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ENGINEER

THE UNIVERSITY OF TENNESSEE, KNOXVILLE • TICKLE COLLEGE OF ENGINEERING

MANUFACTURED ADVANCEMENT

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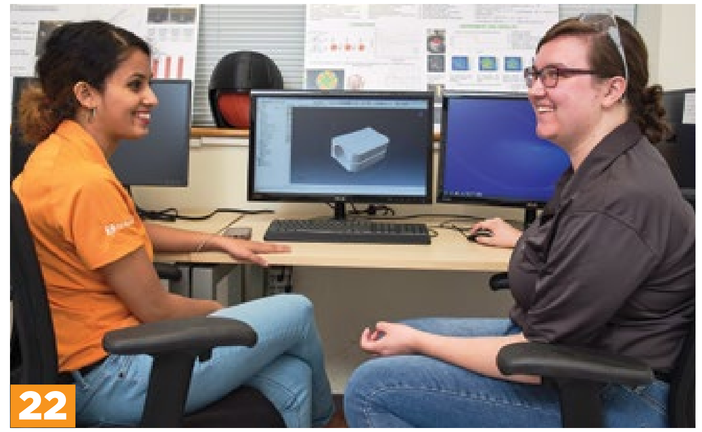

Features

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On the cover:
UT is a leader in the advanced manufacturing revolution. Page 22.

TICKLE COLLEGE OF ENGINEERING
THE UNIVERSITY OF TENNESSEE, KNOXVILLE

Dean's Message

Much has changed about our college and the UT campus since I started here as an electrical engineering student in 1975. When I returned in 2013 as a faculty member, the Min H. Kao Electrical Engineering and Computer Science building had just opened. Today, we also have the John D. Tickle building and just broke ground last month on the new 228,000 square-foot engineering complex, set to open in 2021. This new "gateway to engineering" will be the new home for our top-ranked Department of Nuclear Engineering. It will also give a consolidated space for our freshmen to gather, engage, collaborate, and learn. In short, it will be a point of pride for the college, the university, and Knoxville for decades to come (page 45).

Throughout the past decade, during Interim Chancellor Wayne Davis's tenure as dean, our campus facilities, research activities, student body, and faculty have grown significantly. In May, we graduated the most PhD students ever at 118. In August, we welcomed our largest-ever class of incoming freshmen, 12 percent larger than the previous year. And we have reimagined the Innovation and Collaboration Studio—a dynamic space for students of all levels to bring their creativity to life (page 2).

Our role as a nationally recognized research institution was confirmed this year through an Office of Naval Research MURI award in advanced manufacturing (AM) and a $9.8 million hypersonics project with the US Air Force Research Laboratory (page 22). Faculty from every department are actively working on AM projects with multiple partnering institutions and companies, and our collaborative relationship with Oak Ridge National Laboratory has never been stronger.

In 2018, we are celebrating the 45th anniversary of our Minority Engineering Scholarship Program (MESP) and Engineering Diversity Program (EDP). Diversity continues to be an area of focus and need for the college. We are continuing to explore new ways to prepare, attract, and retain minorities and women in engineering. I look forward to celebrating the success of our diversity programs and of our MESP/EDP alumni on November 2.

Our commitment to making the Tickle College of Engineering the best it can be remains steadfast. Since I was asked to serve as interim dean, I have been energized by the dedication and ideas of our faculty, staff, and students, and I look forward to leading our Engineering Vols family to even greater heights. To our students, faculty, staff, alumni, and local community, we are open to your ideas and recommendations to continue the growth and success of the Tickle College of Engineering. Thanks for your support.

Go Vols,

Mark Dean

Mark Dean
Interim Dean,
Tickle College of Engineering

> We were in Estabrook Hall, with no name, just a maker space. Back then, it was primarily freshmen working on projects. But Will Schleter had an idea and a vision of what we could be. [Then-dean of engineering] Wayne Davis asked me, 'What would you do if you had a million dollars to improve things?' and, well, here we are.
>
> —Richard Bennett, Director, Engineering Fundamentals

making SPACE for makers

By David Goddard.

The origin of what is now the Innovation and Collaboration Studio dates back 20 years to 1998 and the creation of the *engage*™ Engineering Fundamentals program.

Championed by then-dean Jerry Stoneking and backed by NSF funding, the program that now bears Stoneking's name has served as a stepping-off point for incoming freshmen since it launched. In more recent years, a key component has become the Innovation and Collaboration Studio on the lower floor of Perkins Hall.

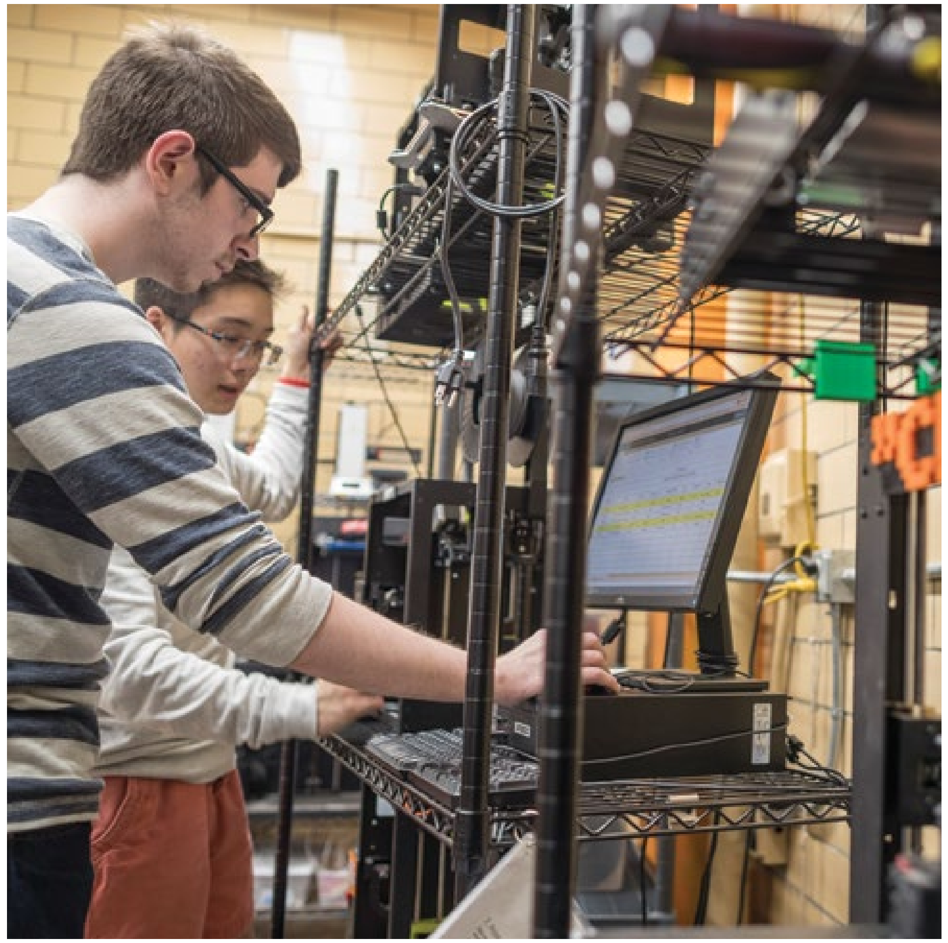
"The ICS space certainly draws in new students," said new Edwards Assistant Dean and Director of Integrated Engineering Design Keith Stanfill. "They come through on tours and see current students working and it allows them to see tangible possibilities. They see applications of engineering, see the help they can get, see the opportunity at UT. That's super powerful."

It's also purposeful. Richard Bennett, director of *engage*, recognized the value of having a "wow" factor for the space to make a solid first impression on freshmen and inspire them to become involved. His team also encourages work across class levels.

"When you look around the country, a lot of places have freshman- or senior-specific spaces, sometimes not even in the same building or area of campus," Bennett said. "We very much want our freshmen and seniors to work alongside one another. We had a specific vision to be together."

Tommy Duong, who, along with Michael Allen, helps run the ICS and advise students, noted that such interactions are beneficial to both upperclassmen, who might be inspired by an idea from a younger student, and freshman, who pick up on tricks and techniques their older collaborators have learned over the years.

Duong said that while he and Allen supervise, it's really the students who create the culture in the lab, making their ability to work with one another that much more important.



Vol Means All

Sometimes, though, creating an inclusive culture requires direct intervention. In years past, Allen and Duong observed that students can be quick to fall into long-held gender stereotypes, with men doing the physical work and women pigeonholed into the design aspects of projects.

Recognizing this issue, they started a series of women-only classes, aimed at building both confidence and experience.

"We hold classes of 12 students at a time to help them grow as makers and empower them to have more self-assurance when they are in mixed groups," Allen explained. "Some of them come back to do projects on their own. We had one student who said that she wished she'd done it earlier, because she wouldn't have let herself be pushed to the side like she had been before."

The initiative taken by Allen and Duong to resolve the issue hits one of Stanfill's main goals of the lab; that he doesn't just want all students to feel invited, but rather to actually take part.

Another group that can sometimes be overlooked in engineering despite its inherent importance has also found its niche in ICS: artistic thinkers.

Stanfill, whose motto for ICS is "Cultivating Creative Confidence," noted that engineers can get trapped thinking only in technical ways.

"There's something to be said for the artistic part of your brain being engaged," said Stanfill, citing data that students in sciences with artistic traits can get burned out if their artistic side is not nurtured. "There's a joy that comes with making things with your own hands. Our more creative students can get disillusioned with theory and fundamentals, but the ICS can give them tangible proof of concept."

Going to Work

There are plenty of shiny, state-of-the-art machines in the ICS space, including the standard icon of any modern maker space, the 3D printer. But what stands out as a practical and vital skill is wood working.

"It's a lot easier to train someone on a wood lathe than it is, say, a laser cutter," Allen said. "It gives us a chance to get them some hands-on experience quickly while they get training on things they might have never seen or heard of."

"Wood is a de facto soft material learning experience," Stanfill adds. "It can stand in for a number of more expensive things, such as composites, allowing students a chance to experiment without fear of wasting a costly material."

Through wood, the lab mimics the real world: no business would scale up a product without first running smaller tests.

"If a picture is worth one thousand words, then a prototype is worth one thousand pictures," Stanfill said. "Innovation is about failing fast and failing cheap. That's how you learn. Failure isn't a dirty word in innovation."

ICS helps students innovate, but changes are coming that will revolutionize the entire program.

If You Build It...

The $129-million complex scheduled to open in 2021—when this year's incoming freshmen will be seniors—will raise the profile and promise of ICS to unprecedented levels.

"It is clearly going to be a showcase," Stanfill said. "We'll be able to attract students, companies, faculty. The equipment we'll add once we get that space will generate its own excitement."

Alumnus Min Kao (MS/PhD EE, '74/'77) and his wife recently made a transformative gift to the college to specifically enhance the space in the new building, where it will become the Min H. and Yu Fan Kao Innovation and Collaboration Studio.

The new space will have a full electronics shop, metal shop, and a six-axis robotic arm, with the possibility for fiber lasers, plasma cutters, vacuum form machines, and welding. Large glass partitions will allow visitors to observe activity and adjustable entrance ways will allow for innovation fairs.

"Students will be able to lay out, design, build, assemble, and adjust, with everything they need close by," Duong said. "It's going to be a great space."

It will also allow the team to fully realize integrating the different classes and disciplines together, as well as open up possibilities for industry collaboration.

After all, as Stanfill, Allen, Bennett, and Duong all pointed out, if a real-world engineering project demands an understanding of computer science, mechanical, industrial, and civil engineering, shouldn't the college prepare students to thrive in that world?

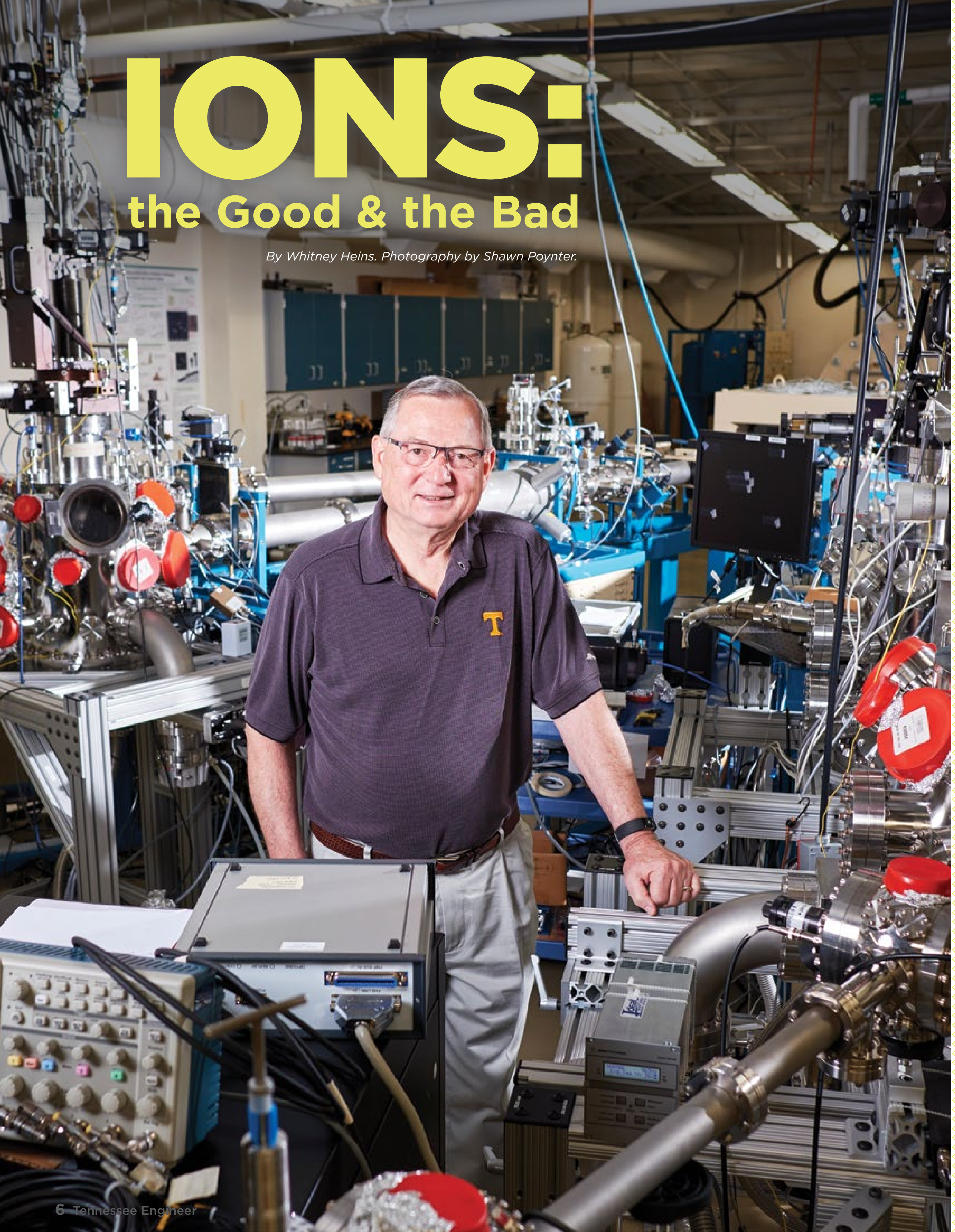
Stanfill said future projects will be multi-disciplinary by design, giving potential industry collaborators a "menu of disciplines" to draw upon, and providing students the benefit of cross-disciplinary study with added insight into what companies are like.

"Companies will benefit as well," Stanfill added. "Putting students on a senior project sponsored by their company gives them what amounts to an 8-month interview, gets a project done for them, gets exposure for them to faculty, and lets them make impact on education."

For students, faculty, the Tickle College of Engineering, and industry partners, the future is what they make it. Literally.

Going Above and Beyond

Haslam College of Business alumnus Bradley Fraser Kerr Sr. (MBA Marketing '73) and his wife Joyce recently supported the purchase of several essential new pieces of equipment for ICS, including a laser cutter and engraving system, a table saw and accessories, a sander, and a cordless tool bank.



IONS: the Good & the Bad

By Whitney Heins. Photography by Shawn Poynter.

When UT-ORNL Governor's Chair William Weber began his career studying the effects of radiation materials, his work was constricted, somewhat dangerous, and time-intensive.

"We always had to put on protective clothing and handle the materials in glove boxes," he remembered. "The materials were remotely handled using tweezers or tongs, and there was always a background level of radiation."

But now, what took years of study can be done in just a day without the risk of radiation and the confines of glove boxes.

How? UT's Ion Beam Materials Laboratory (IBML), which is home to an ion beam accelerator.

The accelerator has the ability to speed up the effects of radiation without actually exposing people to them. It does this by energizing ions, then shooting them at materials mounted in one of four target chambers. The lab, housed in UT's Senter Hall, is the brainchild of Weber who directs it.

In general, IBML harnesses the power of ions to study their good, bad, and not-so-ugly abilities as it relates to materials interactions.

So, what's the good? Weber uses the ion beams to improve existing materials by modifying their magnetic, electrical, or optical properties, thus changing their functions and abilities.

"We can add ions of different elements to materials and force them into a material even if they don't want to be there," Weber explained. "We have the power to induce transformation to phases that wouldn't exist naturally or in normal manufacturing processes."

The possibilities of this fundamental work, funded by the US Department of Energy's (DOE) Office of Science, are seemingly endless—from improving semiconductors and information transfer between devices to developing mini-labs on a chip.

Weber also studies the so-called bad side of ions created in nuclear environments—their damaging effects on materials—but without the radioactivity.

"These ions act as billiard balls on a pool table," Weber explained. "They knock the atoms inside materials around but they also excite the electrons. So, it is very challenging to understand and model their behavior."

By using the IBML to shoot heavy ions at materials, Weber and other researchers simulate the radiation effects of what sixty years inside a reactor, or hundreds of thousands of years sitting in nuclear waste would look like in order to predict their performance in a nuclear environment. The work is especially relevant to making nuclear power safer.

"A lot of our research is aimed at improving the accident tolerance of fuel in our reactors," said Weber. "Specifically, we are trying to improve the fuel cladding so it doesn't rapidly oxidize."

Oxidization can occur on the zirconium-based metal cladding when exposed to high-temperature steam during an accident. When rapid oxidation occurs, it exposes the fuel to the air creating the danger for release of radioactive materials.

With funding from the DOE Office of Nuclear Energy, Weber also researches the performance of new materials that could be used in the next generation of reactors and how their radiation tolerance could be improved. His research is also useful for nuclear waste disposal plans.

Members of the UT-ORNL IBML team (from left to right): Gihan Velisa, Zhe Fan, Miguel Crespillo, William Weber, Yanwen Zhang, Chen Xu, Lauren Nuckols, and Christopher Ostrouchov.

Finally, Weber's work peers into the not-so-ugly side of ions by harnessing their ability to reveal the chemistry of materials.

Weber has been surprised and fascinated by the way ions behave for more than forty years. Ironically (or ionically), Weber began his work with radioactive materials as an undergraduate student during a summer internship at ORNL. Now, his career has come full circle as he is now the one training the next generation of scientists.

Weber has accomplished a lot—with or without the power of an ion beam accelerator—and he can only imagine what his students will accomplish with the power of ions at their fingertips.

> **"Finding a better solution means fewer fossil fuels and minimizing cost. It also means solving problems faster."**
>
> —James Ostrowski

finding the best SOLUTION

By Whitney Heins. Photography by Shawn Poynter.

Riddle you this:

You are betting on six soccer games. There are only three outcomes—the home team loses, wins, or ties. What's the fewest number of tickets you can buy to cover all outcomes and win the most money?

Called the "football pool problem," this riddle seems simple enough but it's actually really difficult and people have spent years of computing time trying to solve it to no avail. One of those people is Jim Ostrowski, associate professor and director of graduate studies in the Department of Industrial and Systems Engineering.

Ostrowski was introduced to this problem while in graduate school and it was a game changer for him. The lure of the challenge put him on the path of studying mathematical optimization.

Optimization is the selection of the best element from a set of available options using computational methods. It's used every day to save time, money, and lives in areas like routing planes, charting delivery trucks, and scheduling surgeries.

One of the known difficulties is eliminating solutions with similar outcomes—known as symmetric solutions—that slow down the process and make problems harder to solve.

"Optimization is finding the best solution possible given the constraints that you have," explained Ostrowski. "And, that's hard to do if there are a lot of solutions."

Ostrowski's continuing efforts to come up with a solution to having too many solutions have garnered him a DOE Early CAREER award.

In his project, called "Symmetric Convex Sets: Theory, Algorithms, and Application," Ostrowski notes that the growth in use and improvement of algorithms has allowed computers to take on new roles in areas that require rapid decision making, but some persistent quirks, like symmetric solutions, remain.

"I'm trying to come up with a general algorithm for general problems that addresses this quirk," he explained. "The tool will help determine what makes problems difficult, and then avoid that difficulty. It will have the power to improve the computational speeds by orders of magnitude."

In addition to his theoretical research, Ostrowski is developing complex algorithms to be used in real-world situations, particularly as it relates to energy usage.

Every day, around the world, multiple times a day, energy clearinghouses determine the best mix and amount of fuel sources to power our communities. Get it wrong and power can be more costly, unreliable, and harmful to the environment. Ostrowski's algorithms would optimally schedule power generators while considering pricing, usage, and reliability constraints.

"Finding a better solution means fewer fossil fuels and minimizing cost. It also means solving problems faster," said Ostrowski, noting that he anticipates his work, funded by nonprofit organization MISO, to be used in production soon.

Ostrowski is also working on developing the technology for "smart neighborhoods" based in Oak Ridge, Tennessee. These "neighborhoods of the future" use leading-edge microgrid technology to support the community's energy needs including sources like solar panels, battery storage, and a backup natural gas generator.

Ostrowski is developing optimization algorithms to be used in the software that controls the microgrid and decides when to turn on homes' systems for use in the most efficient way.

"This work uses forecasted data to develop a market that ensures that the neighborhood's assets are distributed efficiently. We aim to spread out coast and demand to the different solar or gas systems based on when people use things like their HVAC or water heaters," he explained.

Common to these projects is the persistent quirk of symmetric solutions. So, when Ostrowski is finished developing his algorithm to help avoid them, his energy-focused research and many other needs, will be a lot easier to tackle.

Ostrowski is also investigating how to harness the power of quantum computing to improve optimization. Currently, it's not proved very useful, but it can be when blended with traditional computing. Ostrowski plans to look into how to design algorithms that take advantage of the benefits of both types of computing. The result would be much, much faster solutions—and, maybe—finally—a solution to the football pool problem.

Detecting Danger

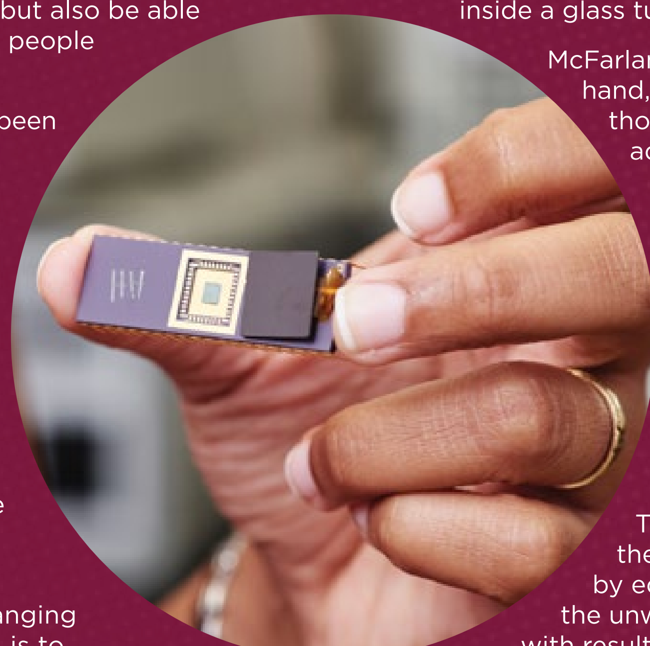
By David Goddard. Photography by Shawn Poynter.

One of the most routine procedures for patients with diabetes is also one of the most painful: the frequent need to draw blood for a glucose test.

Thanks to ongoing innovation from Nicole McFarlane, those days may be numbered.

McFarlane, an assistant professor in the Min H. Kao Department of Electrical Engineering and Computer Science, has made great strides in recent years in the development of new types of sensors.

"We've taken a two-pronged approach," McFarlane said. "We've aimed to build a better sensor that will require a smaller sample size, but also be able to reliably replace the sensors people currently use."



McFarlane and her team have been working with analyte sensors, which are designed based on biology and can be implanted inside a patient to allow for continuous, accurate monitoring when paired with a neuro transmitter.

Doing so would not only eliminate the need for people with diabetes to prick their fingers multiple times a day, but would resolve the issue of patients skipping testing.

In keeping time with ever-changing technology, the eventual goal is to take these first-generation sensors and add machine learning, allowing for "smart" devices.

Such devices could potentially deliver medication as needed, which would allow for a reduction in or elimination of the need for insulin injection.

"From our standpoint as researchers, fine tuning the signal processing is important," said McFarlane. "Also, since we're talking about medical devices that would be used on humans, the health impact has to be weighed by the Food and Drug Administration and then they have to approve their use in clinical trials."

In addition to having practical application in the medical arena, the properties of the sensors being developed by McFarlane also hold promise in other areas. For example, as a detector at the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory.

Scientists working at SNS gain access to behaviors and properties of materials at the smallest scales, allowing them to improve fields as diverse as electronics and medicine.

The problem is that a common means of measurement requires the use of photomultiplier tubes, which are expensive, require massive cooling efforts, and can be somewhat delicate, since they are inside a glass tube.

McFarlane's sensors, on the other hand, provide solutions for all of those issues and have a key added advantage as well.

"The Department of Energy is very interested in the ability to use the sensors because they are smaller, faster, and more cost efficient than tubes," McFarlane said. "We use the same technology as the camera in your phone, which has the added benefit of not being magnetic."

That last point is vital because the vast magnetic field generated by equipment at SNS could have the unwanted outcome of interfering with results of experiments.

The DOE's Office of Science was impressed enough with the idea that it recently awarded McFarlane and her team $600,000 to build out the concept for use at SNS.

Proof that, while the device itself is small, the impact it could have is huge.

A Catalyst for Change

By David Goddard. Photography by Shawn Poynter.

A memorable scene from the 1985 movie *Back to the Future* shows one of the main characters placing organic garbage in a device called "Mr. Fusion" that is being used to power the car.

While it still seems farfetched to think such a scenario might ever be possible, the reality is that research being done by people like Assistant Professor Siris Laursen has led to breakthroughs that are turning once unimaginable concepts on their heads by taking new approaches to science.

Laursen's work is in the realm of catalysts; materials that help improve the speed and efficiency of a huge range of chemical processes without being consumed by the transformation, meaning they can be used over and over again.

"The approach we are taking will reduce our reliance on such an expensive material, while at the same time giving us the ability to do new and exciting things"

—Siris Laursen

From fuel to food, catalysts have played a key role in shaping society since the dawn of the industrial revolution, but one of the things preventing them from having an even greater impact is the cost of the catalysts themselves.

"The most widely used material in catalysts for many decades now is platinum," said Laursen. "It has served its purpose, but it comes with limitations, not the least of which is its price tag."

As with any precious metal, the cost comes because of limited quantities and the volatile world markets where it is traded. Additionally, when used with hydrogen or methanol, platinum can produce quantities of carbon monoxide that hamper reactions.

Laursen has proposed a new tactic: using computers to explore possible catalysts at the atomic level, studying information on their surface areas, and collecting data about their performance.

His method also includes combining two or more metals in preparing the catalyst, giving his team increased flexibility to fine tune the finished product based on what the computer modeling shows to be the most effective design.

This development of using what is known as intermetallic compounds also opens up the use of catalysts in areas where platinum has historically not performed as well or at all, leading to seemingly endless possibilities.

"The approach we are taking will reduce our reliance on such an expensive material, while at the same time giving us the ability to do new and exciting things," said Laursen. "The use of emerging materials will allow us to keep up with changing needs and demands."

Chemicals, rubber, foam, medicine, and yes, even one day turning garbage into fuel someday, are just the start of how Laursen's work could change our future.

ENGINEERING DOUBLE AGENTS

By Randall Brown.

"but what I really want to do is…"

Students and alumni often have passions parallel to their engineering disciplines and follow these passions to great heights. Meet a few of our alumni—and one current student—whose experiences took them in unexpected directions.

Joel Seligstein (BS/CS '06) learned a set of skills during his time in at UT that helped him lead the development of one of the most familiar apps in use today: Facebook Messenger.

"I learned how to work on a variety of engineering challenges: from big data to services to front-end product development," said Seligstein. "Working on the Messages platform required all of these skills. Having a solid foundation from UT EECS in each of these allowed me to be a leader cross-discipline."

He launched a couple of other companies following his time at Facebook, and went downhill from there—enthusiastically. He dove headfirst into Olympic sledding, specifically the skeleton competition.

"I competed in international skeleton competition for three years leading up to the Olympics," he said. He missed making the 2018 Olympics with the Israeli Bobsled and Skeleton Team, edged out by a teammate by only a few points. Training for the 2018–2019 season starts in October to prepare for World Cup competitions and hopefully the right to compete at Beijing 2022. Meanwhile, Seligstein maintains a full-speed approach to entrepreneurship.

"Being an entrepreneur is intoxicating and something I cannot run away from," he explained. "I have been continually investing and advising startups from California to Tennessee and even some in Canada. I find that my leadership and management experience from Facebook and other companies is extremely useful to share with young entrepreneurs."

Two years ago, Seligstein started Parallel Plaid, a mobile games company.

"Since I was a teenager, I have always been fascinated by the process of building video games," he said. "The games industry is bigger than ever and game players cross every demographic in high numbers. With Parallel Plaid, I would like to build a business that employees love to work at while making as many people in the world smile as we can."

Will Rutemeyer (BS/BioE '09) is the brewmaster and co-owner at Balter Beerworks in downtown Knoxville. Not too many years ago, he was working with a UT biosystems engineering team to design and build a small recirculating sand filter to manipulate the nitrogen content of wastewater prior to discharge.

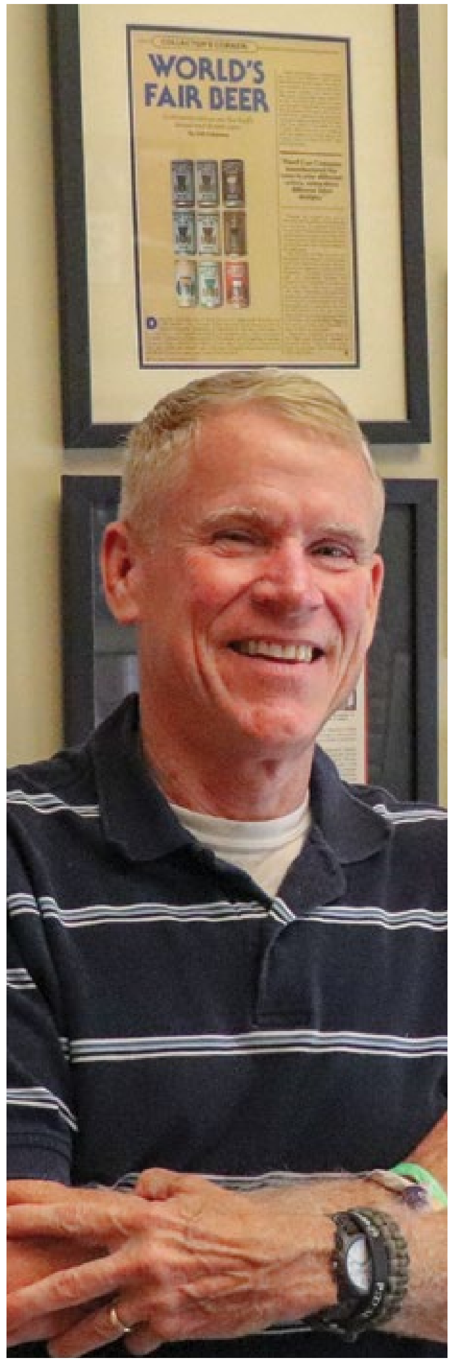
"The challenge was to use instrumentation and control systems to optimize for certain microbial activity," he explained. "Pretty applicable to brewing beer. The biosystems program is a hands-on, design-build-test experience, which is what a small brewer does almost every day."

Balter is Rutemeyer's second foray into entrepreneurship. The first didn't pan out, so he worked for TVA for five years before having another go at self-employment. Balter does a steady business, and at three years along he is slowly getting comfortable with calling it a success.

"I guess the biggest change is the validation after stepping out from a 'career track' job and starting something new," Rutemeyer said. "After the first business experience, it's really gratifying to see Balter do well."

The brewing job often finds him tapping into his biosystems experience.

"All the time—simple things like knowing how to dig into a programmable controller manual, how to talk intelligently to a sanitary pump supplier, some basic thermodynamics, and lots and lots of chemistry," said Rutemeyer. "I'm not sitting down working out integrals or reaction kinetics or whatever, but it's helpful to have some foundational knowledge when you're trying to dig into a problem."



Rick Kuhlman (BS/ISE '73) has enjoyed a long and varied career since finishing his industrial engineering degree, but he still keeps UT time at his downtown Knoxville office.

"These clocks on the wall are all from UT," said Kuhlman. "They turn 100 years old next year."

He acquired around 250 of the clocks long ago at a UT surplus auction. He decided their time had come again during development of the Knoxville Fellows and Café 4 headquarters on Knoxville's Market Square.

A lot of Kuhlman's career is tied into UT and Knoxville history. He was working with a wholesale beer distributor when the 1982 World's Fair geared up, and he spearheaded the creation of an iconic merchandising item.

"We came up with World's Fair Beer. That was exciting," he said. "Like everybody else—the World's Fair was coming to town, we wanted to make our mark."

To insure the investment, his boss insisted they pre-sell 10,000 cases—240,000 cans.

"He gave me that challenge," said Kuhlman. "Here I am, 31 years old and someone challenges me, I'm going to do it."

Kuhlman, his son, and some other partners—all UT grads—recently organized a reboot of World's Fair Beer just in time for the 35th anniversary. While the original was a light version of the long-defunct Falstaff discount brand, the new version is a definite upgrade.

"It's more of a richer, higher-alcohol beer," said Kuhlman. "More hoppy."

After the original World's Fair Beer adventure, Kuhlman bought Stefano's Pizza from its founding owners and operated it for 20 years. He established a key promotional tie-in that assured a legendary position for the near-campus location.

"We were the first real sponsors of the Lady Vols," he said. "If you walk into Stefano's now, you'll see Chamique Holdsclaw's jersey still in there."

Kuhlman sold Stefano's in 2004, but remains a loyal customer. He believes forming solid personal relationships has been an important element throughout his career. He now applies that lesson as director of Knoxville Fellows. This faith-based mentoring organization offers housing, job connections, and study support to 12 to 14 post-graduate men and women at 4 Market Square. Their mission is to help students build relationships as leaders in the Knoxville community.

"I think the value of people was really brought home to me through industrial engineering," said Kuhlman. "We can have the greatest plans all day, but if we don't have somebody that's willing to do it, we're in trouble."

Bryn Davies (NE, senior) currently studies nuclear engineering after a long and successful career in quite a different arena. Her previous "day job" was as a Grammy-award-winning professional bass player with some of the biggest names in Americana music.

"I was an independent contractor, meaning I wasn't beholden to one project or band," she said. "I took as many gigs as I could at first, then was able to pick and choose projects that I really liked. As I slowly got more well-known around Nashville, I started getting better and better recording sessions and gigs."

Davies played with bluegrass and Americana folks such as Peter Rowan, Tony Rice, Patty Griffin, and Justin Townes Earle. She recorded on Guy Clark's last five albums and did session recording with other top songwriters and players. She still plays part-time backing up singer-songwriters like Scott Miller and Darrell Scott.

"The year before I got off the road full-time, I recorded and toured with Jack White for his 'Blunderbuss' project," said Davies. "That year I got to travel all over the globe, play on numerous TV shows, including the *Grammy Awards*, all while I was pregnant with my son."

Her musical experience started early—piano at age three and cello at age eight. She took up the bass in high school and in her senior year received a scholarship to Boston's Berklee College of Music.

"I thought I might not get another opportunity like that, so I decided to try it out for a year," said Davies. "I ended up loving it, stayed for three years, joined a band, and went on the road. I did that for 17 years until I met my husband (Knoxville musician Vince Ilagan), then decided it was time to settle down when our son was born."

She took classes at Pellissippi State Community College and found success in math and science.

"I decided to give engineering a try," she said. "I looked into the different disciplines offered at UT and was very impressed with the nuclear program. I am loving the program and the opportunities it has afforded me as an undergrad."

One such opportunity was participation in the summer 2018 faculty-led study-abroad nuclear engineering program in Prague, Czech Republic—a much more structured experience than touring with a band.

"Almost every part of the day was filled with a planned activity the first week, and the second week was absolutely bananas with lectures, labs, and trying to finish lab reports," said Davies. "Touring with a band is rarely that structured. It helps when you are friends with the people you are traveling with, and that was a nice aspect of the NE Prague trip."

John Clark (BS/ChE '76) started the Vienna Coffee Company to cover the cost of his growing coffee-roasting hobby. The pastime developed out of necessity as he migrated to the west coast and back over the years working in environmental cleanup for the chemical industry.

"My favorite gigs in the cleanup world seemed to always revolve around burning things," said Clark, whose career passion was sparked by a co-op assignment at Eastman Chemical.

"Incineration involved air and fume measurement and handling, temperature control, burner management and safety, the chemistry of combustion, stack emissions, and nuisance odors."

The smell of a good cup of joe was never a nuisance to Clark.

"I loved coffee and paid close attention to the little coffee roasters—sort of incinerators—around San Francisco where we raised our family," he recalled. They couldn't find the same quality of coffee when they moved back to his hometown of Maryville, Tennessee, in 1996.

"Rather than mail-order California coffee, I just started buying great green coffee and roasting it myself for my own consumption," said Clark. "That grew from a self-satisfaction exercise to be an expensive hobby. I was giving a lot of coffee away to family and co-workers because it was noticeably better than they had ever tasted locally."

That led him to launch Vienna as a wholesale enterprise—letting his coffee pay for itself.

"For the first few years, I still burned chemicals for a living while Vienna developed a following," said Clark. "Then, in 2002, rather than accept a transfer to Philadelphia with my engineering job, I left the corporate world for coffee roasting full time."

The wholesale business became retail with the opening of their first coffeehouse in Maryville and their second in Knoxville.

"I love being an integral part of the community—a 'third place' type of space where everybody knows your name," said Clark. "The absolute best part is schmoozing the customers and accepting their rave reviews of our product. That never gets old."

Mahasti Vafaie (BS/ES '87) opened a little restaurant on Knoxville's Market Square in 1990, a time when most of the nearby storefronts were dark all day. A minor name refinement after opening turned The Flying Tomato into The Tomato Head, a now-legendary pizza-sandwiches-and-more establishment just a few blocks from the UT campus.

Her earlier post-grad job was a short tenure as an engineer with an oil well servicing company in Mississippi. She describes it as "interesting," though not her particular cup of tea in the long run.

"Although I didn't enjoy my first and only engineering job, at the time I thought I would come back to Knoxville, go back to my bartending job for immediate income, and continue to look for a job in engineering," said Vafaie. She went back to school for a couple of years, then opened The Flying Tomato "on a whim."

"Up until that point I had never really considered opening a restaurant, nor was it a lifelong dream," she said. Though just an experiment at first, her engineering background played a huge role in what eventually became The Tomato Head.

"There is a lot of problem solving in the restaurant business," said Vafaie. "Taking the methodical approach to problem solving that I learned in school has been instrumental in working through all the issues and problems that arise day to day."

The approach has allowed her business to expand along with the re-blossoming of Knoxville's downtown. There are now two Tomato Head locations and the related Flour Head Bakery supplies bread for both. The bakery enterprise arose over the years from the restaurant's need for fresh bread, but not in the bulk quantities offered by other sources.

"I also fell in love with baking bread," said Vafaie. "I opened Flour Head Bakery to fill the needs of the restaurant as well as fulfill my love for baking."

The bread and products like Tomato Head hummus are also distributed throughout local stores.

"I love so many different aspects of what I do," said Vafaie. "However, what I love most is the relationships that I've built with staff and customers through the years. My favorite creations on the menu are the ones with stories behind them. Some come from collaborations with some wonderful former employees and some come from regular customers. When I eat or serve one of those menu items, I think about the people and stories behind the food for an entirely emotional as well as culinary experience."

Vafaie keeps an open mind and an open eye toward plans for the next stage of her "Head-y" career.

"One thing that I've learned is that plans always change, so I try to avoid answering this question when I can," she said. "I have a few new projects I'm working on, but I'm not entirely sure how they will develop—so for now mum's the word."

Benita Fitzgerald Mosley (BS/ISE '84) found an engineering edge in her extracurricular activities while studying at UT. Knowing the right lingo helped her prepare to win a gold medal for the 100 meter hurdles at the 1984 Olympic Games.

"There were all kinds of technical changes that the coach needed to make with me in order to help me run faster, negotiate the hurdles more efficiently, or come out of the blocks more quickly," said Mosley. "The coaches were able to be a lot more technical with me when they were describing the technique changes and that sort of thing."

Mosley has kept her focus on encouraging positive change in the sports world, working with USA Track & Field, the Women's Sports Foundation, the US Olympic Committee, and Women in Telecommunications.

She is currently the CEO of the Laureus Sport for Good Foundation, a nonprofit organization that uses sports involvement to improve the lives of disadvantaged youth.

"Our mission is to improve the lives of youth and unite communities to the power of sport," said Mosley. Laureus supports programs that will improve physical and mental health and enhance education and employment outcomes for underserved youth.

"It's coach training, professional development, other development resources," said Mosley. "It's coalition building in communities to try to get various sectors together to help these organizations grow and thrive so that they can serve more kids in the communities."

Laureus trains and places coaches in more than 100 cities around the country, with deeper, community-based work in New Orleans, Atlanta, New York, and Chicago. Mosley's leadership role continues her life-long, hurdle-clearing momentum that began at UT.

"Industrial engineering includes operations management and time and motion studies," she said. "You're a bit of an efficiency expert, always trying to use resources the most effectively and efficiently. I think it's the analytical perspective that you learn as an engineer that I apply to pretty much all aspects of my life."

Mosley and family now live in her hometown in Prince William County, Virginia, where she is honored by a street named after her.

"My mother has a school named after her on that street," said Mosley. "She was one of four teachers selected by the superintendent back in the mid-1960s to help integrate the school system in Prince William County."

Fannie W. Fitzgerald Elementary School sits at 15500 Benita Fitzgerald Drive. Mosley's sister teaches there, and her nieces attended from kindergarten through fifth grade.

"The street is wonderful, and I enjoy seeing it," said Mosley. "But it makes me even prouder to know that my mom's school sits on the same street."

Image courtesy of Saul Young, Knoxville News Sentinel

Robert Nutt (BS/EE '87) followed a circuitous path to his current career, and it started with actual circuits.

"In the 80's you were analog, digital, or computer science," said Nutt. "I went the digital route but ended up getting into the first ASIC (application-specific integrated circuit) classes offered at UT by Professor Bolden. This would have a significant impact on my engineering career a few years after I graduated."

He spent some time in the fast lane immediately after college.

"I road-raced motorcycles," he said. He led Team Kino's Kawasaki racing crew, with duties on and off the racing course. "I managed other racers careers and negotiated their employment contracts."

He merged his engineering background with his management experience and launched an ASIC company that eventually became a medical-imaging company called Concorde Microsystems Inc. After selling that company, he became vice president in charge of preclinical imaging at Siemens Molecular Imaging. He struck out on his own again, entering the residential and commercial real estate world with Nutt Properties.

Then, he turned on to a delicious dead end.

"A good friend of mine, George Ewart (of George Armor Ewart Architects—on the Board of Advisors for the UT School of Architecture) was doing competition BBQ and being quite successful at it," said Nutt. Ewart's Dead End BBQ Team won the Tennessee State Championship in 2008, and represented the state at the Jack Daniel's Invitational, where they finished quite well.

Nutt cooked with the team a few times and they tossed around the idea of a retail venture.

"When it came down to it, George and I and were the only ones dumb enough to think we could open a restaurant," said Nutt. So, they opened Dead End BBQ in 2009 on Sutherland Avenue in Knoxville.

The business has been a success, and Nutt sees it as a good distance down the road from circuits and motorcycles.

"There are no parallels with engineering and the restaurant world," he said. "At first, I thought it was analogous to a factory, of which I had some experience. But the social nature of a restaurant makes it nothing like a normal factory."

Through the restaurant, Nutt enjoys feeding his neighbors and providing a good place for people to work and grow. He also likes to hear diners talk about how good the food is—even before they know he is the owner.

"No one is getting rich at Dead End," said Nutt. "But there is a lot of love and pride going into the product we serve."

From Co-op to Career: **Jerrika Hall**

By Laura Tenpenny.

> **The most important lesson I took away from my co-op experience was how vital networking and creating connections can be to career progression.**
>
> *—Jerrika Hall (BS/ChE '12)*

Jerrika Hall (BS/ChE '12) learned this lesson well, having participated in three co-op stints at Dow Chemical Company before the company hired her after graduation. As a co-op student and ambassador for the program, she got to know the Office of Engineering Professional Practice quite well. This office and the experiences it provided to her have opened countless doors.

What did these student experiences at Dow teach you about your studies and your career interests?

During my first co-op term, I was exposed to real-world situations that engineers face on a daily basis. Upon returning to school, I was able to apply what I learned in the field to the engineering concepts that were taught by my professors. This gave me a deeper understanding of my classes. The experience also reassured me that I did want to pursue a career in chemical engineering.

How important have these co-op opportunities been to your career?

My co-ops provided me a foundational experience which has proven to be essential in my career progression at Dow. I was able to get a sense of what type of projects I would be working on as a full-time employee. I had the opportunity to connect with incredible people whom I still keep in contact with today. My co-op experiences also exposed me to the amazing things that Dow has to offer as a company

What advice would you give current students to help them prepare for their futures in the professional world?

I would highly recommend doing a co-op or internship and to take full advantage of the opportunity. Meet and network with as many people as you can. Work hard and do well on the projects given to you. This will set you up for a better chance of hiring on full-time with the company. And if you do not wish to work for the company that you co-op or intern with, most companies look for work experience when considering candidates to hire.

Where has your degree and this experience taken you since graduation?

After graduating from UT in 2012, I began my career at Dow as a process automation engineer in the engineering solutions work group. I have since moved into Dow's performance plastics business as the process automation engineer for the commissioning and start-up of two world-class production facilities. Not too many people can say they have had the chance to do this in their career. It has been an honor to be a part of this history.

Hall is passing on her wisdom by serving as a supervisor to Dow interns and co-op students. She remembers her own mentors during her student terms with the company as essential to her future.

"To this day, I still maintain ongoing communication with several Dow colleagues I met during my co-ops," Hall asserts. "Some have been instrumental in helping me navigate my way through the company."

The Office of Engineering Professional Practice has guided many like Hall down the well-worn path of co-op to career. On average, it has seen 75 percent of its co-op and internship participants receive an offer of full-time employment from the companies for which the students have worked.

Hall confirms, "participating in a co-op was one of the most important things that prepared me for my career."

Engineering Vols Share a **Silicon Valley Experience**

By Randall Brown.

At left, students tour Hewlett-Packard. At right, students visit Google's headquarters.

A select group of upperclassmen and graduate students in electrical engineering and computer science traveled to California in May to meet with alumni for a shared "Silicon Valley Experience." Students toured the headquarters of Bosch, Cisco, Google, Hewlett-Packard, and Pariveda Solutions. They also visited the Computer History Museum, saw the San Francisco Giants take on the Cincinnati Reds, and visited the Muir Woods National Monument.

Company reps offered information on job application processes, resume tips, and insight into work life at their facilities.

"It was great to be exposed to so many different companies in a short amount of time," said electrical engineering senior Sam Brown. "It helped me to realize the extent and variety of the types of projects that engineers work on in industry."

Students enjoyed a first-hand look at some of the major players in their fields.

"I had an absolute blast," said computer science senior Charlie Rizzo. "I learned so much from the companies we visited, and it was really neat to be able to see how other UT alumni ended up on the other side of the US, in Silicon Valley, no less."

"I thoroughly enjoyed meeting alumni and hearing their experiences," said electrical engineering senior Quillen Blalock. "It was encouraging to hear how UT prepared them for success in one of the most prestigious professional environments for electrical engineering."

Graduate student Shaghayegh Aslanzadeh enjoyed the opportunity to meet with fellow researchers.

"I got more exposure to different techniques that will potentially optimize my work for the future," said Aslanzadeh. "Now I can assure my work could get more aligned with future technologies."

PhD student Mihaela Dimovska agreed. "I got to learn more about the newest technology and software on the market, especially in the area of AI and machine learning," she said. "This puts my research into a better perspective."

Computer science senior Surya Manikonda enjoyed the time spent with HP and Google. "It was amazing to look at their products and the technology they were developing there," she said.

The idea for the trip came from Joel Seligstein (BS/CS '06), an incoming member of the college's Board of Advisors, who hopes to see more UT engineering graduates recruited by the region's tech companies. Alumnus Mike Dodd (BS/EE '95), of Google, funded the trip.

"I love that the Silicon Valley trip gives students the opportunity to connect with UT alum at some of the top companies in the field—and see that UT grads really can go anywhere," said Dodd.

Other alumni who participated included Mike Evans at Pariveda and May Lee at Hewlett Packard.

"One or two companies said that they might send recruiters here in the near future, in addition to those that are already hiring our grads," said Min H. Kao Professor Leon Tolbert, who accompanied the students.

"It was a great opportunity both ways for us, to expose the students to companies like Google that are global leaders in innovation," said Brian Shupe, executive development director for the college. "Also, it was a great opportunity for the alums to play a part in recruiting."

Ultimately, the shared Volunteer experience shortened the distance between the Tennessee Valley and Silicon Valley.

MANUFACTURED ADVANCEMENT

By David Goddard. Photography by Shawn Poynter.

To be a specialist only requires you to be good in one or two areas. To be a leader takes pushing the boundaries of innovation across a wide range of initiatives.

And that's what is taking place in Tennessee due to the unique partnership between UT and Oak Ridge National Laboratory (ORNL).

"We've made big progress, even in just the last five years," said Suresh Babu, UT-ORNL Governor's Chair for Advanced Manufacturing. "We went from zero people specifically focused on advanced manufacturing to a point where faculty in the Tickle College of Engineering, the College of Arts and Science, the College of Architecture and Design, the UT Space Institute, the UT Institute of Agriculture, and several directorates at ORNL all now bring a wealth of expertise to the table."

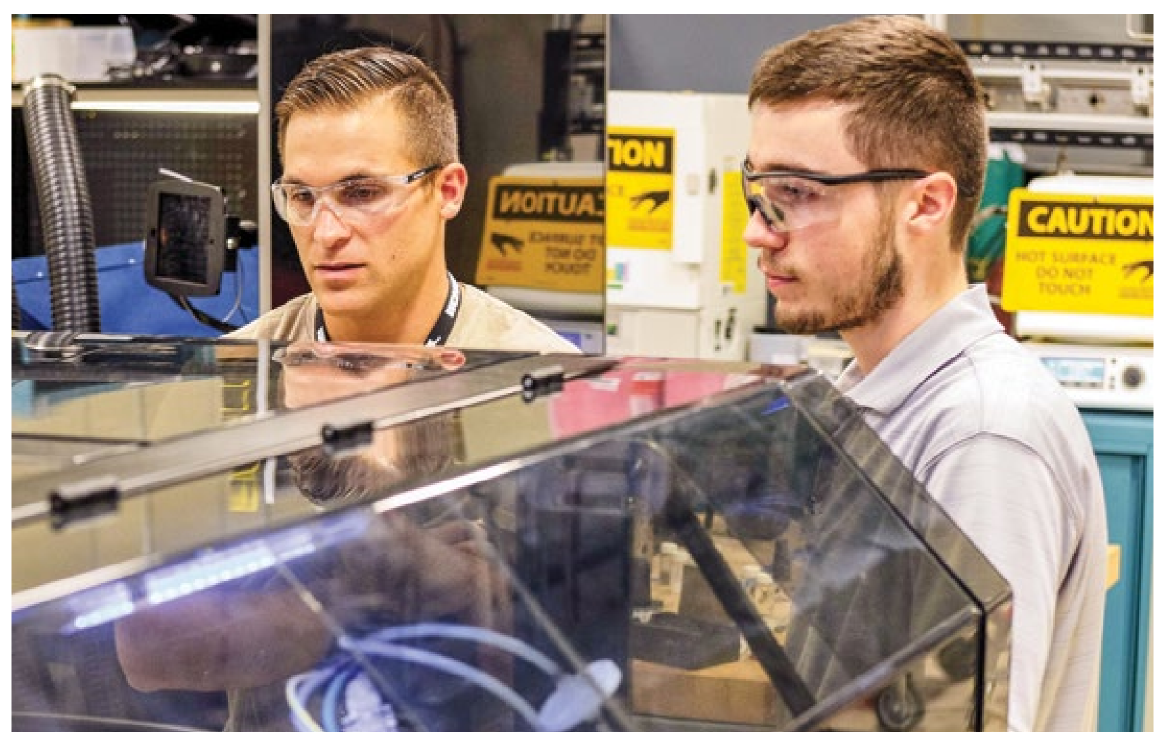
The impact of advanced manufacturing (AM) is rapidly growing and UT and ORNL have teamed together to lead the way forward in this area of critical national importance through strategic hires, innovative initiatives, and world-class laboratories.

"We're working closely with UT to strengthen the region's scientific leadership and to develop the next generation of researchers for the future of manufacturing," said Moe Khaleel, ORNL's associate laboratory director for energy and environmental sciences.

"The lab's signature strengths in materials, neutrons, and computational science are essential as we tackle the nation's biggest technology challenges," Khaleel added. "ORNL is home to the Department of Energy's Manufacturing Demonstration Facility and Carbon Fiber Technology Facility—dedicated to developing breakthroughs for additive manufacturing and carbon fiber and composites.

"Working with universities like UT has also allowed us to significantly advance collaborations such as IACMI—The Composites Institute that demonstrate America's scientific ingenuity."

From Knoxville to Tullahoma, from carbon fibers to composites, researchers at those organizations are reshaping the way we think of manufacturing, taking the lead in projects covering everything from the future of flight to national security.



Clockwise from top: Students from UT-ORNL Governor's Chair Uday Vaidya's group complete testing for projects using the extrusion compressions modeling operation at FCMF. / Students and ORNL staff monitor the binder jet additive manufacturing process at MDF. / UT-ORNL Governor's Chair Suresh Babu (center) works with past UT students and current ORNL staff to observe the direct energy deposition process, which uses laser and metal powder to repair expensive components.

UT-NASA Partnership

Recognizing UT's expertise, NASA is partnering with the university to combat the challenges of off-planet manufacturing during space travel. Specifically, the goal is to figure out how to utilize whatever materials happen to be available as base elements, be that moon dust or asteroid particles.

Since moon dust is only so similar to materials found on Earth, NASA is counting on UT Assistant Professor Jeffrey Reinbolt, of MABE, to come up with a way to use them effectively.

Another challenge? Advanced manufacturing printers and the consistency of materials used on Earth don't work in space due to a lack of gravity. To solve those riddles, UT has developed an extrusion-based printer that uses a material that is 70 percent solid, keeping it from floating away in a micro-gravity environment. Critically, the printer can be "aimed" in any direction to allow for as-needed production in the often-cramped confines of space modules.

An ORNL staff member cleans parts necessary for the binder jet additive manufacturing process at MDF.

"Even though our core disciplines are different, we've come together, centered on a common focus of advanced manufacturing, composites, and additive manufacturing, and are recognized as leaders in the field," added Babu.

The results are bolstering not just the institutions, but the regional economy as well.

"Advanced manufacturing is growing in importance, not only to the University of Tennessee, but to the state and to the world at large," said Stacey Patterson, UT's vice president for research. "Supporting new initiatives in this field isn't just an investment in the university; it's an investment in our future."

Marc Gibson, UT's senior director for corporate engagement, pointed out several statistics that highlight the role AM is playing in shaping the state's economy, noting that 350,000 Tennesseans are employed in some form of the field.

In fact, AM now accounts for more than 16 percent of the state's GDP, accounting for more than $55 billion in goods and services in 2017.

While funding research initiatives in AM is key, UT's work in that arena also helps the state in another way.

"Our initiatives help support the state's renaissance by developing and graduating an educated, well-skilled workforce," Gibson said. "It also allows UT to form collaborations with industry and government partners to push the boundaries of innovation."

Major Projects

Babu was the first of three appointments to the UT-ORNL Governor's Chair program that were made with a specific focus on AM, along with Uday Vaidya, Governor's Chair for Advanced Composites Manufacturing; Easo George, Governor's Chair for Advanced Alloy Theory and Development; and Art Ragauskas, Governor's Chair for Biorefining. Babu and Vaidya work through the Department of Mechanical, Aerospace, and Biomedical Engineering (MABE), while George works in the Department of Materials Science and Engineering and Ragauskas is housed in the Department of Chemical and Biomolecular Engineering.

Since coming to UT in 2013, Babu has earned the university representation on or leadership of several high-profile projects, the most recent of which was his selection as leader of the first Multi University Research Initiative award given to UT in the program's 30-year history.

Both the international team of universities he is leading—which includes The Ohio State University and Virginia Tech University—and the focus of the project—improving materials the United States Navy uses in its ships—highlight the importance of the work and the validation of UT's role in the field.

"We're helping the Navy develop new, more reliable alloys, yes, but the work we are doing will impact all advanced manufacturing processes involving metal and the use of high-energy deposition," said Babu. "Our work in better understanding the properties of these alloys directly impacts national security at many levels."

While Babu has the sea covered, work through the UT Space Institute (UTSI) will revolutionize the way we journey through the skies. The US Air Force selected a team to investigate and overcome barriers related to hypersonic flight, which is faster than a speeding bullet at roughly 3,800 miles per hour.

While such speeds would allow flight times of less than two hours from Knoxville to Tokyo, they have two major problems: intense heat and pressure.

With such obvious benefits hanging in the balance for the Air Force, it was important that they have the right people on the team. Enter John Schmisseur, the H. H. Arnold Chair in Computational Fluid Dynamics and B. H. Goethert Professor at UTSI.

Continued on page 28

Ask the Expert: *Brett Compton*

How does advanced manufacturing draw upon various disciplines?

Successful AM relies on the integration of precision motion control and robotics, materials science and process-structure-property relationships, and mechanical design. In addition, optimization of a given process may require real-time sensing and feedback, data mining and cross-correlation from large data sets, and advanced path planning. Thus, AM incorporates aspects of robotics, materials science, industrial engineering, computers science, electrical engineering, and design.

What are some of the advantages of UT and ORNL working together, particularly at MDF?

The relationship is highly beneficial to both parties and increases the opportunities for impactful research by creating a pipeline between fundamental, lab-scale research at the university and highly applied, large-scale projects at MDF. In addition, the industry-focused projects at MDF provide a strong commercial pull that guides and highlights the most relevant fundamental research challenges that can be addressed with university research. MDF and ORNL benefit from having a steady stream of creative, engaged students from UT, and UT benefits from the public awareness that large-scale MDF projects bring.

How does UT help prepare students for future roles in the field, whether as employees or researchers?

UT offers a unique environment for students that provides unprecedented exposure to a broad range of state-of-the-art AM processes and projects through the faculty and research at UT and the close proximity and collaboration with ORNL. With many faculty jointly appointed or closely collaborating with experts at ORNL, students gain experience in the normal course of their studies that students at other universities cannot get without participating in a dedicated internship.

What are some specific projects and research that you have worked on?

I have done projects on composites, polymers, and AM-compiled rare earth bonded magnets with partners including ORNL, the Air Force Research Laboratory, the Army Aviation and Missile Research Development and Engineering Center, the Kansas City Nuclear Security Campus, and Lehigh University, among others.

Brett Compton began his career as a post-doctoral research fellow at Harvard University before coming to ORNL's Manufacturing Demonstration Facility. He is now an assistant professor in UT's Department of Mechanical, Aerospace, and Biomedical Engineering.

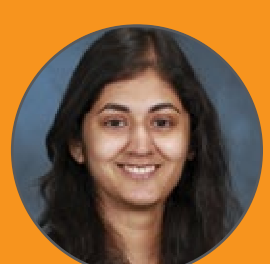
Multiple examples of the materials used with the extrusion compression molding process.

Long fiber thermoplastic pellets (LFT) fall from the gravimetric feeder into the heated barrel of a single screw B-30 extrusion plasticator. The molten LFT charge will be extruded and placed into the compression press to create a part.

Growing Advanced Materials

Agriculture isn't the first thing most people would associate with AM, but UT's Center for Renewable Carbon could change that. Housed in the UT Institute of Agriculture (UTIA), the center is a leader in biofuels, biomaterials, and biorefining research.

UTIA faculty, researchers from ORNL, and UT-ORNL Governor's Chair Arthur Ragauskas are exploring ways of using plant-based materials to produce supplies of cutting-edge goods, including bio-based carbon fiber. Having an endless supply of materials to make carbon fiber will ensure the AM revolution will be well supported for years to come.



Graduate Student:
Vidya Kishore

The Bredesen Center for Interdisciplinary Research and Graduate Education allows graduate students like Vidya Kishore to work on AM research initiatives taking place at both UT and ORNL.

Why is additive manufacturing important?

Additive manufacturing makes it possible to create complex structures that would otherwise be impossible or hard to create using traditional manufacturing methods. In addition, it makes manufacturing complex geometries faster and cheaper with significant reduction in weight and also offers the potential to tailor the properties of printed components at specific locations. It makes your imagination tangible.

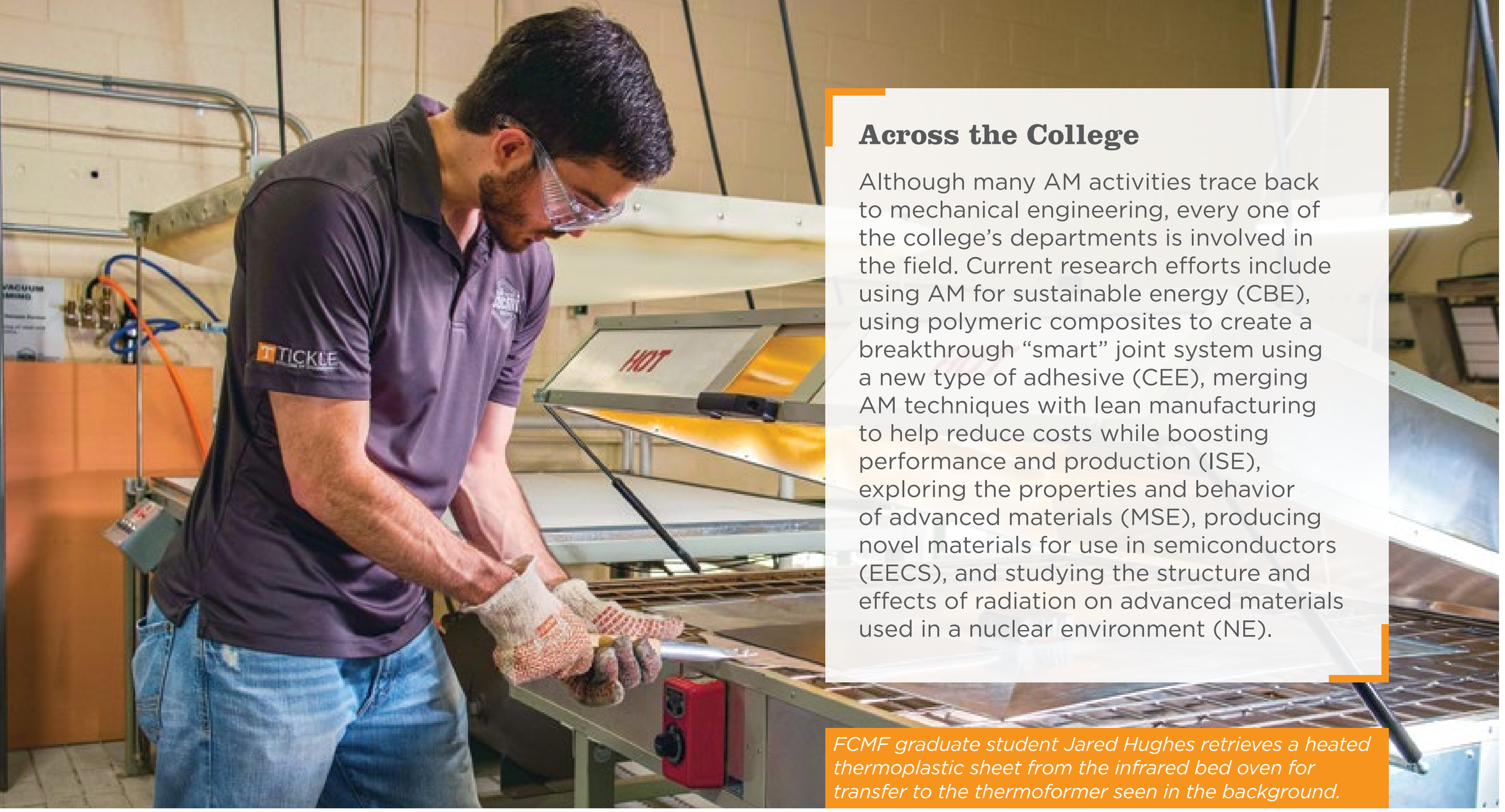
How has the Bredesen Center experience helped you as a student?

The Bredesen Center experience is one of a kind. The interdisciplinary nature helps build a complete experience of skills across the board, while the flexibility and personalized curriculum makes it possible to make the most out of grad school time. I had the opportunity to work with two east Tennessee startup companies as a part of the entrepreneurship aspect introducing me to business aspects of startups, giving me the chance to lead an entrepreneurial team, and connecting me with the rich local entrepreneurial environment.

What opportunities for research/work have you had because of the Bredesen Center?

I got introduced to additive manufacturing research at ORNL and have had the opportunity to join Chad Duty's group and also work closely with the polymer materials development team at MDF, led by Vlastimil Kunc. As a grad student, the possibility of working with the experts in this field and with 3D printers that only a few people in the world get to work on is just fascinating. Being a part of initiatives and projects that's the first of its kind and knowing that your research is actually making an impact in the real world makes the whole process a lot more exciting and gratifying.

Associate Dean of the Graduate School Ernest Brothers and Kishore at the Legislative Plaza in Nashville. Kishore was representing UT as a part of Graduate Education Week events organized by the Tennessee Conference of Graduate Schools.



FCMF graduate student Jared Hughes retrieves a heated thermoplastic sheet from the infrared bed oven for transfer to the thermoformer seen in the background.

Across the College

Although many AM activities trace back to mechanical engineering, every one of the college's departments is involved in the field. Current research efforts include using AM for sustainable energy (CBE), using polymeric composites to create a breakthrough "smart" joint system using a new type of adhesive (CEE), merging AM techniques with lean manufacturing to help reduce costs while boosting performance and production (ISE), exploring the properties and behavior of advanced materials (MSE), producing novel materials for use in semiconductors (EECS), and studying the structure and effects of radiation on advanced materials used in a nuclear environment (NE).

"We will gain an understanding of how that heat builds and distributes, and the pressures it places on aircraft," said Schmisseur. "The combined knowledge and resources we have within the UT system will allow us to craft a solution."

To accomplish those goals, Schmisseur and his team won't just call upon UT's expertise in advanced materials, but also one of the largest wind tunnels in use in academia, yet another critical advantage for the university. Turn to page 30 for the rest of this story.

Hands-On Experience

Speak to any faculty involved in AM at UT, and the value placed on creating opportunities for students quickly becomes clear.

Thanks to the world-class facilities at UT and ORNL, UT engineering students also get hands-on experience with projects that directly impact society.

One such area is the light-weighting of machinery and materials, which increases the strength of materials while reducing the weight, cost, and energy requirements of vehicles, industrial machinery, and biomedical devices.

Other projects at UT include using composites to help a home manufacturing company design and build custom "bamboo" flooring, aiding an auto manufacturer in developing a new air breaking system, and even teaming up with one business to improve the recycling of carbon fiber itself.

UT's Fibers and Composites Manufacturing Facility provides a specific example of how research, education, and experience come together.

There, Vaidya has developed a cutting-edge research space that opens up the world of AM to students of all levels, including 20 undergraduates and 15 graduate students.

"We teach them about a variety of materials, how to use them, how to take fibers, resins, and additives to composites to components," Vaidya said. "We promote thinking outside the box and collaboration. We've made the space a melting pot of work and interaction."

In Vaidya's group alone, students work on projects with partners ranging from small-scale manufacturers to industry giants like Volkswagen, often reinforcing their classwork by interning with those same companies.

Having such a wide array of opportunities is a hallmark of AM education at UT, something the faculty takes very seriously.

"Many others are good in one way or another," said Hu. "We're good in a comprehensive way, across many areas."

Moving advanced manufacturing forward. Energizing the next generation of researchers, workers, and scientists. Building world-class knowledge, innovation, and faculty.

Leading. It's what UT does.

Multi-Institution Partnerships

IACMI—The Composites Institute, which is a collection of universities, states, and research centers with UT as the lead institution, is the best known AM partnership at UT. Other key national initiatives involving UT include:

The Institute for iacmi Advanced Composites Manufacturing Innovation THE COMPOSITES INSTITUTE

- **Lightweight Innovations for Tomorrow,** founded by The Ohio State University, the University of Michigan, and EWI with a focus on lightweight manufacturing. Other partners include the US Department of Defense, General Electric, Lockheed Martin, MIT, and Penn State University, among others.
- **America Makes,** the country's leading AM and 3D-printing consortium. Four US departments, the National Science Foundation, NASA, Boeing, and the Air Force Research Laboratory are among its members.
- **Advanced Functional Fibers of America,** a $317 million public-private partnership led by MIT that aims to speed up the development of new fibers and textiles for production in the US.
- The **Manufacturing and Materials Joining Innovation Center,** housed at Ohio State and focused on the development of new materials, new joining processes and techniques, and new ways to automate AM.
- **High Performance Computing for Manufacturing,** a major program between ORNL and Lawrence Livermore National Laboratory in California with the goal of harnessing exascale computing to improve AM.

UT-ORNL Governor s Chair Uday Vaidya and his students work to produce a sheet molding compound (SMC), commonly used in the automotive industry for the production of car body panels. This piece of equipment was designed from the ground up by Vaidya and his students to enable the study of novel SMCs.

BEYOND SUPERSONIC

By David Goddard. Photography by Sam Thomas.

It's a bird! It's a plane! It's a plane traveling at hypersonic speed!

Anyone familiar with the fictional exploits of Superman knows that one of his super powers is that he is "faster than a speeding bullet."

Thanks to research being done in part by UT's John Schmisseur, it will soon be possible to produce aircraft that make even the Man of Steel seem slow.

Schmisseur, the H. H. Arnold Chair in Computational Fluid Dynamics and B. H. Goethert Professor at the UT Space Institute (UTSI), is part of a team exploring the production of materials and structures for use in hypersonic aircraft travelling at more than five times the speed of sound.

At sea level, that equates to a speed of 3,800 miles per hour, meaning an aircraft could fly from Knoxville to Tokyo in less than two hours.

There's just one problem.

> **"The heat generated by vehicles travelling that fast goes well beyond our current capabilities. We have to gain a better understanding of how and where that heat is most likely to build, the loads and pressures it exerts, and identify the most critical regions of the aircraft. The institutions in UT's system have the competencies to help solve those riddles."**
>
> *—John Schmisseur*

Schmisseur has named his program the High-Speed Original Research and Innovation Zone, or HORIZON.

"Our three campuses have a lot of intellectual firepower to bring to bear on this," said Schmisseur. "The Tennessee Department of Economic and Community Development feels that aerospace and defense are keys in the state's economy. UT system-wide partnerships to enhance research and innovation in support of those efforts will be bolstered by this project."

Within the next year, Schmisseur's hope is that UTSI's experiments will travel 15 minutes down the road to the Arnold Engineering Development Complex (AEDC), which he calls the crown jewel and epicenter of Air Force hypersonics research in the US.

AEDC operates more than 55 aerodynamic and propulsion wind tunnels, rocket and turbine engine test cells, ballistic ranges, sled tracks, centrifuges, and other specialized units, but testing takes hundreds of thousands of dollars per week, if not millions per test, according to Schmisseur.

To get around that problem, he and his team have developed a massive, state-of-the-art wind tunnel facility known as the Tennessee Aerothermodynamics Laboratory, or TALon.

Schmisseur said that TALon creates "a natural pathway to a discovery, innovation, technology development, and early research environment," and that it easily helps support the mission of AEDC. It will also offer relatively low-cost experimentation at tens of dollars per test.

"We want to use hypersonics research to drive new accomplishments and growth from an industrial and economic standpoint here at home," said Schmisseur. "Understanding how test data ultimately translates into the acquisition process will benefit manufacturing."

Aerospace and defense sectors are already the fourth-largest economic areas for Tennessee. Improvements to those fields at UTSI could greatly benefit the state, helping its economy soar for decades to come.

What is UTSI's main role in the project?

Schmisseur and others at UT are working on the aerodynamic loads generated by the hypersonic flow—the extreme heat and pressure loads generated on the surface due to flight.

The team will then turn over that data to Dayton, who will use it to help design the structure and material design, meaning the results UT collects will be vital to the success of the project.

Team Composition

The $9.8 million project, funded through the US Air Force Research Laboratory, includes Schmisseur and his colleagues at Purdue University and the University of Dayton Research Institute.

Schmisseur will be UT's system-wide leader of the project, which will be performing both simulations and experiments to guide designs being done at Dayton. The UT team consists of 15 faculty researchers from UTSI, UT Knoxville, and UT Chattanooga.

US Senator Lamar Alexandar and US Representatives Scott DesJarlais and Chuck Fleischmann were key players in moving the project forward.

Project Goal

The team is charged with developing new materials for use in its craft that can overcome the issues created by heat at hypersonic speed.

L-R: Adam Harris, MS 2018, now at AEDC; Lara Lash, PhD student; Phil Kreth, MABE assistant professor; and Brian Kocher, MS 2018, returned to AFRL at AEDC.

Vacuum tank for wind tunnel.

Just how big is one of academia's largest wind tunnels?

While the diameter of most supersonic wind tunnels can be measured in inches, UTSI's will be two feet wide, 156 feet long, and housed in a nondescript metal building on campus.

During operation, a powerful vacuum is created in a large tank outside the building. The tank connects to a 105-foot tube that passes through an exterior wall, creating air flow in the wind tunnel.

Looking Small to Solve Bigger Issues

By David Goddard. Photography by Randall Brown.

If you can build it, it can break.

From a paper clip to a jumbo jet, if you use something enough times, it will eventually wear down to the point of failure. Such breakdowns are often caused by what is known as fatigue cracking.

Those cracks start small, but forces ranging from weather to changing weight loads can add to stresses that begin to break the materials further apart.

Gaining an understanding of how these stresses play out at the smallest level may help researchers develop better materials by being able to predict where such stresses are likely to occur.

Assistant Professor of Civil and Environmental Engineering Timothy Truster is playing a leading role in that undertaking by using the novel approach of applying computational methods to crack the code on material interactions at those granular levels.

With almost no limit to the number of things impacted by such destructive forces, both materials science and civil engineering have made it a major area of research.

Truster identified distribution as a key area of concern early on, leading him to try to develop his new approach, the first in the field to use computing in such a way.

"The ways loads distribute between regions within the microstructure were not fully understood," Truster said. "Gaining a knowledge of those correlations will allow us to come up with specifically tailored material design."

By using advanced mathematics to study zones of influence within materials at both large and small scales, he hopes to gain insight into why some flaws within objects lead to cracking while others do not.

That, in turn, holds tremendous potential for developing more reliable materials to be used in everything from energy production to the defense industry.

While Truster has made a career out of cracking the code of where such failures occur, the National Science Foundation recently backed his work with a prestigious Early CAREER award.

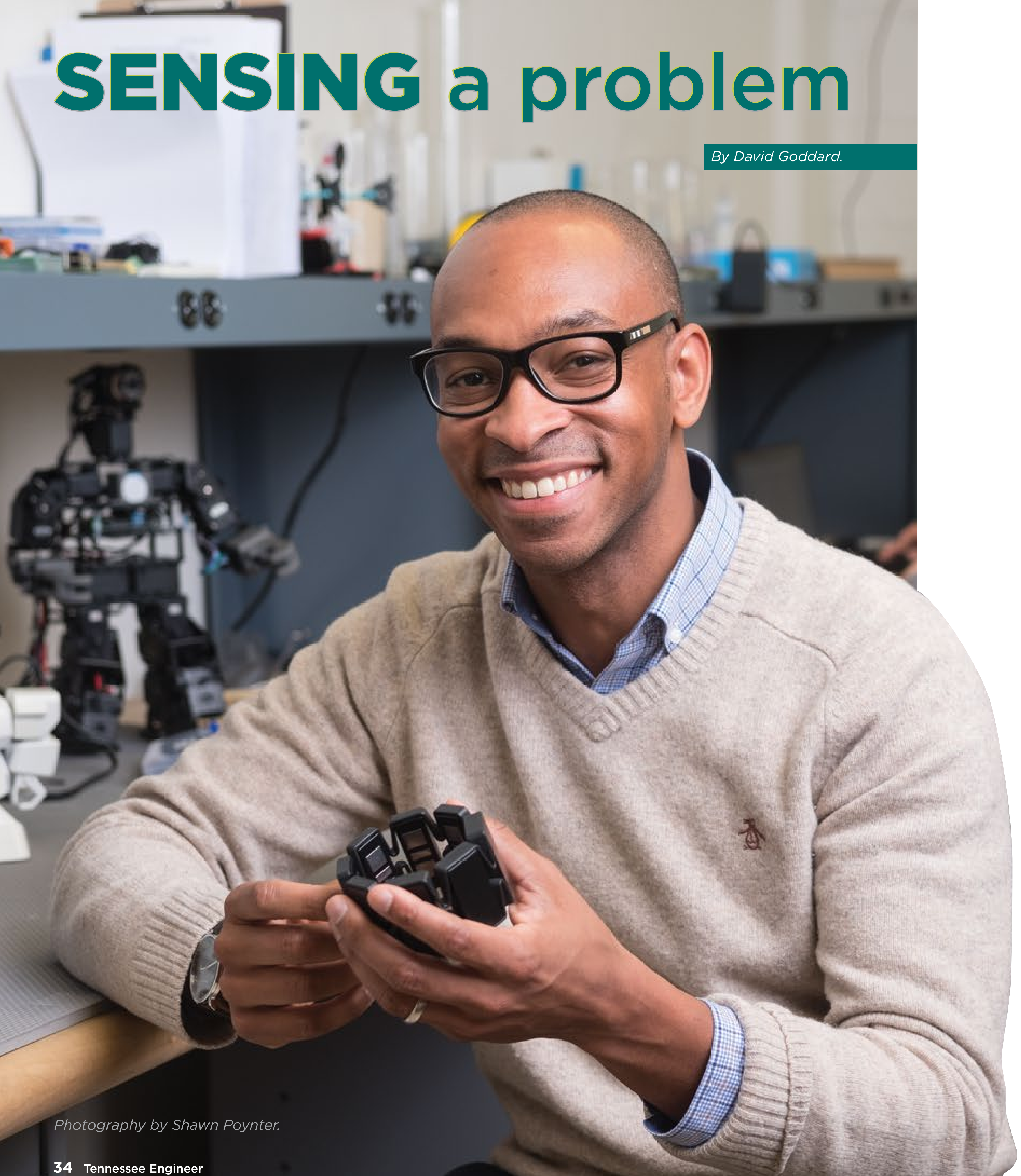
"This [award] is a great honor, and I'm happy that it reflects well on the work that my students and I have been doing," Truster said. "I am encouraged that others see the need for studying fatigue behavior and developing new methods to help design better materials."

Part of the CAREER program is making sure awarded projects include an outreach program.

To that end, Truster plans on introducing high school juniors and seniors to an enhanced curriculum based on simplifying physics, helping better prepare them for college and beyond.

SENSING a problem

By David Goddard.



Photography by Shawn Poynter.

One of the biggest stumbling blocks for medical practitioners is something that is inherent to patients themselves: human nature.

"People have a tendency to relate back to their doctors only the good news, unless something really bad happened," says assistant professor of biomedical engineering Eric Wade. "It's like how everyone tells their dentist that they floss regularly, when maybe they only remember once a week.

"You have the same thing with patients undergoing rehab or treatment who only relate back the progress they are making, but not the times that they took shortcuts."

That's where biomedical sensors come into play.

Such sensors, capable of registering a wide array of data, could help patients, doctors, and facilities alike gain a better picture of two key populations: patients recovering from strokes, and those dealing with the mobility-impairing effects of Parkinson's disease.

For stroke rehabilitation, incorporating prescribed exercises into daily living is vital for patients to rebuild muscle strength.

The problem is what is known as the "vicious cycle:" Patients find the exercise hard, so they don't do them fully or correctly. In turn, patients experience even more loss of function, making the exercises even harder to accomplish.

By monitoring these activities through wearable sensors, patients and doctors would know if they were doing the required amount of work, and doing it correctly.

"A lot of quality of life is related to being able to use your upper extremities," said Wade. "What happens a lot of times is that patients might lean in with their torso to help lift an object or complete an exercise, but that limits the redevelopment of the motor function in their hands and arms. Sensors would help them distinguish between good and bad movement strategies."

Wade's research is being completed through a partnership with Columbia University and Chapman University. His team receives ongoing data from 20 stroke patients to help decide what information is most useful in developing the sensors, which resemble Fitbits that people use to track their steps.

Since what works best or is more important for one patient might not be true of another, Aaron Miller, a graduate research assistant on the team, is using an algorithm to figure out the best overall methodology for the devices to capture patient behavior.

The biggest hurdle is that most people do even the simplest tasks differently, so finding a "best fit" for overall use will prove critical. Eventually, the goal is to have the monitoring data available in real time via cell phone apps.

Unlike stroke patients who can choose to stop their rehab exercises, patients with Parkinson's may suffer from freezing of gait, an attribute that can lead to uncontrollable falling or instability. Wade is tackling the problem with backing from the National Science Foundation.

Parkinson's patients have reduced levels of dopamine, a compound in the brain that helps transmit signals to the body that coordinate motion, among other things. As a result, neurological resources can rapidly become swamped when presented with too many decisions, leading to a freeze in motion. It can be as simple as just stopping in place or as dangerous as falling to the ground.

Wade partnered with neurologist Michelle Brewer—who sees roughly half of all Parkinson's patients in East Tennessee—to develop a way to identify what might trigger such freezes.

"Our plan is to use advanced sensors to observe what happens in the body when patients come to a normal stop versus when they have a freezing gait episode," said Wade. "If we can figure out the differences, we might be able to identify what causes such episodes and develop a way to prevent them."

Past research has shown patients are less likely to fall when walking over tiled floors or carpets with patterns as opposed to walking on uniformly toned surfaces, for example.

In a separate project, Wade is using virtual reality to help train the Parkinson's-afflicted brain for particular environments.

Patients are able to "walk" through virtual recreations of environments they frequently encounter, helping pre-wire their brains to the layout.

Ideally, once they are comfortable functioning in the virtual realm, their brains will have less to process in the real world. Less processing equals more stability, helping ensure the safety and well-being of patients, one step at a time.

On a Scientific
MISSION TO MARS

By Whitney Heins. Photo courtesy of NASA.

For decades, a human mission to Mars has been dreamed, discussed, and even worked toward—but it hasn't happened yet. And there are many reasons including the significant technical challenges that stand in the way.

For one, it takes a lot of fuel to get there and viable techniques haven't yet been developed to successfully harness enough energy to launch a rocket on a 33.9-million-mile road trip—and then bring it back.

Also, a trip like that would take a long time. More time spent in space means more potentially harmful effects on the astronauts' health. Living in low gravity and being exposed to space radiation for long periods of time changes the human body, as NASA is now finding out, thanks, in part, to a recent year-long space mission by UT alumnus Scott Kelly.

But, UT engineering students led by UT-ORNL Governor's Chair for Nuclear Materials Steve Zinkle are working on overcoming these challenges by peering into "exotic" materials that can withstand extreme environments—as in those created by nuclear-powered thermal propulsion.

That's because one promising approach to get a rocket to Mars and back in a shorter time is by going nuclear.

"Mars is a relatively close planet but it is much farther away than the Moon," shared Zinkle. "The Moon only takes a couple of days to get to whereas Mars could be six months to a year or longer. Conventional rocket technology doesn't cut it. A higher power rate is desired."

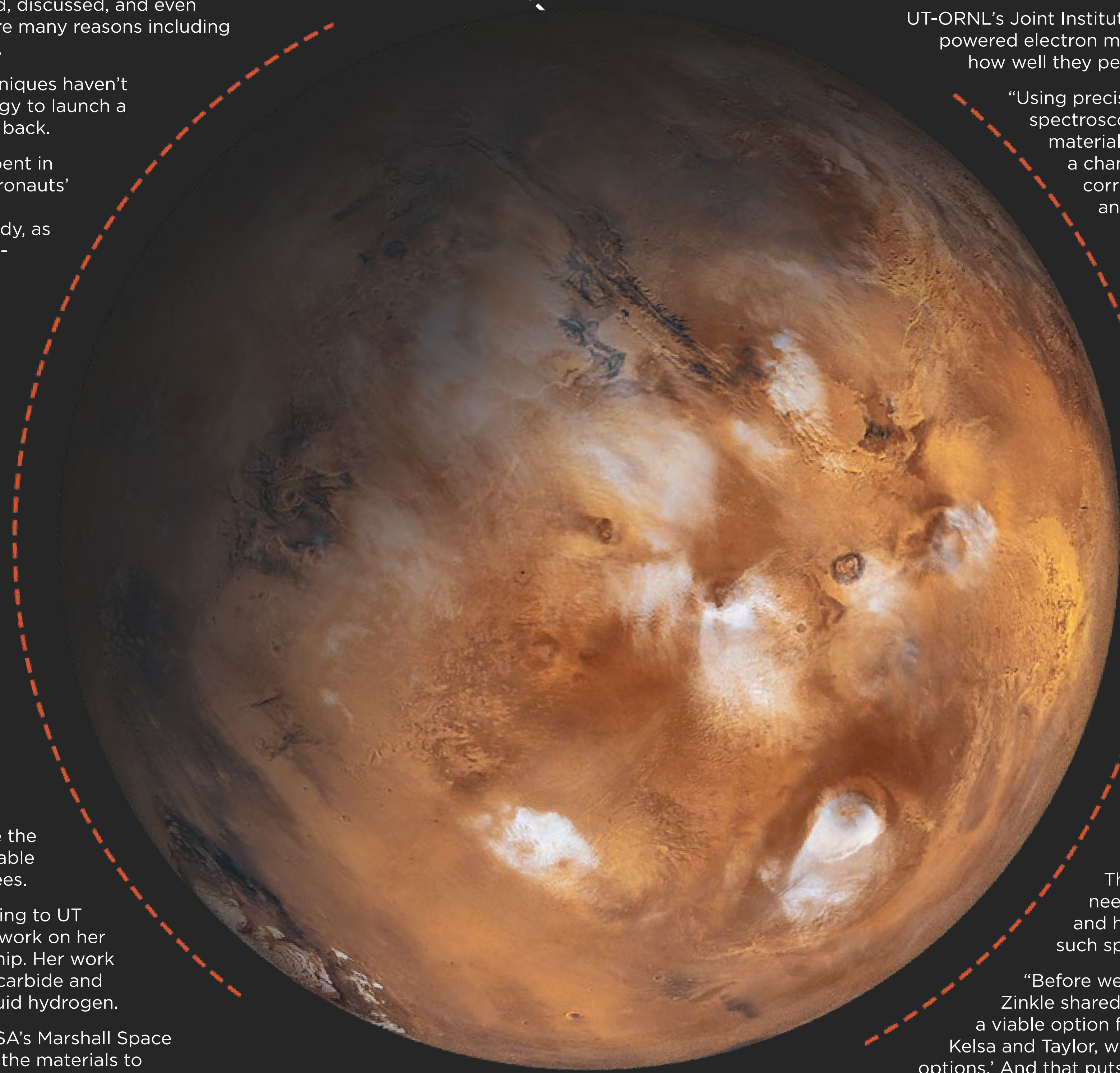
A nuclear energy reactor can be the answer.

Here's how it would work: cryogenic hydrogen would flow through a heat source causing it to rapidly expand and release a huge thrust that can propel a rocket.

The science behind this propulsion approach is well established but a key challenge is identifying materials that can withstand exposure to corrosive hydrogen at the extreme temperatures required for the reaction. The necessary temperatures are roughly 2,500 Kelvin—above the melting temperature for many elements in the periodic table and hot enough to melt steel by nearly a thousand degrees.

This is where exotic materials come in. Shortly after arriving to UT in 2015, Zinkle's doctoral student Kelsa Benensky began work on her prestigious NASA Science Technology Research Fellowship. Her work centers around investigating the compatibility of silicon carbide and ultra-high temperature ceramics to high-temperature liquid hydrogen.

She conducted her testing at a specialized facility at NASA's Marshall Space Flight Center in Huntsville, Alabama, where she exposed the materials to temperatures as high as 2,750 Kelvin. Then she brought back the samples to UT-ORNL's Joint Institute for Advanced Materials to be characterized using the high-powered electron microscopes and other advanced characterization tools to reveal how well they performed.



"Using precision weight change, glancing x-ray diffraction, Raman spectroscopy, and scanning electron microscopy, Kelsa obtains the materials' microstructural and chemical fingerprints to see if there is a change in the surface composition, for example, if it eroded or corroded. Transmission electron microscopy can then be used if anything needs further scoping," Zinkle said.

Benesky's results have been promising. No one had tested the compatibility of these materials with hydrogen at temperatures above 1900 Kelvin before she started her PhD research. Several of the materials she is investigating are doing well at resisting hydrogen corrosion up to at least 2500 Kelvin.

"I'm very grateful to have an advisor who encourages me to step up to the plate on my own projects and allows me the freedom to follow my own research path," shared Benensky, who added she came to UT because of Zinkle's experience working on materials development programs for nuclear space applications.

Another doctoral student, Taylor Duffin, is also doing research in Huntsville analyzing the hydrogen compatibility of ceramic-refractory metal, or "cermet," materials to high temperatures. The plan is for these composite materials to be used as fuel in a nuclear rocket. Zinkle is helping Duffin organize experiments, conduct follow-up characterization, and report his findings.

Without Zinkle and the electron microscopes, Duffin says his research wouldn't be possible.

"Dr. Zinkle has been essential to my project," Duffin shared. "And, so have the electron microscopes. Without them I would have to rely on only bulk data like mass loss or size changes without understanding the processes taking place."

There are many reasons for a mission to Mars: curiosity, a future need for resources, and, potentially, even survival. The work Zinkle and his students are doing is getting us closer to one day making such space travel a mission accomplished.

"Before we started these projects, it was a blank sheet of paper," Zinkle shared. "We wondered, 'are some of these high temperature materials a viable option for this extreme operating environment?' Thanks to the work by Kelsa and Taylor, we have solid experimental results that say 'yes, these are viable options.' And that puts us one more step up the ladder to making this a reality."

Student Notes

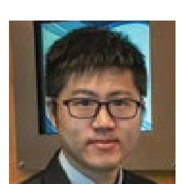
William Ferrell (MABE, PhD) and **Will Buttrey** (ME, Jr) are part of a team partnering with the Naval Surface Warfare Center, Carderock Division, to study the materials side of additive manufacturing. The group is working as part of the Naval Engineering Education Consortium, which is designed to provide students research funding for relevant research at academic institutions and provides opportunities for students to participate in hands-on research.

TranSCEnD, the first cohort: A team of faculty and staff from UT and Pellissippi State Community College have developed a program intended to support academically, socially, and financially TCE students who have transferred from one of the community colleges in the state of Tennessee. The goal is to raise the graduation rates of engineering transfer students to rates comparable to (or better than) students who enter the program as freshmen.

Three of UT's newest class of Haslam Scholars joined the college this fall. **Kinley Koontz** and **Deanna Riley** plan to major in biomedical engineering with **Athena Tran** pursuing chemical engineering. Each year, up to 15 first-year students are admitted to the Haslam Scholars program and become part of an intimate academic, service, and leadership cohort mentored by top UT faculty.

After placing second in the regional competition this April, UT's Chem-E-Car team has advanced to the finals, to be held at the 2018 Annual AIChE Student Conference at Pittsburgh this October. The team's car, the Myst-Air-y Machine, is powered by a PEM hydrogen fuel cell, which uses hydrogen from a rubber balloon and reacts with oxygen from the air to produce electricity. Team members are **Christopher Neal** and **Catherine Weiss**, **Matt Adams**, **Matt Bush**, **Maria Bruce**, **Jason Chung**, **Hana Gouto**, **Tyson Johnson**, **Michelle Lames**, **Shannon Mulhall**, **Jason Pan**, and **Lacey Roberts**.

Abubakr Zeidan (CE, PhD) is the 2018 recipient of the Donald C. Hyde Memorial Essay Scholarship ($5,000) from the American Public Transportation Foundation. He received the award at a ceremony in Nashville in September. He wrote on the topic of transit data and how it can help both transit users and providers. His research focus areas include transit operations, transit mobile ticketing, and transit safety.



Rui Feng (MSE, PhD), who is working with Professor Peter Liaw, won first place in the graduate division of 2018 TMS Best Paper Contest at the 2018 TMS Annual Meeting and Exhibition, held in Phoenix, Arizona.

Amany Alshibli (CE, '18) and **Cullen Johnson** (ISE, '18) were each named Torchbearers, the highest honor a student can earn at UT, at the 2018 Chancellor's Honors Banquet. Alshibli, a Haslam Scholar and Grand Challenge Scholar, pursued research in cardiac regenerative medicine at the Scottish Centre for Regenerative Medicine, while Johnson revamped the Intervarsity Christian Fellowship's men's Bible study, Brother to Brother, which provides leadership and service opportunities to male students.

Two engineering students earned awards in the 2018 Innovations in the DOE-NE Nuclear Technology R&D Awards. **Kelsa Benensky** earned second place in the Advanced Fuels category. **Daniel Rutstrom** won a 2018 Innovations in Nuclear Technology R&D award from the DOE, one of five nationally in the undergraduate category.

The "Radiation Busters," a team of students from the Scintillation Materials Research Center, presented an exhibit of homeland security and medical imaging technology for high school students at STEMpunk in the Knoxville Convention Center on April 21. Team members **Eleanor Comer**, **Josh Smith**, **Kaycee Gass**, and **Daniel Rutstrom** explained the details of radiation detection and measurement with scintillators to future engineers from various high schools in East Tennessee.

Eric O'Quinn (NE, PhD), was chosen by the DOE Office of Science for enrollment in its graduate student research program. O'Quinn's work revolves around what are known as disordered materials, such as glasses and ceramics, that may have a more complex structure at the atomic level than previously thought.

UT's YNOT competitive robotics team finished in 11th place in Robot Skills and received the Community Award at the 2018 Vex Robotics World Championship, held April 25–28 in Louisville, Kentucky. This leaves the team ranked fifth worldwide in this year's VEXU Skills Competition. The team includes **Clare Remy**, **Grant Kobes**, **Richard Swan**, and **Craig Wiley**.

Associate Professor Qing Cao (EECS) recently co-authored a paper with two of his graduate students, **Yunhe Feng** and **Zheng Lu**, entitled "Secure Sharing of Private Locations through Homomorphic Bloom Filters." The paper won Best Paper award at IEEE BigDataSecurity 2018, the 4th IEEE International Conference on Big Data Security on Cloud.

Ten members of the fall 2018 incoming freshman class were named National Merit Finalists: **Charles Blalock**, **David Dodd**, **Kyle Dolwick**, **Matthew Floyd**, **Natalee Jobert**, **Paxton Lifsey**, **Emma Lynch**, **Joshua Mandzak**, **John McElroy**, and **Konnor Porter**.

Faculty Notes

Assistant Professor **Steven Abel** (CBE) became the college's sixth NSF CAREER award recipient of 2018, and 13th since 2016. The award is given by NSF in recognition of young faculty members making an impact in their field.

The team at CURENT, led by UT-ORNL Governor's Chair for Power Electronics **Yilu Liu** (EECS), was issued its first patent this July. The patent, titled "Mobile Platform Phasor Measurement Unit Based on Electric Field Sensor," describes a device to monitor and assess the health of the electric power grid in real time.

Assistant Professor **Shuai Li** (CEE) was awarded the Collingwood Prize from ASCE for his paper "Integrating Natural Language Processing and Spatial Reasoning for Utility Compliance Checking." Li was first author on the paper during his previous time at Purdue. The prize recognizes an outstanding paper published by investigators under the age of 35.

Professor, Leonard G. Penland Chair, and Associate Department Head **Phillip Rack** (MSE) was named a fellow of the American Vacuum Society (AVS). Rack also currently serves on the executive committee of the Thin Film Division for AVS.

Professor Emeritus **Belle Upadhyaya** (NE) received the American Nuclear Society Don Miller award in June at the society's meeting in Philadelphia, Pennsylvania. Upadhyaya is the third NE professor from UT to receive the award, which recognizes the culmination of a recipient's career in the area of nuclear instrumentation and control or human-machine interface.

Professor **Mingzhou Jin** (ISE) was appointed director of the Institute for a Secure and Sustainable Environment. He will also remain the associate department head for ISE and director of the college's Reliability and Maintainability Engineering graduate program. Earlier this summer, Jin was elected to be a fellow of the Institute of Industrial and Systems Engineers in recognition of his outstanding leadership and significant, nationally recognized contributions to the field of industrial engineering.

Distinguished Professor and Director of the Innovative Computing Laboratory **Jack Dongarra** (EECS) has been selected to receive the 2019 SIAM/ACM Prize in Computational Science and Engineering next February. This award is presented every two years by SIAM and the Association for Computing Machinery in the area of computational science in recognition of outstanding contributions to the development and use of mathematical and computational tools and methods for the solution of science and engineering problems.

Professor **Khalid Alshibli** (CEE) and two former CEE graduate students **Maha Jarrar** and **Andrew Druckery** were awarded ASCE's J. James R. Croes Medal for their paper "Influence of Particle Morphology on 3D Kinematic Behavior and Strain Localization of Sheared Sand." This prestigious and competitive award is selected from outstanding papers across all of ASCE's divisions.

Associate Professor and UCOR Faculty Fellow **Jason Hayward** (NE) and PhD student **Michael Moore** made measurements July 12–17 with the neutron microscope instrument at the Paul Scherrer Institute's SINQ Spallation Neutron Source in Villigen, Switzerland. Their work pursuing the development of 1-micron spatial resolution in neutron imaging instrumentation is part of Hayward's DOE Office of Science CAREER grant.

Associate Professor **Xiaopeng Zhao** (MABE) recently received $35,000 in backing from Alzheimer's Tennessee in support of his efforts focused on slowing the rate of cognitive decline by giving the brain what amounts to a computer "workout."

Postelle Professor and Department Head **Wes Hines** (NE) received the Thomas French Achievement award from The Ohio State University Department of Mechanical and Aerospace Engineering. The award is presented to alumni who have distinguished themselves as scholars and educators. Hines was also recently named a UT Chancellor's Professor for his distinguished record of research, teaching, and service to the university.

Alumni Notes

Leslie Benmark (BS/ISE '67, MS/ISE '70) was honored as the Tickle College of Engineering's 2018 Nathan W. Dougherty Award winner. She served as president of the Accreditation Board for Engineering and Technology, for the National Science Foundation, the National Research Council, and was a member of the US delegation of the Council for International Engineering Practice for Canada, Mexico, and the United States. In 1993, she was elected to the National Academy of Engineering, the highest honor an engineer can achieve, in both industrial, manufacturing, and operational systems engineering as well as in computer science and engineering.

Gabriel "Gabe" Bolas II (BS/EE '94, MS/EIM '01) will be the new president and CEO of the Knoxville Utilities Board (KUB), starting in October 2018. Bolas joined KUB in 1995 as an engineer and has held his current position of senior vice president and chief engineer since 2017. He has served as manager of engineering systems, environmental programs, and overhead construction, and assistant to the chief operating officer. He is a member and past president and state director of the Tennessee Society of Professional Engineers, receiving the Young Engineer of the Year award in 2001 and the Engineer of the Year award in 2013.

Kim Greene (BS/ESM '88) has been named the chairman, president, and CEO of Southern Company Gas. She transitioned to the new position from her previous role as the company's executive vice president and chief operating officer on June 1. Greene joined the company in 1991, leaving for a five-year stint as an executive with TVA before returning in 2014.

Southern Company is America's premier energy company, with 46,000 megawatts of generating capacity and 1,500 billion cubic feet of combined natural gas consumption and throughput volume, serving 9 million customers through its subsidiaries.

In Memoriam

John Michael Barker (BS/EE '82), July 13, 2017.

Edwin Carl Barringer (BS/EE '58), September 4, 2018.

Jimmy F. Bates (BS/CE '55), March 31, 2017.

William Carroll Batts Sr. (BS/EE '68), June 21, 2018.

Herschel W. "Bud" Belew (BS/ME '49), September 3, 2018.

Larry Dale Bishop (BS/EE '70), March 11, 2017.

Donald Richard "Boogie Bear" Bundy (BS/EE '65), June 18, 2018.

Garry L. Child (BS/CS '80), August 6, 2018.

James Aaron Crowson (BS/EE '50), April 13, 2018.

A. Thomas Early (BS/EE '50), July 18, 2018.

Robert O. Ewart (BS/ME '65), March 16, 2018.

Franklin Daniel Edwards (BS/EE '59), April 11, 2018.

John Franklin Ellis (BS/EE '62), February 5, 2018.

Thomas Edwin Eustis (BS/IE '63), February 6, 2018.

Lee Eugene Gentry (BS/ME '71), July 14, 2018.

Ted Newton Gentry (BS/ME '66), May 31, 2017.

Glenn Wallace Greene (BS/EE '53), June 4, 2018.

Winifred W. Halley (BS/EE '39), January 15, 2018.

James H. Hawkins Sr. (BS/EE '61), November 17, 2017.

Ted Dwayne Helms (BS/IE '60), May 11, 2018.

Michael S. Holtcamp (BS/EE '60), June 28, 2018.

Thomas Jack Hopper (BS/ME '56), July 21, 2018.

James E. Jenkins (BS/ME '57), September 17, 2017.

Hugh Aaron Johnson (BS/IE '60), February 16, 2018.

Timothy Clark Keener (BS/ME '75, MS/EnvE '77, PhD/CE '82), April 9, 2018.

Kyle W. King (BS/ChE '44), April 16, 2018.

Y. Deaver Littlejohn (BS/EE '77), July 24, 2018.

Lowell Thomas Litton (BS/ME '56), October 9, 2017.

Thomas Allen Lomax (BS/ChE '63), March 23, 2018.

Kenneth Ray Lord (BS/EE '72), December 6, 2017.

William Harry Lynn (BS/ME '69), August 25, 2018.

Dennis Stephen Milewski (MS/ISE '91), August 4, 2018.

James Richard Munsey (BS/IE '63), February 4, 2018.

Russell David Myers (BS/ChE '56, BS/CE '60, MS/CE '69), January 15, 2018.

Rodney Alvin Norum (BS/EE '62), September 22, 2017.

Robert J. "Jerry" Palmer (BS/IE '54), October 23, 2017.

Ernest Perez (MS/EE '71), April 22, 2018.

Newton Hudson Perry (MS/CE '74), March 31, 2018.

Howard Franklin Randles (BS/IE '60), December 8, 2017.

Marcus Luther Reed (BS/EPh '68), October 20, 2017.

James William Roote (BS/EE '62), June 1, 2018.

John "Jay" Waltz Salvage (MS/ES '70), March 20, 2018.

James Shanteau (BS/EE '74), March 13, 2018.

James Reid Seaman (MS/AvSys '92), April 20, 2018.

Walter Seaman (BS/CE '57), July 4, 2018.

Charles Frank Shipp (BS/CE '51), December 31, 2017.

Jared Lane Smith (BS/MSE '17), August 9, 2018.

Robert Daniel Smith (BS/ME '72, MS/ES '90), May 16, 2018.

Norman Eugene Smith (BS/ME '51), October 25, 2017.

Leslie Clay Thomas (BS/ME '53), June 27, 2018.

Ronald W.T. Urbanik (MS/AE '68), January 1, 2018.

James Preston Vineyard (BS/CE '55), May 28, 2018.

Ben Frank Watkins (BS/ChE '57), May 22, 2017.

George B. Westrom (BS/MS, EMSci, '50/'52), February 23, 2018.

Frank Grant Whitney (BS/EE '49), March 14, 2017.

Lawrence Whicker (BS/EE '57, MS/EE '58), June 21, 2018.

Mark Lane Williams (PhD/NE '79), July 18, 2018.

Ronald Homer Wilson (BS/CE '58), March 1, 2018.

The Tickle College of Engineering lost one of its key figures last spring when longtime professor Edwin G. Burdette passed away on May 18.

Burdette was an icon of civil engineering, earning the respect of peers around the world. The Edwin G. and Patsy H. Burdette Fellowship in Structural Engineering and the Dr. Edwin G. Burdette Endowed Professorship were established in 1994 and 2015, respectively, thanks to generous support from former students and colleagues in his honor.

A letter from Interim Chancellor Wayne T. Davis ('74)

Throughout my time as a UT engineering student, faculty member, and administrator, one constant I have always observed is the unwavering Volunteer spirit of our UT community. This dedication to serving others and stepping up to lead is how the college and university continue to provide unmatched educational experiences for our students and contribute impactful research that is advancing the frontiers of human knowledge.

Earlier this year, I was asked by UT System President Joe DiPietro to postpone my retirement in order to serve as interim chancellor for the university. UT holds a special place in my heart, and I was both humbled and honored to be called upon to serve once more.

The college's then-associate dean for faculty affairs and fellow alum Lynne Parker agreed to serve as interim dean of engineering and did a marvelous job over three months, from May through August to ensure the continued support of students, faculty, staff, and alumni. Provost David Manderscheid and I are grateful for her outstanding service and the continuity she brought to the college.

Lynne is so exceptional, she was asked to serve in another capacity—this time by the highest levels of government—as assistant director for artificial intelligence (AI) for the White House Office of Science and Technology Policy for the next one to four years. It is a testament to her unique expertise in AI that she was selected to help lead our nation in an area of such strategic importance. We are lucky she will remain connected to UT and the college through her research and other strategic opportunities.

Following the news of her impending departure, Provost David Manderscheid and I turned to the college's deep pool of talented faculty to find another interim dean. Mark Dean, specifically.

Like Lynne and myself, Mark is also a UT engineering graduate. He holds three of the original patents for the first IBM PC, is a globally respected expert in his field, and is a member of the prestigious National Academy of Engineering. Both the provost and I are thankful for Mark's dedication to the university and for stepping up to serve as interim dean to maintain the positive trajectory of the college during this important transition.

The search for a new dean of engineering recently resumed under the able oversight of Provost Manderscheid, who joined our Volunteer family in July. With the college climbing in national rankings, a new engineering complex under construction, and steady growth in both enrollment and research expenditures, the position has garnered widespread national interest. Without doubt, it's truly a great time to be on Rocky Top.

I have been committed to the University of Tennessee for more than 47 years. Although leadership may change, UT and the Tickle College of Engineering remain ever-resilient because of our most valuable asset—the great people who call UT home. I am inspired by the direction we are heading and I remain grateful that we, as members of the Volunteer family, are sharing this journey together.

Update:
New Engineering Complex

In late September, the college broke ground on the new engineering complex, which is set to open in 2021. 1: An excavator lunges in to pull down the north facade of Estabrook Hall. **2:** The new engineering complex will stand adjacent to Neyland Stadium in the heart of UT's engineering campus. **3:** Workers dismantled elements of the Estabrook entrance for possible display in the new building. **4:** The demolition crew spent a week bringing down the myriad sections of Estabrook Hall.

TICKLE
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