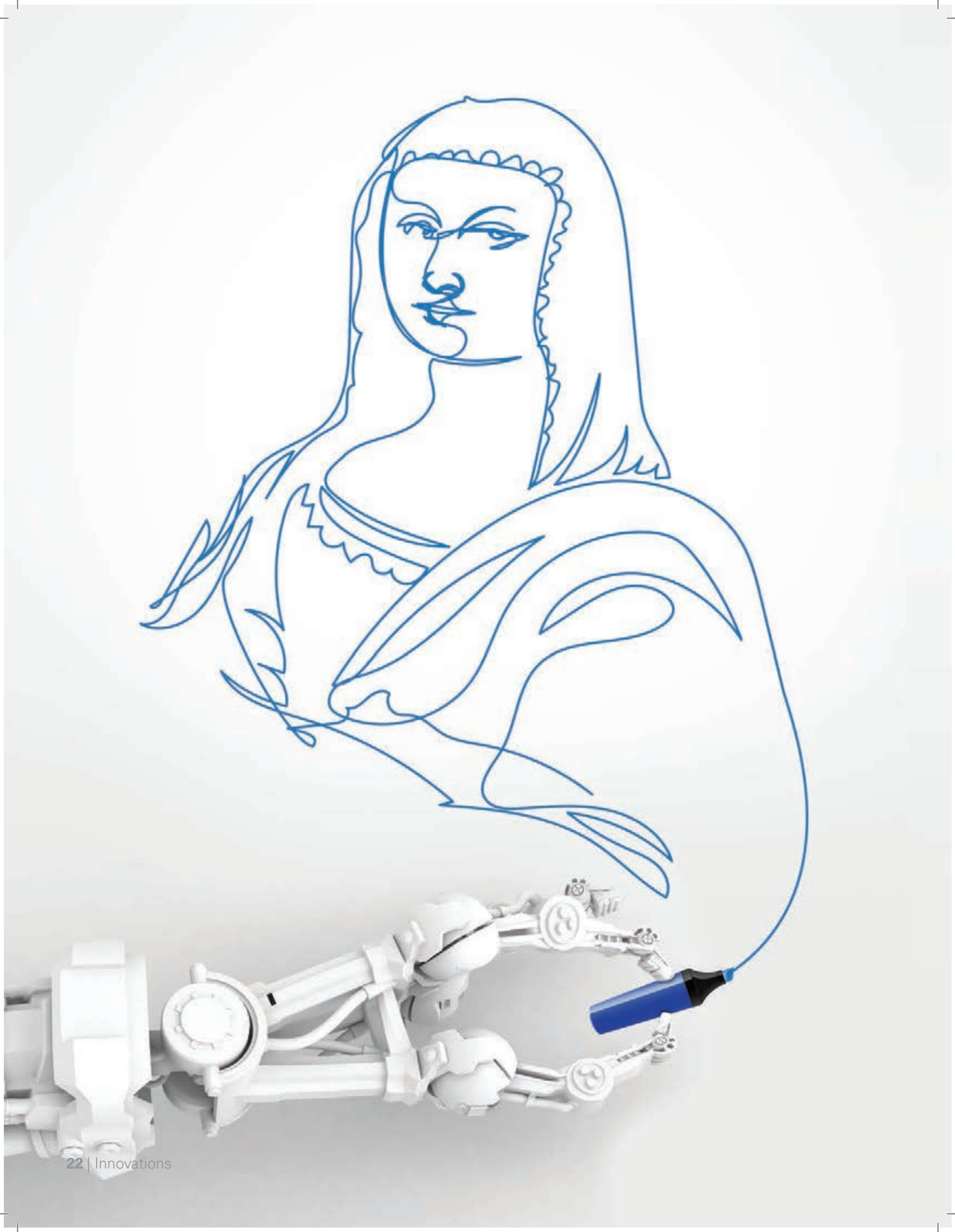
When **Jennifer N. Lovett** joined the MTSU Department of Mathematical Sciences faculty in August 2016, she came as an already nationally recognized researcher. In 2015, while a graduate assistant at North Carolina State University, Lovett received an Association of Mathematics Teacher Educators (AMTE) National Technology Leadership Initiative Fellowship. The fellowship focuses on incorporating technology to enhance teachers' education lessons and undergraduate student teachers' learning. This year, Lovett led a five-person group to what has become her second AMTE national fellowship in four years, this time for their manuscript "Developing Preservice Teachers' TPACK of Function Using a Vending Machine Metaphor Applet." Technological Pedagogical Content Knowledge (TPACK) is the information teachers need to understand how to incorporate technology into their lessons to effectively teach specific subject matter. An applet is a small computer application. Since the fall of 2000, the Society for Information Technology and Teacher Education has collaborated with four teacher education associations representing math, science, English language arts, and social studies education through the National Technology Leadership Initiative (NTLI). "Technology is being used to deepen MTSU students' understanding of function and understanding of how middle school students learn about function with an online applet," Lovett said. "My cross-institutional research team is one of the few groups researching 'professional noticing'—understanding students' thinking—in technology-based mathematics tasks. . . . So having my research and our team receive this honor means a great deal and validates the importance of our work."

A Sense of **Danger**

Three years of investigation conducted by Chemistry associate professor and researcher **Charles Chusuei**, MTSU graduate students, and Maryland researchers has led to a unique design for monitoring acetaminophen to prevent overdose resulting in liver damage. The findings made the inside cover of the May issue of *Electroanalysis*, an international journal devoted to electroanalysis, sensors, and bioelectronic devices. The group made the discovery through electrochemical detection of acetaminophen with silicon nanowires. Chusuei worked on the project with two of his graduate students, doctoral candidate **Raja Ram Pandey** and master's student **Hussain Alshahrani**, along with Sergiy Krylyuk, Elissa H. Williams, and Albert V. Davydov of the Materials Science and Engineering Division at the National Institute of Standards and Technology in Gaithersburg, Maryland. Liver failure can occur if people overdose on acetaminophen, a common ingredient in Tylenol and other pain medications. The researchers have produced an electrode that can measure acetaminophen concentrations in real time. The device works by inducing a chemical reaction at the electrode surface that generates an electrical signal. The signal is then interpreted by a computer to determine chemical concentration. "The sensor has potential application for monitoring toxicity in blood, detecting acetaminophen overdose," Chusuei said. "Acetaminophen toxicity is a common cause of unintentional poisoning."



(Basic Highlights continued on page 36)



TRUE TECHNOLOGY

News from MTSU's fast-growing, nationally-recognized Mechatronics Engineering degree program

by Vicky Travis

In a few short years, the Mechatronics Engineering degree program has grown from a handful of students in 2013 to about 300 students in the 2017–18 school year. Students field constant offers for jobs and internships to design or enhance robotics and automated systems in a fast-growing field that combines computer science, electrical, and mechanical engineering.

Walter Boles, chair of the MTSU Department of Engineering Technology, said exit interviews with graduates show healthy salaries for those with bachelor's degrees.

"Of salary numbers, the lowest I've heard was at $65,000, and the highest was at $90,000," he said. "It's a direct response to severe shortages in industry of people who can design and maintain automation systems."

And now the young program is proving that its research opportunities and motivated professors are also preparing students to pursue graduate degrees. Five of the 22 who earned their degrees in May are going to grad school. Three of them planned to continue graduate studies at MTSU. All of the other graduates were quickly employed.

TECH TRANSFER

Two recent Mechatronics Engineering graduates, Brad Hobbs and John Blankenhorn, began pursuing doctoral degrees this August at Arizona State University and Worcester Polytechnic Institute, respectively.

Both Hobbs and Blankenhorn, who were often lab partners at MTSU, felt the need to go further with their education because the jobs they sought require at least a master's degree.

"It's outstanding that they're going on to further their education," Boles said. "It shows we have a high-quality program academically for these students to go directly into Ph.D. programs."

Engineering students in grad school often receive the cost of full tuition covered, as well as a healthy stipend.

Five of the 22 who earned their degrees in May are going to grad school. Three of them planned to continue graduate studies at MTSU. All of the other graduates were quickly employed.

"Being paid to contribute completely new ideas and theory to the engineering field is an opportunity many students can't resist," said Brian Slaboch, assistant professor in Mechatronics Engineering, who worked with both Hobbs and Blankenhorn in his research lab.

Slaboch said he provides students research experience in part because they may not have that opportunity for pure research once they're employed in the industry.

"In my lab, we are always thinking long-term," he said. "Most students that graduate have a 40- or 50-year career ahead of them. Spending five years in graduate school sets you up nicely for the next 35 to 45 years to have an exciting and rewarding research career."

During their time together at MTSU, Slaboch and Hobbs invented a classification system for specific joints and wrote software to identify mechanisms and uses. They presented their paper at an American Society of Mechnical Engineers conference in Quebec in August.

"This type of accomplishment is incredible for an undergraduate student," Slaboch said.

"This is one of the largest in-kind gifts that Siemens has awarded, and we are the only university in Tennessee to have access to such technology."

Hobbs, who graduated in May, is pursuing a doctorate in Mechanical Engineering with a Robotics concentration at Arizona State, where he will do research on powered prosthetic devices.

"Dr. Slaboch let us know, 'If you want to go further, I can help you with that,' " Hobbs said. "I probably wouldn't have gotten into grad school if I didn't have a professor who was able to show me the things he did with research and publishing."

Robotics piqued Blankenhorn's interest and intellect like nothing else had and became his focus after he changed colleges and his major a few times.

"I have always liked space and have always wanted to work on robotics," said Blankenhorn, who is building a robot in his free time.

Slaboch noted that Blankenhorn started his research career by programming an iRobot Roomba vacuum cleaner to assist people with visual impairments.

"MTSU was an extremely positive experience overall," Blankenhorn said. "Teachers were very personable and always available after class for help and career advice."

His dream job would be in space robotics, and he applied only to graduate schools that offer Robotics Engineering as a degree—and there are just a handful in the country.

He graduated last December and took an internship at a robotics company in Virginia as a software engineer writing code for autonomous vehicles until starting his graduate studies this past August at Worcester Polytechnic in Massachusetts.

THE GIFT OF KNOWLEDGE

Germany-based Siemens, one of MTSU's partners in its Mechatronics Engineering program, recently gave the institution software that represents a charitable gift value of $2.2 million—with a commercial value of $278 million—to teach state-of-the-art computer-aided design.

The Siemens Product Lifestyle Management Software grant will give MTSU access to the same technology that companies use to develop and manufacture robotic systems in a wide range of industries, including automotive, aerospace, machinery, and high-tech electronics.

"This is one of the largest in-kind gifts that Siemens has awarded, and we are the only university in Tennessee to have access to such technology," MTSU President Sidney A. McPhee said. "Students in our Engineering Technology and Mechatronics Engineering programs will have the most advanced software for computer-aided design, modeling, and systems simulation."

Siemens, one of the world's largest producers of energy-efficient, resource-saving technologies, is a leading supplier of efficient power generation and power transmission solutions and a pioneer in infrastructure solutions as well as automation, drive, and software solutions for industry.

Boles told trustees that access to this software will help MTSU students be more competitive in the job market, since graduates with Siemens PLM software skills are highly valued by companies looking to fill advanced technology roles.

More than half of the top 1,000 manufacturing companies cited by *Industry Week* magazine use Siemens PLM software and, in the automotive, aerospace, machinery, and high-tech sectors, the total is close to 80 percent.

The software has been used by NASA to conceive *Curiosity*, the Mars rover; Calloway to design golf clubs; and Space X to develop its Falcon rocket and *Dragon* space capsule.

Along with Boles, McPhee singled out two MTSU alumni, Judith Bevels, a senior service account executive at Siemens Building Technologies USA in Nashville, and Rutherford County mayor Bill Ketron of Murfreesboro, for their work in helping the University obtain the gift. The president also recognized Jimmy Davis of the Davis Groupe, a source for equipment used in all aspects of manufacturing, and Keith Hamilton, a retired training executive with Bridgestone Americas. One of MTSU's trustees, Chris Karbowiak,

executive vice president of Bridgestone Americas, said the gift will be transformational.

"Our company is a beneficiary of the Mechatronics program," she said. "The work being done here is so tremendous and so influential."

A LASTING LEGACY

Professor Emeritus Richard H. "Dick" Gould, who died in 2012, spent 29 years at MTSU and was chair of Industrial Studies (later called Engineering Technology and Industrial Studies) from 1979 to 1995, when he retired. A year after his passing, the now-named Engineering Technology Department unveiled the new Mechatronics Engineering degree program, which has grown to become MTSU's fastest-growing undergraduate major.

Jean Gould, his widow, spoke to a gathering of more than 50 people attending the dedication of the Richard H. Gould Mechatronics Laboratory earlier this year. With sons Jeff and Jimmy Gould in total agreement that their father would have supported Mechatronics, Gould said she wanted to give a significant amount of money for the lab, located in the recently-renovated Davis Science Building. "I knew my husband would have thrown himself into supporting this project 100 percent," she said.

The undisclosed gift will provide a robot and additional equipment. Once Engineering Technology secures a new building, the lab will be transferred there.

FLIPPING THE SCRIPT

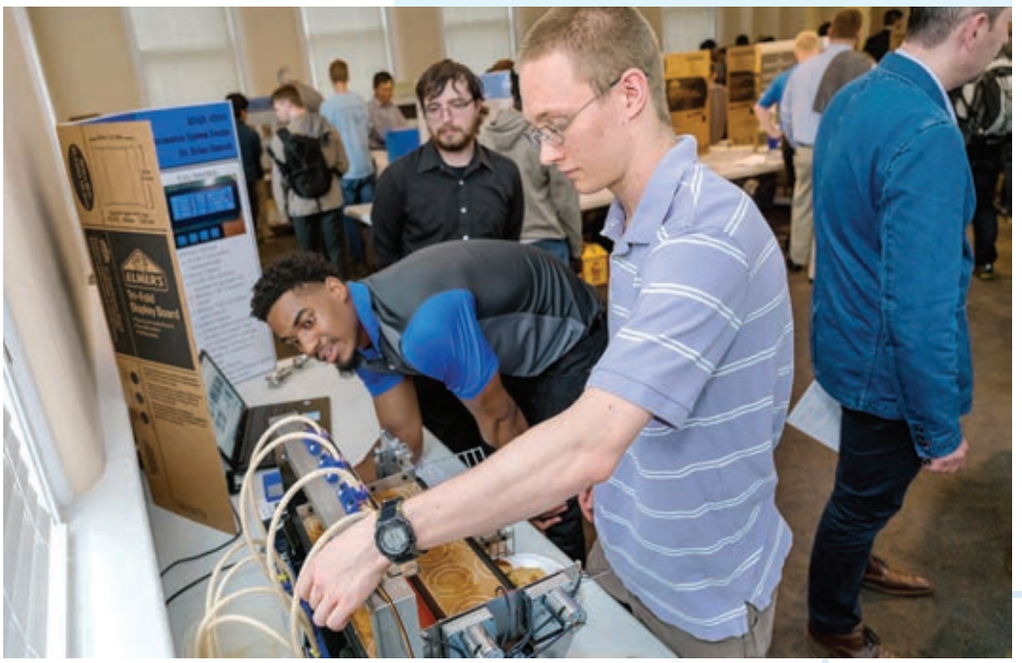
While an MTSU student-athlete, Ed Simpson (right) was a consummate team player. The 6-foot-2 guard was a contributor, both as a starter and coming off the bench, for the men's basketball team—which won a record-tying 100 games during his four seasons. He could hit the 3-pointer or dish out assists.

One of more than 2,600 MTSU graduates in May 2018, the 22-year-old Ocean Springs, Mississippi, native was a team player in his Mechatronics Engineering major, too. Last spring, he was project manager for a four-person team making a robotic pancake-making machine—one of five such devices producing plenty of pancakes for visitors attending Engineering Technology's Open House featuring senior projects from the department.

"I did a lot of documentation, making sure we stayed on track," Simpson said of the group that included fellow seniors Chance Ferguson, Eli Little, and Jeremy Hood.

A member of the Conference USA All-Academic team and a True Blue President's Award recipient, Simpson landed a systems engineering position before graduation with aviation, defense, space, and security giant Boeing and began work in Oklahoma City in June.

MTSU's Department of Engineering Technology in September 2018 celebrated the announcement of accreditation from the Baltimore, Maryland-based Accreditation Board for Engineering and Technology (ABET) and its Engineering Accreditation Commission. This is a remarkable achievement in that the program is only five years old—and growing by close to 100 students per year. It already has 66 graduates who are averaging $65,000–$75,000 a year in salary.



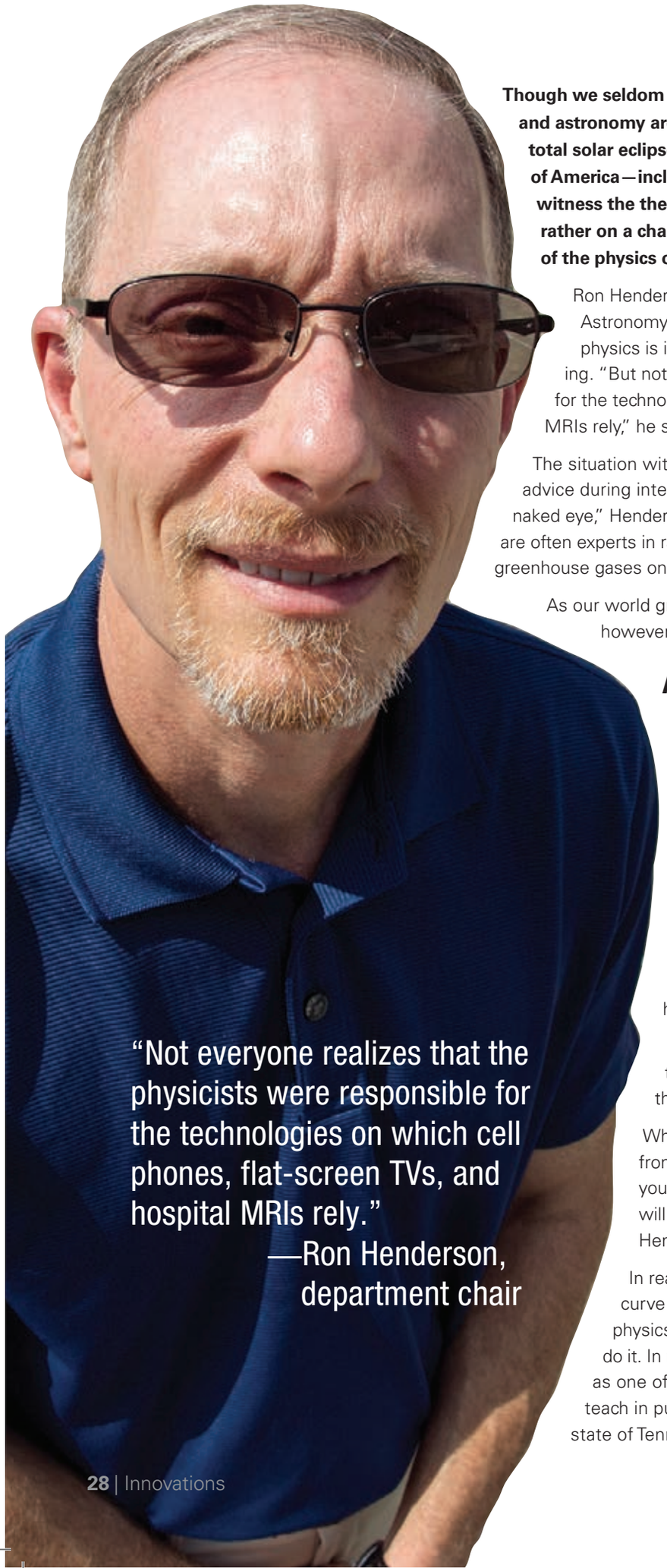
Technology lead assistant Chance Ferguson (center right) adjusts the robotic pancake flipper as project manager Ed Simpson (center left) and programmer, Jeremy Hood (center) look on.

ECLIPS EXPECT

SING TATIONS

The faculty of MTSU's Department of Physics and Astronomy, led by Ron Henderson, works to ensure bright futures for its graduates

by Drew Ruble



Though we seldom pause to acknowledge them, the miracles of physics and astronomy are everpresent in our lives. Consider the August 2017 total solar eclipse, which delighted onlookers across a broad swath of America—including thousands gathered on the MTSU campus. Or witness the the newest iPhones, which charge not using a cord but rather on a charging pad powered by the flow of electrons courtesy of the physics of induction.

Ron Henderson, professor and department chair of Physics and Astronomy at MTSU, acknowledged that most people understand physics is important when choosing how to build a bridge or building. "But not everyone realizes that the physicists were responsible for the technologies on which cell phones, flat-screen TVs, and hospital MRIs rely," he said.

The situation with astronomers is no different. "The public seeks their advice during interesting astronomical events that can be seen with the naked eye," Henderson added, "but may not appreciate that astronomers are often experts in radio frequency communication, or the effect of greenhouse gases on global climate change."

As our world grows more complex and technologically dependent, however, perhaps that's all changing.

An Astronomical Sign

The fall 2017 eclipse, for a day at least, brought physics and astronomy studies front and center for the nation, as its path of totality stretched from Newport, Oregon, to McClellanville, South Carolina, putting 12 states into darkness lasting up to nearly 3 minutes. The event transformed Henderson and his faculty team at MTSU into stars for a day, as well.

"It is a rare occasion to have astronomers in the public eye to this degree," Henderson said. "I think more of the population was simultaneously actively involved in a science experiment during the total solar eclipse than has occurred in many decades.

"On MTSU's campus alone, it was fascinating to see thousands of people all wanting to learn more about the sun and moon."

What's the potential impact of all that interest in science from an academic standpoint on the psyche of the American youth? "My suspicion is that a long-term interest in science will result for many of the K–12 students who participated," Henderson said.

In reality, Henderson and his faculty are already ahead of the curve when it comes to inspiring students to join the study of physics and astronomy—and they didn't need a total eclipse to do it. In recent years, the program has been nationally recognized as one of the top producers of Physics graduates ready to teach in public schools, filling a desperate need across the state of Tennessee.

"Not everyone realizes that the physicists were responsible for the technologies on which cell phones, flat-screen TVs, and hospital MRIs rely."
—Ron Henderson, department chair

It had not been uncommon in Tennessee for the Volunteer State's higher education system to produce three or fewer (sometimes zero) high school physics teachers per year. Henderson's department responded to such a jarring trend a few years back by developing a concentration in Physics Teaching. As a result, MTSU has graduated about 10 physics teachers in the past five years and is committed to informing its majors about this career pathway. Some local examples of MTSU Physics graduates now teaching include Robert Haddard, Jessica Cox, Jason Veal, and Nick Montgomery.

That increased yield earned MTSU recognition from the Physics Teacher Education Coalition as one of only nine institutions in America that graduated five or more high school physics teachers in a single year. (Brigham Young University topped the list with 17.) The organization described MTSU as "a national leader in physics teacher education." The program's overall graduation rate has also climbed steadily to a level that puts MTSU among the top 10 percent of bachelor's degree-granting institutions in the U.S. It all adds up to positive numbers for K–12 education improvement across Tennessee.

Importantly, though, Henderson stresses that Physics grads can do more than teach. In fact, many see physics and astronomy as key frontiers for human progress and evolution in the coming decades—much in the same way that technology and supercomputing transformed the world we now live in.

Recent MTSU Physics majors have become video game programmers, engineers, medical physicists, Department of Defense scientists, physicians, pilots, and architects, just to name a few fields. Jeremy Munday, for instance, completed a Ph.D. in Physics at Harvard, continued at Caltech, and is now a professor at the University of Maryland. Leo Sieben earned a master's degree in Computer Science and works for video game developer Rockstar Games in San Diego. Evan Wise finished his bachelor's degree and uses his physics skills at Nation Recovery Technologies in Nashville. Charlie Manger and Justin Cousineau graduated in 2016, and both work in the space industry at Signature Solutions in Huntsville, Alabama. Shane Fox is a control engineer in the automotive industry in Michigan. Clearly, Henderson's department is producing savvy science graduates with the skills required to excel in the 21st-century workforce.

MTSU's August 2017 solar eclipse event attracted thousands of local students and residents to campus.

Aligning the Stars

The department's push to both improve K–12 education statewide and to prepare a 21st-century workforce dovetails perfectly with MTSU's overriding mantra as a university these days—which is to produce student success both in terms of learning and graduation, as well as (eventually) in the workplace.

From a classroom perspective, MTSU's program has spent considerable effort in improving the way it teaches physics, evidenced by yet another recent accolade—its selection by the American Physical Society physics and science education advocacy organization as one of four Programs of Distinction for improving undergraduate education in recent years. Other winners have included North Carolina State, Cal–Davis, MIT, and Cal–Berkeley. MTSU received the national honor, in part, for "consciously adopting a mission to provide exceptional classroom experiences, career-focused courses, and pathways and intensive research opportunities to prepare students for targeted careers," said Deanna Ratnikova, women and education programs administrator with the American Physical Society. (Every physics department in the country was eligible for the award.)

Such a willingness to go the extra mile to ensure that MTSU students actually stay in school, earn a degree, and leave armed with skills that employers seek—all of which, incidentally, are top priorities of the current governor—hasn't been lost on the University's boss, either. In 2013, MTSU President Sidney A. McPhee awarded his first-ever president's award specifically for programs working to improve student success to Physics and Astronomy. With an announcement at the annual fall faculty meeting, McPhee described the department then as a model, highlighting how Physics and Astronomy had implemented more student-friendly teaching practices for introductory courses and smartly deployed high-achieving undergrads to serve as "learning assistants" for classmates in those courses. The department's reward—in addition to fewer failing grades, additional Physics and Astronomy majors, and more graduates—was a $20,000 check as inaugural recipient of the President's Award for Exceptional Departmental Initiatives for Student Academic Success.

RUNNING ON BRAINPOWER

Nearly a decade after graduating from MTSU, Taylor Arnold Barnes is considered one of the nation's most accomplished young minds in computational chemistry

By Patsy B. Weiler

Taylor Arnold Barnes, who graduated summa cum laude in 2009 with a double major in Chemistry and Physics, attended MTSU as a 15-year-old. Now he's considered one of the most accomplished young minds nationally in computational chemistry.

Barnes had his first computer before the age of 2. At age 8, when many boys are thinking about baseball cards and bicycles, he was reading college textbooks about how to write coding.

Once in college at MTSU, his academic accolades included earning MTSU's first Goldwater Scholarship at just age 16, a distinction presented to students showing exceptional promise of becoming the nation's next generation of research leaders in the fields of natural sciences, mathematics, and engineering.

After graduating from MTSU, Barnes then pointed his compass west and entered the California Institute of Technology, or Caltech—considered one of the top graduate schools in the country, according to 2017 *U.S. News & World Report* rankings—for graduate school. While there, Barnes' interest in computational chemistry—the field where chemistry, physics, and computer science intersect—continued to flourish.

"The goal of computational chemistry is to perform computer simulations of chemical systems in order to study things that would be difficult or impossible to investigate through laboratory experiments," he explained. "Since all chemical processes happen on such a small scale and during such a limited period of time, even the best light microscopes can't see them."

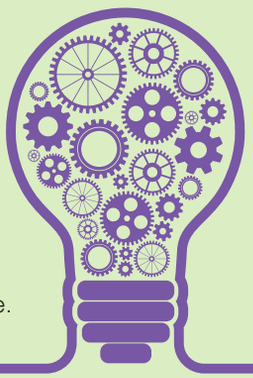
Enter the laws of physics. Why? Because they govern the behavior of the atoms and molecules that make up chemical systems. Although these laws are difficult to calculate, methods have been developed to make them suitable for computer simulations. But there is a challenge: The process can be very slow and speeding it up can result in less accuracy.

Barnes embraced the challenge, and his research has provided a "better combination of speed and accuracy than would be possible with any one method, which allows us to perform calculations that would otherwise be impractical," he said. The former Blue Raider's work was featured on the cover of the *Journal of Physical Chemistry C*, and he was recognized with an Early Career Award for Innovative Use of High Performance Computing from the National Energy Research Scientific Computing Center (NERSC).

This led to becoming the Admiral Grace Murray Hopper Postdoctoral Fellow (named after a U.S. pioneer in computer programming) at NERSC's Lawrence-Berkeley National Laboratory in the San Francisco Bay area. The California lab is home to Cori, considered the fifth-most powerful supercomputer in the world. During his two-year tenure, Barnes was responsible for improving the efficiency of computational chemistry software used there.

With many career options orbiting in his cosmos, including attractive commercial offers, Barnes' next stop in the late spring of 2017 was at Virginia Tech in Blacksburg. His True Blue fingerprints can now be found on the computers at the Molecular Sciences Software Institute (MolSSI), a cutting-edge research initiative funded by the National Science Foundation and housed in the school's Virginia Tech Corporate Research Center.

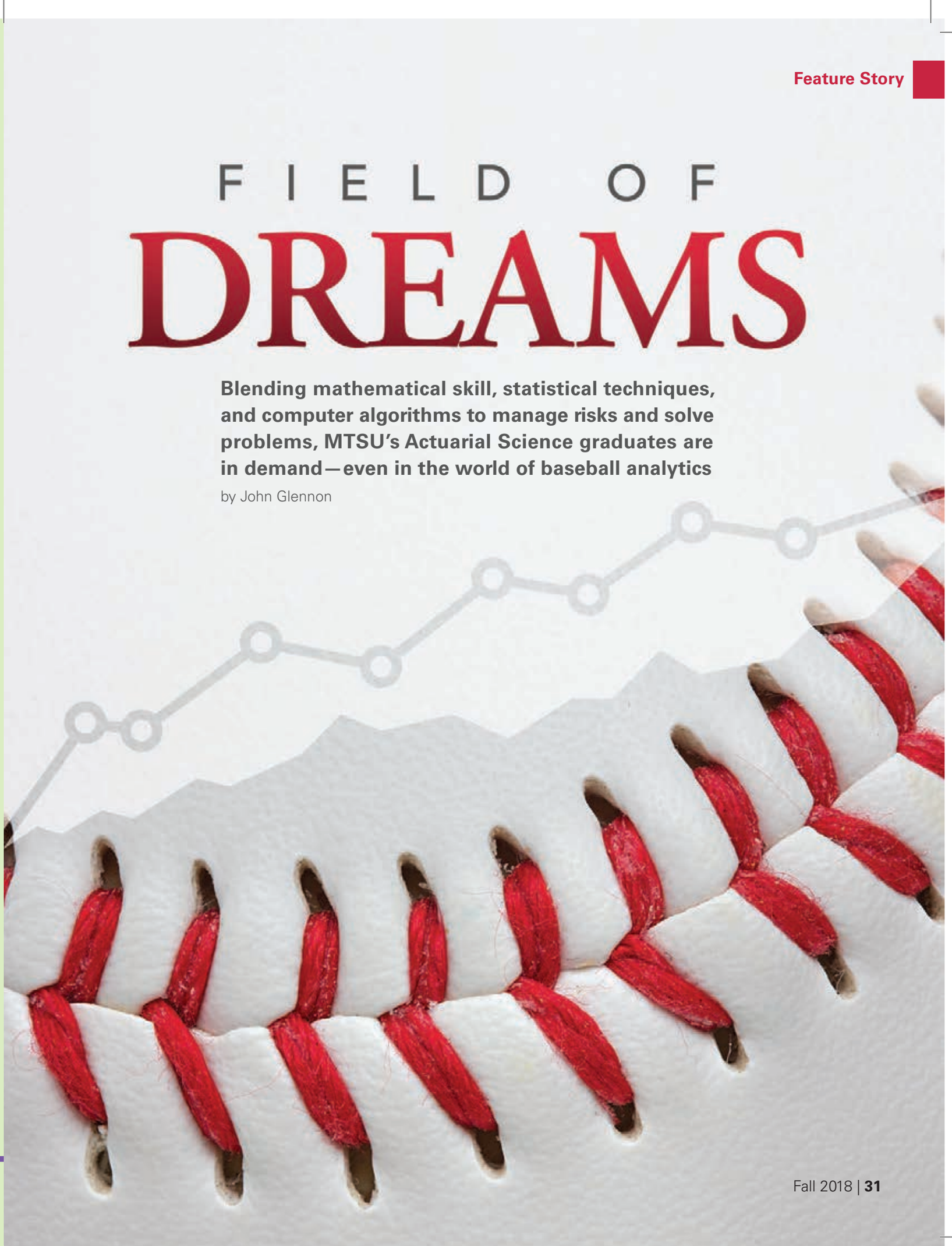
Barnes and his new research colleagues are tasked with developing and building new, powerful software tools to help tackle complex, data-dense issues—from cancer to Alzheimer's disease—that impact lives worldwide. The $19.4 million project aims to build a national team of software scientists to design tools that can help researchers of all stripes address wide-ranging, data-heavy issues like those mentioned above, as well as create new energy storage systems that can help stem climate change.



FIELD OF DREAMS

Blending mathematical skill, statistical techniques, and computer algorithms to manage risks and solve problems, MTSU's Actuarial Science graduates are in demand—even in the world of baseball analytics

by John Glennon



A big New York Yankees fan since interning with the team years ago, Kim Page never figured her Actuarial Science background at MTSU might mix so well with her passion for baseball. But Page, who works full time as a math instructor at MTSU, has made that combination work professionally for the past five years. She does so by spending a good chunk of her spare time doing what thousands of hardcore baseball fans might enjoy—dissecting the statistical data of minor league pitchers and predicting their futures for SIGMA Actuarial Consulting Group Inc. of Brentwood.

Page takes her best stab at determining which players might become major league stars and which might need more help in the minors. She presents her findings every other year at the Actuarial Research Conference and has talked with both Major League Baseball and STATS LLC about sharing her prized information with them, as well.

"I love, love, love what I'm doing now," said Page, who earned her master's with an Actuarial Science concentration from MTSU in 2015. "I love teaching at MTSU. It's a great place. And (the baseball work) is just a really fun thing to do on the side. To me, it's really interesting."

"I love teaching at MTSU. It's a great place. And (the baseball work) is just a really fun thing to do on the side."

Page's efforts on the baseball front and as an instructor illustrate yet another success story for MTSU's Actuarial Science program, which is pumping graduates into the field at an ever-expanding rate—many with a job in hand before they leave school.

Actuarial science students use mathematical skill, statistical techniques, and computer algorithms to manage risks and solve problems, most often for insurance and pension programs. The profession is a growing one, as the U.S. Department of Labor estimated that employment of actuaries would increase 22 percent from 2016 to 2026, much faster than the average for all occupations.

That's good news for MTSU, which is the only university in Tennessee that offers Actuarial Science coursework for both undergraduate and graduate degrees.

THE SKIPPER

When Don Hong, now the Actuarial Science coordinator, arrived at MTSU in 2005, there were only 40 students involved in the program—and just one or two graduate students studying actuarial science under the M.S. math program. But he's engineered great change since then.

In 2010, MTSU established a new concentration in Actuarial Science under the Master of Science in Professional Science. That attracted plenty of out-of-state students who had completed their bachelor's degree in math or business, but were looking to continue in the actuarial science field.

Just five years later, MTSU launched a stand-alone Bachelor of Science in Actuarial Science, which provided further advertisement for the program, nationally and internationally.

Another factor in the program's growth has been an international collaboration with sister schools in countries like China—where Hong grew up—and Ghana, further boosting enrollment.

Kim Page, MTSU Actuarial Science graduate, MTSU math professor, and data analytics consultant, at First Tennessee Park in downtown Nashville

The bottom line is that MTSU's Actuarial Science program featured a combined 112 undergraduate and graduate students in Spring 2018, nearly tripling the 2005 figure. Sixteen of 25 students in their final year in 2018 were accepted into graduate school, and several others received job offers.

> ***"If you're motivated and willing to put in the time, it's definitely very rewarding in the end. I would highly recommend it if you love math."***

All those MTSU numbers were likely to increase this fall, when there were more than 30 graduate-level students alone studying in the field.

"We're very proud because the numbers have just taken off, and it continues to grow and succeed," said Mathematical Sciences departmental chair Donald Nelson, who credits Hong with much of the Actuarial Science growth. "Our students are passing the professional exams in numbers nobody would have dreamed. I don't know if the numbers have literally grown exponentially (since Hong arrived), but certainly by leaps and bounds through his effort."

BATTER UP

Jeremy Richardson is another successful product of MTSU's Actuarial Science program.

When he graduated from high school, Richardson wasn't sure where he wanted to go to college or what he wanted to do with his life. But he knew he was pretty good at math.

So Richardson started researching local schools and potential fields of study, discovering the field of actuarial science and learning that MTSU had a program. Further research on his part revealed that the actuary profession was expanding, it paid well, and—if you could master a rigorous curriculum and pass a series of challenging professional exams—you'd probably wind up with a fulfilling job.

"If you're motivated and willing to put in the time, it's definitely very rewarding in the end," said Richardson, a 2007 MTSU graduate. "I would highly recommend it if you love math."

Richardson now works in Nashville as a consultant for Willis Towers Watson, the largest actuarial employer in the world. Most of his clients are large corporations or public entities—a few local, some national, and others based in foreign countries. In his job, Richardson uses actuarial methods to help self-insured clients, mainly assisting with workers' compensation liabilities.

"We try to help them understand impacts on their businesses and help them make decisions accordingly," Richardson said. "We provide them with a whole report that can be hundreds of pages, and then we kind of give them one paragraph: 'This is what it means. This is what you need to do about it.' "

MAKING IT TO THE BIG LEAGUES

Richardson is among many MTSU Actuarial Science graduates who have stayed in touch with the school even after entering the professional workplace.

Once a year, for instance, Richardson speaks to Hong's MTSU students about the career path he took, giving them a high-level view of an actuary and offering tips about what he did on the way to reach fellowship certification.

In addition, Richardson stays in regular contact with Hong regarding which new MTSU grads might make good hires for his company.

"He's constantly sending out résumés of students to his network of people and getting people hired," Richardson said of Hong. "We've hired, in addition to myself, several other alums from MTSU after they graduated, which is really one of the more important things when you're in college. You're paying all that money for a degree, so you want to have a job lined up when you graduate."

Hong says he hears often from former students who are moving up in the world, and he always encourages them to keep today's students in mind—making sure the MTSU network thrives.

> ***Chinese companies, it appears, are every bit as hungry for MTSU's accomplished Actuarial Science students as are American companies.***

"We say we do not expect you to return anything (after leaving), but just keep in mind one thing: You may like to help the next generation, your academic brothers or sisters," Hong said. "That's networking. And they remember this. We have a good connection. Graduates from our program like to shoot me an email and say, 'Dr. Hong, we have an opening in our company. Maybe you can send information to (students who will be graduating).' "

Lauren Chrisman, who earned her master's from the MTSU program in 2014, is a good example of a student who had a job waiting for her upon graduation. Like Richardson years

earlier, she had originally been unsure of her career plan when she began undergraduate work at MTSU. Chrisman loved math and at first figured she'd be a school teacher in the field, but then changed direction and wound up graduating with a bachelor's degree in Psychology.

She still wasn't satisfied, though, and returned to her math roots after happening upon a flyer for the MTSU Actuarial Science program. Only a year into her master's work in 2013, Chrisman had already passed two actuarial exams, which led to an internship at BlueCross BlueShield in Chattanooga. That experience in turn prompted a full-time actuarial job offer from Findley in Nashville, where Chrisman is now a senior analyst.

"That's such a benefit of the field," Chrisman said. "By the time I left school, I'd already been applying to different places, and I'd already received a few job offers.

AN INTERNATIONAL GAME

Chrisman is a Franklin native, but many of MTSU's Actuarial Science students come from much farther away—China.

Hong himself left China to earn a Ph.D. at Texas A&M University in the early 1990s, knowing very little English at the time. His ability to overcome that challenge makes Hong a good recruiter when he visits Chinese schools that partner with MTSU for Actuarial Science study—like Ningbo University and Guangxi University.

Chinese companies, it appears, are every bit as hungry for MTSU's accomplished Actuarial Science students as are American companies.

"Chinese companies often need actuaries to help with international collaborations—the Chinese company itself cannot handle those," Hong said. "They have to have somebody familiar with U.S. insurance policies. . . . That's why students come (from China) to MTSU and study Actuarial Science, to get familiar with insurance policies. With those risk management skills and actuarial science techniques, they can go back to China and work for those companies."

Nelson says MTSU is already reaping benefits from the growth and success of its Actuarial Science degrees.

"People who are interested in actuarial science . . . if they do very much research at all, they'll find out about our program," Nelson said. "It's being recognized nationally and even internationally for the success of the students. . . . From my perspective, I would absolutely say it's one of our signature programs."

MTSU President Sidney A. McPhee, and Shao Qianium, vice president of Ningbo University in China, sign papers that renew an academic partnership between the two institutions.

Basic Highlights (Continued from page 21)

STEM the Tide

MTSU again hosted a summer STEM camp for young girls in hopes of sparking their interest in the fields of science, technology, engineering, and mathematics. One of the camp's missions is to attract girls underrepresented in STEM fields, specifically African-American, Hispanic, and Native American girls. Started by Tom Cheatham, director of MTSU's Tennessee STEM Education Center before his retirement, the STEM camp is now coordinated by Professor Ginger Rowell. This year, about 15 fifth- through eighth-graders participated in the camp. One of the projects was building a solar robot.

The Future of Tech

By the end of the third Hack-MT at MTSU in January, there was plenty of cheering, whooping, and hollering from a bunch of tired people. Their joy was the combination of a wealth of collaboration and teamwork and an abundance of lack of sleep from Friday, Jan. 26, until the science fair portion of the event Sunday morning. College students from across the region joined those from MTSU for the hackathon, a 36-hour gathering of young programmers, software developers, visual designers, and others teaming up for projects in the Science Building. At 10:15 a.m. Sunday, two separate divisions of an MTSU team developing a ping-pong game with artificial intelligence were busy wrapping up their creations. "It was slow going to begin with, but once you get going, it's like any project—getting started is the hard part," said senior **Serenah Smith**, a Computer Science and Biology double major from Nolensville. Smith's brother, Ian Smith, a home-schooled high school senior planning to attend MTSU, took part in the event and helped their team. Judges awarded first place to a team that created Lawnbots, a system related to lawn care. A five-member team of students from MTSU and the University of Tennessee earned second place. MTSU students **Karla Robles** and **Marshall Cooper** joined forces with mentors Zach Kauble and Michael Millen of SERVPRO and finished third with their Blimp Race entry. Robles said their team's large red and gold balloons were attached to a computer board with wires connected to motors. The gadget had Wi-Fi capability, which allowed its programmers to send a command to take the balloons up or down, or left or right. Robles, who got six hours of sleep Friday night and two hours of sleep Saturday night due to her dedication to the project, said working with the mentors was "super fun." Hacker's Choice winners for the third consecutive year went to an MTSU team led by Computer Science grad student **Steven Sheffey**. "It's definitely cool to be recognized by your peers. You have to have a good idea and a lot of teamwork," Sheffey said. Yolanda Greene, who serves Hack-MT sponsor First Tennessee Bank as Rutherford County market president, said "it amazes me every year how much brainpower these students have." During the awards, Greene drew MTSU junior Computer Science major **Vanessa Serao's** name as the winner of an iPad Pro. Serao participated with an all-female MTSU team that created a simple trivia game. "It was stressful, but so worth it," Serao said. "We had no sleep, as we were trying to figure out everything." Twenty-seven teams began the process, but only 18 made it to the end, said **Chrisila Pettey**, chair of MTSU's Department of Computer Science. "One team had a motor short out Saturday night and there's no replacing it," she said. "A few other teams had problems, too." Students from Tennessee Tech, Tennessee State University, Belmont University, UT–Chattanooga, and the University of Alabama–Huntsville also participated. Along with First Tennessee, sponsors included Bondware Web Solutions, CAT Financial, and Jackson National Life Insurance Co. In addition to SERVPRO, other financially supportive friends of the event were DecisionSource, Rutherford Works, Axial Healthcare, Genesco, and Eventbrite.

Hack-MT participants share the results of their projects with judges and others attending the three-day, 36-hour event in the Science Building.

Expo **Adventures**

Thomas Jones, a 17-year-old junior from Stratford STEM Magnet High School, already has a contract with Microsoft for a game he created called *Blanco: The Color of Adventure*. At the sixth annual Middle Tennessee STEM Expo, held in April at MTSU's Student Union Ballroom, Jones showed off his Conceptual Forensic Retrieval System, an educational tool for children. He was among more than 600 students from across the mid-state taking part in the expo that showcases the fifth- through 12th-graders' recent STEM projects. Pet Zoomer, The Quick Feet Baseball Cleat, and Energy Drinks vs. Orange Juice were just a sampling of other project titles.

Self-Proclaimed **'Barnstorming Babes'**

Elizabeth Keller and **Madison Taylor** embarked this past summer on the race of their young lifetimes. The MTSU senior Professional Pilot majors and self-proclaimed 'Barnstorming Babes' left Murfreesboro Municipal Airport June 13, bound for Sweetwater, Texas, and the June 19 start of the four-day Air Race Classic. The event is the longest running all-women pilots transcontinental air race. (MTSU senior Gabriella "Ella" Lindskoug and Aerospace alumna Jordan Cantrell competed and placed 26th overall in 2017 and became the first pilots from MTSU to finish. They also competed again this year.) After raising about $12,000 from sponsors, family and friends, a yard sale, and a Facebook page GoFundMe account to help finance the endeavor, Taylor, 22, of Franklin and formerly from Houston, and Keller, 20, of Maryville, spread their wings and soared. "This will help us grow as pilots," Keller said. Keller played a major role in helping land the plane they were using, a new Cessna Skyhawk 172 as part of Textron Aviation's Top Hawk program *(see page 19)*. The duo logged about 4,000 miles and 40 hours roundtrip by the time they returned to Murfreesboro. The Air Race Classic, which stopped in Murfreesboro in 2016, features nine stops along the route that zig-zags to the north and then to the east, ending in Maine. Sponsors include Kelmont Farms Inc., Murfreesboro Aviation, Xpress Aircraft Maintenance, Pet Goat Farm, Open Roads Media, and MTSU Aerospace.

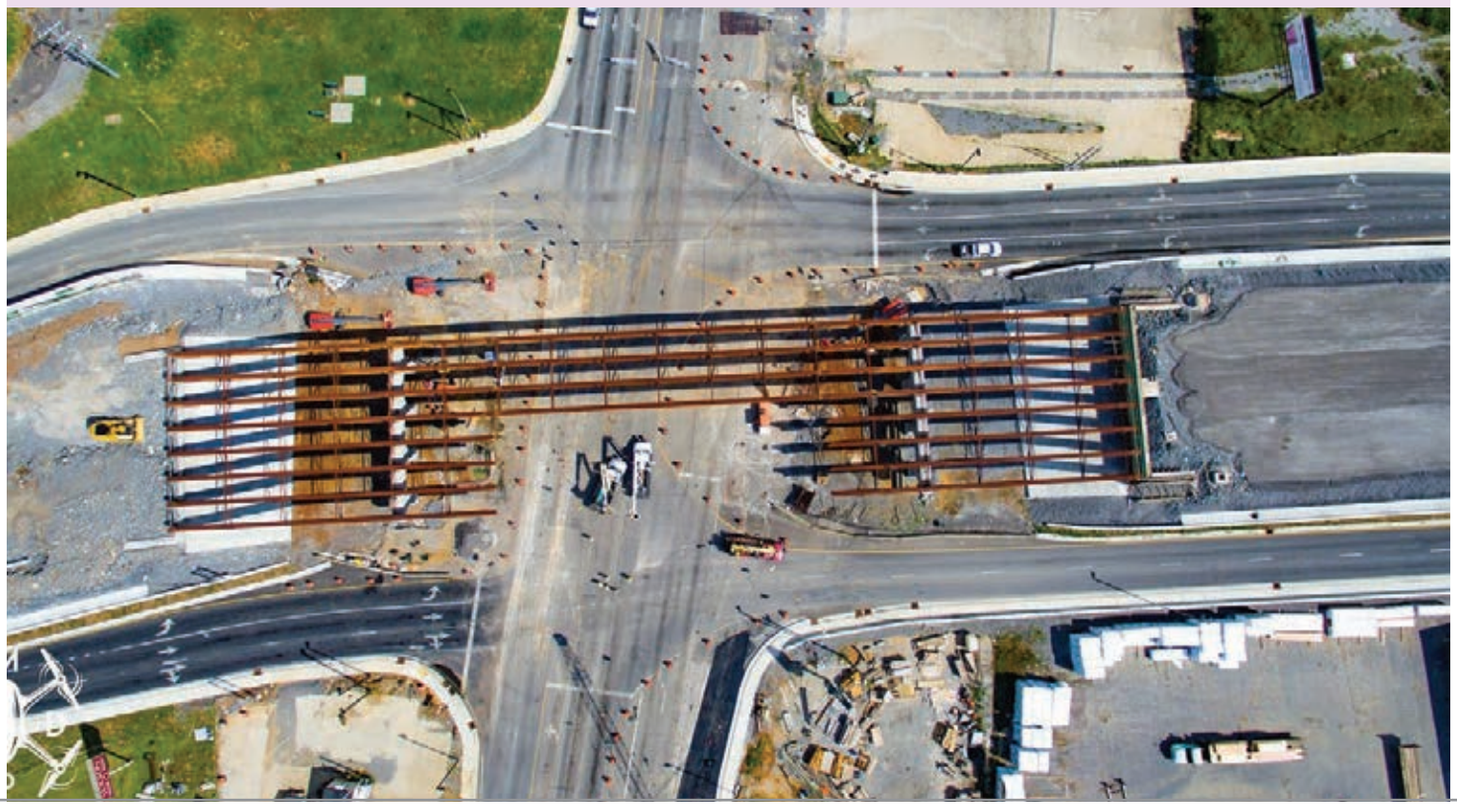
Madison Taylor (l) and Elizabeth Keller (r)

A Concrete **Advantage**

MTSU's internationally recognized School of Concrete and Construction Management makes an impact where rubber meets the road in Tennessee. The 2017 passage of the IMPROVE Act was big news for Tennessee's roads and bridges. The bill set aside $350 million for the dedicated highway fund and will kick-start almost a thousand infrastructure projects across the state. While all 95 counties will be under construction as a result of the legislation, one road that gains special significance under the plan is already built: That's the short stretch of I-24 connecting the Tennessee Department of Transportation (TDOT) in Nashville and the School of Concrete and Construction Management at MTSU.

As the first such degree program in the nation, and still one of a select few, MTSU's Concrete Industry Management (CIM) has a long history of using research to help TDOT keep our state's roads and bridges among the best in the country. For decades before the IMPROVE Act, funding for new construction projects was hard to come by, so a big part of TDOT's success has been the longevity and quality of its construction, as well as its repairs. The state regularly relies on CIM faculty to comparison-test patching materials and other ready-made products, along with various concrete formulations, to determine which will perform best under Tennessee's traffic, geological, and weather conditions. Having the nation's flagship concrete industry academic program less than an hour away allows for easy collaboration, and the MTSU research-oriented perspective encourages TDOT to "evolve into something better" rather than simply sticking to what it knows, said Jamie Waller, who oversees concrete operations for TDOT's Materials and Tests.

For example, TDOT engineers turned to MTSU faculty researcher **Zhifu Yang** for answers when they learned that some of their pre-stressed concrete beams had been fabricated using contaminated well water. The worrisome contaminant was chloride, an ion in salt, which can corrode the steel used to reinforce bridge decks and similar concrete structures. The engineers' concern was well-placed. According to Yang, the rusting of steel in concrete is the No. 1 infrastructure problem in the world. Yet surprisingly little research had been done on the subject. The project dovetails with Yang's interest in using industrial byproducts in concrete—a common practice among transportation departments, he said. It turns out that slag from iron- or steel-making or fly ash from coal-burning power plants can make concrete less permeable and, therefore, more resistant to the corrosive effects of chloride. By exploring the interplay between aggregate blends, chloride levels, and permeability, Yang can help refine this clever form of recycling.



Green **Gold**

This past spring, MTSU President Sidney A. McPhee traveled to China with then-state Sen. Bill Ketron, now mayor of Rutherford County, and businessman Paul Martin, the first graduate of MTSU's Honors College. The highlight of the trip occurred in Nanning, where McPhee announced the creation of a new institute in concert with MTSU's primary research partner in China—the Guangxi Botanical Garden of Medicinal Plants. In the agreement, MTSU's Tennessee Center for Botanical Medicine Research (TCBMR) agreed to create a joint ginseng institute in concert with Guangxi to study, develop, and promote Tennessee-grown herbal products for sale in Asia and other emerging markets.

The new International Ginseng Institute, with MTSU faculty researcher **Iris Gao** serving as its American director, will spin off from the TCBMR, which will continue to work with the garden on other projects. Miao Jianhua, Guangxi director, said the garden plans to spend the equivalent of about $30 million in U.S. dollars for the construction of a new lab at the Nanning complex to support the effort. The garden has been designated one of China's top 10 research facilities in funding priority. He also outlined the garden's plans to hire up to 130 researchers and staff devoted to the institute. McPhee was accompanied at the signing by two local businessmen, Ted LaRoche and Edward Chiles, whose Greenway Herbal Projects firm has given $2.5 million toward MTSU's herbal research. Martin arranged for the first contribution to the new institute: a $2,500 check from the Walter and Edith Loebenberg Foundation. Separately, MTSU recently received a special $148,000 U.S. Department of Agriculture grant. Tennessee farmers earn about $620 per acre from corn, but the same land yields more than $40,000 per acre when planted with ginseng. The University's pursuit of the study of ginseng goes back to 2013, when Ketron encouraged MTSU to use its China ties and research expertise to help Tennessee farmers add ginseng as a cash crop. The former senator also helped gain state funding in November 2013 for a demonstration plot on the MTSU campus.

Iris Gao and a Doctoral student in her lab.

Project **SEED**

High school senior Jessica Bullock of Murfreesboro did not hesitate when given the opportunity to participate in MTSU's Project SEED Program. The 16-year-old Central Magnet School student took part in the summer intensive Project SEED (Summer Education Experience for the Economically Disadvantaged) sponsored by the American Chemical Society (ACS), which gives high school juniors and seniors an opportunity to gain scientific knowledge through research and hands-on activities in academic, industry, and government research labs across the country, including at MTSU. Bullock also received a $2,500 stipend from the ACS and the MTSU Office of Research Services. Bullock worked on a National Science Foundation research project under the advice of Keying Ding *(see page 13)*, a Chemistry assistant professor at MTSU. The project's goal is to use a metal complex as a catalyst to trigger chemical reactions between the compound amines and alcohols, resulting in amine or imine products that are important chemicals for pharmaceutical companies.

EXPANSES AND EXOPLANETS

National Science Foundation research experience provides opportunity to observe the night sky and beauty of Wyoming

***By Jackson Cole**, a Physics major and student president of the MTSU Astronomy Club*

Wyoming is possibly the most beautiful state I've ever seen. When I arrived in Laramie for my National Science Foundation's Research Experience for Undergraduates (NSF REU) at the University of Wyoming, I had to pass through Medicine Bow National Forest and the Laramie Range, and I quickly noticed that the horizon is filled with mountains. The Laramie Range is to the east, the Snowy Range is to the west, and the Rockies are immediately south. The wildlife is unbelievable. Antelope are everywhere, along with moose, black bears, and an occasional mountain lion.

The first full day we were at UW, our group of REU students observed with a professor and a grad student, and within a week the REU students took the project's reins. In the afternoons, we met in the astronomy

computer lab to reduce data, discuss data reduction/processing techniques, and talk about the specifics of the data analysis that we were conducting. Also, professors and grad students gave talks on various topics.

Around 6 p.m. each day, those who were observing that night would load the observatory vehicle to head to work. The observatory was about 45 to 60 minutes away, with a 30-mile drive to the base of Jelm Mountain, followed by a 5- to 7-mile drive on dirt mountain roads with steep dropoffs.

We spent the summer observing giant exoplanet transits, which allowed me personally to spend about 30 nights operating a world-class 2.3-meter infrared telescope on top of a mountain in Wyoming with my REU peers. Our project was specifically focused on confirming prior published results, confirming and updating transiting exoplanet ephemerides for our targets, and providing adequate data for characterizing their atmospheres. Basically, this boiled down to a collective total of 66 nights of continuous observation of 12 targets, coupled with a significant amount of time programming and reducing data.

> “We spent . . . about 30 nights operating a world-class 2.3-meter infrared telescope on top of a mountain in Wyoming.”

In the fall, the other REU students, the grad school project leader, and I co-authored a paper. We also created posters about our research, which we presented at the American Astronomical Society conference in Washington, D.C., in January 2018.

While in Wyoming, I hiked, camped next to Jackson Lake in the Grand Tetons, stepped in thigh-deep snow, visited the hot springs, watched Old Faithful, swam in Jackson Lake even though it was 40 degrees, and wished I lived there.

All in all, it was an absolutely unbelievable experience and a lot of fun. I am incredibly thankful to have been able to spend a summer in beautiful Wyoming being paid for doing astronomy.

[Editor's note: This article first appeared in Areté*, the magazine of the MTSU's Honors College.]*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CLEARING THE AIR

One MTSU professor's work wields analytical chemistry to curb pollution and its ill effects

by Drew Ruble

Ngee Sing Chong, a professor of Chemistry, is director of the MTSU Interdisciplinary Microanalysis and Imaging Center. From 2004 to 2008, he also served on the Tennessee Air Pollution Control Board to address air quality issues in in the state and helped formulate strategies for pollution control. Prior to coming to Tennessee and MTSU, Chong worked for the Texas Commission on Environmental Quality, monitoring air pollutants at industrial sites in Texas.

Clearly, Chong knows a thing or two about clean air. The air quality expert applies analytical instrumentation for studying environmental pollution and health-related issues. From electrochemistry to chromatography, mass spectrometry, atomic and molecular spectroscopy, and electron microscopy, he works to solve problems related to environmental risks to human health. His research interests include the air quality impact of wildfires on the health of firefighters, the effects of tobacco smoke and electronic cigarette emissions on smokers, methods for removing air pollutants from engine emissions, and urban air quality.

Chong partners with MTSU's renowned Unmanned Aircraft Systems (UAS) Operations program to carry out chemical cartography. "For the study of emissions from wildfires, it is especially beneficial to use air-sampling drones for tracking the dispersion of pollutants by real-time monitoring of carbon monoxide, inhalable particulate matter, and other toxicants, so that the extent of the human population affected by poor air quality can be estimated accurately," he said.

Chong made a major contribution to the field of analytical chemistry with his development of a prototype instrument, combining gas chromatography with inductively coupled plasma-mass spectrometry (GC-ICP-MS). This technique allows the quantitative analysis of toxic compounds like methyl mercury, tributyltin, and dimethyl arsine that may be found in contaminated seafood. Various methods based on GC-ICP-MS have been used by industrial laboratories, government research institutes, and academic research groups. Chong's research group has recently discovered that surface-enhanced Raman scattering (SERS) can be used for trace analysis of aromatic amines, many of which are carcinogenic and may be generated as waste products of dyes used in textile and leather industries.

His research interests include the air quality impact of wildfires on the health of firefighters, the effects of tobacco smoke and electronic cigarette emissions on smokers, methods for removing air pollutants from engine emissions, and urban air quality.

Currently, Chong is collaborating with researchers at the Shelby County Health Department and University of Memphis in the air quality study of Memphis and surrounding areas. Results indicate that there are several chlorinated and fluorinated compounds detected that are not in the U.S. Environmental Protection Agency's toxic release inventory list and yet may be significant from the standpoint of risk assessment.

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