helluva engineer

FALL 2020

GEORGIA TECH COLLEGE OF ENGINEERING

RISING STARS

- ROBYN GATENS & NASA
- ALUMNI UNDER 40
- INDUSTRY TO ACADEMIA

A SEASON OF CHANGES

THE ONLY THING CONSTANT IS CHANGE

Dear Friends of the College,

These days when walking around Tech, I see the leaves turn and campus begin to dress itself in gold and orange as the trees shed their summer wear. Campus may have the look and feel of fall semester, but what I don't see on campus is students, and it's a surreal feeling. There are the rare sightings of people going to and from buildings. And, there is also a distinct lack of connection, as masks cover faces. A quietness permeates the grounds, with the exception of the ear piercing, but fondly comforting, whistle which still announces class times. The changes are obvious and, in a way, painful to absorb. But seasons change, and so do I.

The past several months have certainly been a time of transitions here at Tech. From on-campus to virtual learning and for many, from dorm to home life. For me personally, there is another change on campus — this will be my last letter to you as the dean of Engineering, as I recently transitioned to a new role as provost and executive vice president for academic affairs at Tech.

While I still consider the role of dean of the College of Engineering to be the absolute best job on campus, the opportunity to be part of something even bigger was an incredible draw. The key initiatives we have begun in the College — student mental health, diversity and inclusiveness and entrepreneurial confidence — will still go forward, reaching across all of Tech. I am extremely proud to be able to have an impact in these areas while dean of the College, and now, campus wide as provost. My new role is a chance to have a broad and hopefully long-lasting impact on the Institute.

This season is all about change and embracing it with a restored promise for a better year to come. Like many others, I am staying positive and navigating new changes and challenges as they come. I am grateful to each and every one of you for your support of the College, and I will always be a helluva engineer.

Steve McLaughlin

inside

HELLUVA ENGINEER > FALL 2020

Alumnus Jorge Guzman uses his industrial engineering and problem-solving background to bring craft beer to his hometown of Antigua, Guatamala.

FEATURES

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Dear Readers,

First, I hope everyone is staying safe and healthy as we all continue to adapt to the changes and challenges of the pandemic. For me, I've learned to take things one day at a time, stay positive, and focus on work — which means telling the stories of our College as your magazine editor. It's been six months since our last issue came out, and regardless of quarantine, teleworking and modified business operations, we are still able to bring you a magazine that features our students, faculty and alumni who continue to do great things amidst Covid-19.

This issue is all about *Rising Stars* — the engineers who are laying the groundwork to advance the human condition through innovation. As I've worked to put this issue together, I'm in awe of an 18 year-old aerospace student who, upon watching *Hidden Figures*, was motivated to study spacecraft design. I'm star struck by our cover woman, Robyn Gatens (ChBE aluma), who is currently the acting director for the International Space Station. She gives breaking the glass ceiling a whole new meaning with her work at NASA.

What impresses me the most with our rising stars is their tenacity, drive and passion to advance engineering, science and technology even in the face of a pandemic. The studying, research and work doesn't stop just because our lives have changed. A common trait of our engineers, regardless of where they are on their career path, is natural curiosity and the drive to solve problems. And, so many stories in this issue exemplify those values.

I remain in awe of the engineers that I have the privilege to write about. Telling their stories makes me feel like I'm playing a small role by keeping readers like you aware of our rising stars to make you proud of the College.

I might not be an immunology researcher or a student who wants to be a physician who treats astronauts, but I find the dedication and grit of our engineers inspiring. I hope you do too as you read through this issue of *Helluva Engineer*. Yep, new name, same look, reflecting our past, our present and who we will always be — one Helluva Engineer.

Stay safe and happy reading,

Georgia Parmelee
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A common trait of our engineers, regardless of where they are on their career path, is natural curiosity and the drive to solve problems.

Following His Strengths

Clark Scholar, Vincent Bell, eyes a career in space vehicle design

The Daniel Guggenheim School of Aerospace Engineering's newest Clark Scholar, Vincent Bell, refuses to take sides in a debate that often divides engineers of a certain ilk.

"I like *Star Wars* because it's got The Force, but I also like *Star Trek*," says the good-natured, 18-year-old Lawrenceville native. "They both have always made aerospace seem interesting and exciting. And that drew me to the field when I was younger."

The movie that most captures his dreams these days is *Hidden Figures*.

"In *Hidden Figures* you see these strong African American women working at NASA to achieve their goals during Jim Crow. You can't help but be inspired," he said. "It's also great because you get to see people working to achieve space flight."

That sounds an awful lot like what Bell wants to do, and he's got a plan to do it. At Tech, he will focus on strengthening and building upon his natural talents in mathematics and the sciences.

"Growing up, I realized that I picked up math pretty quickly, easily, and that I could even teach others," he said. "My first job was as a tutor at Mathnasium. I've just tried to follow where my strengths lead me."

Bell also knows how to make the most of circumstances. As a high school freshman, he joined his school's robotics club, thinking it would give him a leg-up in his bid to become an engineer.

"But the advisor for the club was also the softball coach, so he wasn't around to teach us much during the year," Bell recalls.

"I mean the seniors in the club were nice, but they didn't have the skills to teach the

freshmen how to make a robot work, and that's why I joined. So, I ended up joining my school's debate club instead, which was great, because I've always liked making arguments about interesting subjects."

Those skills will come in handy, he figures, when he is called to make presentations before his professors or employers.

"You have to know how to present yourself logically, calmly, professionally," he said.

Since coming to Tech in August, Bell has picked up new tutoring jobs and has also gotten involved with Lambda Delta Rho, the freshman leadership component of the Georgia Tech Society of Black Engineers. His long-term goals include a master's degree and most likely a doctorate, he says, but they will definitely include a career in spacecraft design.

"I've actually got a little bit of a fear of heights, so I'm thinking more about designing than actually flying," he said with a laugh. "That could change, but I'm fine sticking with design."

The courses he chose to take for his first semester are a testament to how serious he is about attaining that goal: Computer Science 1371, Applied Physiology 1040, Multivariant Calculus 2551 and English 1102.

"Next semester, I might take chemistry, but I might put it off just to make sure I can do well," he said. "I want to keep my grades up."

While many of his classmates are new to the world of virtual learning, Bell says it harkens back to his childhood when he used distance learning tools as a part of his home-schooling curriculum.

"As a kid, I was used to getting material to learn on my own and then sending it to a tutor to be checked," he said. "That's made this semester a little easier, I guess."

Looking ahead, Bell is cautious but also confident. He's learned that hard work pays off and knows an aerospace engineering degree at Tech will require all the effort he can give it. The key, now, is pacing.

"I'm going to concentrate on absorbing as much knowledge as I can from classes, and when I'm ready, I'm going to go out for internships and maybe a co-op," he said. "Nothing will top getting an internship at NASA or a private company, like SpaceX. My job now is to prepare myself for that chance when it comes along."

▶ KATHLEEN MOORE

Solving the World's *Growing* Problem

Marta Hatzell's research on global sustainability in the fields of food, water and energy seeks to solve the world's hunger problem through environmentally sustainable fertilizer

Across the world, people young and old, close to home and far away, go to bed hungry. Moderate or severe food insecurity affects more than 25 percent of the global population, or about two billion people.

In order to help alleviate this food scarcity, the world demand for fertilizers is consistently on the rise, having increased nearly every year for the last two decades. Estimates show that foods produced from nitrogen fertilizer support about half of the world's population.

Some of the concerns surrounding this reliance are that nitrogen fertilizer is challenging to make and has a negative impact on the environment. The base of most nitrogen fertilizers is ammonia, which can only be made at about 100 locations around the world. This current system requires a huge infrastructure for both manufacturing and shipping, and it can be highly dangerous as well — the explosion at a warehouse in Beirut in August 2020 involved the storage of ammonium nitrate.

Enter Marta Hatzell, assistant professor at Georgia Tech in the George W. Woodruff School of Mechanical Engineering, whose current research looks at how to make nitrogen-based fertilizer easier and safer, as well as how to make its use more sustainable and environmentally friendly.

A Bumper Crop of Sustainable Solutions

Hatzell's inclination toward mechanical engineering began when she realized the impact that her research and innovations could have on the energy industry.

"Growing up, I was always interested in energy and how we could move toward a more sustainable energy infrastructure based primarily on renewables," says Hatzell. "That sparked my drive to work in environmentally sustainable technologies in the areas of food, energy and water."

Hatzell's goal is to consider the interplay of these three areas as she creates solutions for real problems affecting people all over the world. One way these three realms combine is through the use of synthetic nitrogen fertilizers — created using energy and water — that help mitigate worldwide hunger by producing more food safely, effectively and sustainably.

"In the 1900s, there was a scientific race to figure out how to make synthetic nitrogen for fertilizer because we realized that we were going to run out of food for the growing world population," said Hatzell. "It was a very challenging process, but after two Nobel Prize-winning breakthroughs, researchers figured it out, discovering a chemical process that uses high pressures and temperatures to convert nitrogen from the air into ammonia. Now, our grand challenge is to make it less environmentally harmful."

Hatzell and her team are working on electrochemical technology that can make ammonia in low-pressure, low-temperature situations using nothing more than air, water and a cheap mineral-based catalyst like titanium dioxide, which is found in many mineral sunscreens.

This method of manufacturing synthetic nitrogen can be carried out inexpensively and in more places around the world, meaning the shipment and long-term storage of volatile ammonium nitrate will be lessened.

Closing the Loop

In addition to making the production of fertilizer more sustainable, Hatzell also seeks to create a way to capture some of the excess nitrate from the use of fertilizers before it enters back into the environment.

"A percentage of the nitrogen contained in fertilizers is absorbed and used by the plant, but not all," says Hatzell. "Excess nitrates can run off into surrounding soil and water, causing health concerns for the people and animals who come into contact with it."

Nitrate runoff is linked to pollution in drinking water, poisoning of various plants and animals and atmospheric emissions that damage the Earth's ozone layer.

Using electrocatalytic or membrane-based technologies, Hatzell seeks to capture and convert this runoff from the fertilizer to either remediate the nitrate back into ammonia to be reused or by altering it into inert nitrogen gas that would be released harmlessly into the environment.

"We need fertilizer to feed the world — it's a simple fact," Hatzell said. "By creating these decentralized technologies and providing fertilizer in places where we have food shortages, we could increase agricultural yields, maximize productivity and promote equity in nutrient distribution — all in an environmentally conscious way."

▶ KATHRIN HAVRILLA-SANCHEZ

The Building Blocks of Life and Community

For Chiamaka Obianyor, leadership is in her DNA

While growing up in Nigeria, Chiamaka Obianyor was raised with the principle that it takes a village to raise a child. "Everyone is involved in the community to make sure that others are doing okay," she says. The Ph.D. candidate in the School of Chemical and Biomolecular Engineering lives by that principle to the fullest in her current "village" of Georgia Tech. She has demonstrated leadership not only in the laboratory but through her participation in two interdisciplinary teams working on Covid-19 testing technology and as a mentor in multiple Tech organizations.

"I came to the U.S. for my studies because once I decided that I wanted to be a chemical engineer, I knew I wanted to go to the best schools in order to make the kind of impact I wanted to have," Obianyor says. She is already making an impact through her research in the building blocks of life: nucleic acids, the "NA" in DNA and RNA.

In nature, enzymes play a role in nucleic acid replication. Obianyor strives to understand how DNA and RNA strands can make more of each other (replicate) without using enzymes. Particularly, she is interested in the joining together (ligation) of the strands of nucleic acids without using enzymes in the replication process. In her recent results, she found that by optimizing DNA reaction conditions, she was able to cut down the time it took past researchers to join strands without enzymes from six days to just under 24 hours. These microscopic reactions could potentially have big-picture implications for understanding the origins and evolution of life.

> "IT WAS ONLY NATURAL WHEN I CAME TO GEORGIA TECH THAT I LOOKED FOR WAYS I COULD CONTINUE TO SERVE AND GIVE BACK."
>
> Chiamaka Obianyor

"Chiamaka is a natural in the lab," says Nicholas Hud, Ph.D., Obianyor's co-advisor and Director of the Center for Chemical Evolution (CCE), which funds her research. "She can extract important information about reactions involving DNA and RNA that can easily be overlooked if such reactions are carried out in a less systemic or less quantitative manner."

Obianyor's skills in the lab and expertise in nucleic acids were sought out after the pandemic broke out this past spring. She eagerly accepted an invitation to join the interdisciplinary Georgia Tech Covid-19 Test Kit Support Group, which helped fill in the gap in testing supplies by creating components for hundreds of kits a day. Obianyor was responsible for making sure the enzymes produced in-house were free of contaminants that could lead to false test results. She also performed a similar role — conducting technical assessment of assay reagents — for the Georgia Tech Research Institute's continuing efforts to develop a rapid point-of-care Covid-19 test kit.

"In my daily research and in academia in general, it takes time to develop and learn new techniques to make profound discoveries," she says. "To be able to use my skills to contribute to these projects with such a high impact in such a short amount of time was really rewarding."

Her contributions to the Covid-19 test projects are just the latest of numerous examples of how Obianyor gives so generously of her time to help others. During her time at Tech, she has served in leadership and mentorship roles for several organizations.

"Being heavily involved in my community is something I've always done since I came to America for college," she says. "It was only natural when I came to Georgia Tech that I looked for ways I could continue to serve and give back."

In her two years as CCE's outreach chair, she developed fun STEM demonstrations for not only elementary school students in their classrooms, but also high schoolers attending the Hands On Future Tech Expo on Campus. She also led professional development seminars for fellow CCE grad students and post-docs on such topics as building a solid LinkedIn profile.

As a graduate mentor for the School of Chemical and Biomolecular Engineering's Exxon Success Program, she has supported undergraduate students from underrepresented groups. "Our goal is to provide a space for these students to be able to function and thrive in the department," she explains. She provided formal training such as mock interviews, as well as informal one-on-one mentoring sessions and roundtable lunches during which students can share their life and classroom experiences with their professors. "Chiamaka is an intentional leader and a tireless contributor," says Martha Grover, Obianyor's other co-advisor and a professor in the School of Chemical and Biomolecular Engineering.

But it has been Obianyor's role as a leadership coach through the Leadership Education and Development program that has made the greatest impact — on her own life. "It's one of the best things I've ever done," she says. "It taught me the difference between being a mentor, which is based on your own experience, versus being a coach, where you remove yourself entirely from the narrative and ask the coachee insightful questions to help them come up with their own unique solutions. They can chart their own journey. It has taught me to ask these questions of myself as I walk through my own leadership journey."

Obianyor's still deciding whether that journey will lead into industry or academia after completing her Ph.D. next spring. True to her guiding principle, though, she's ready to serve and contribute, wherever her next village may be.

▶ KRISTIN BAIRD RATTINI

A New Strategy to Fight Cancer

Johnny Blazeck's research at the intersection of immunology, engineering and metabolism is creating novel therapies to help cancer patients in the fight of their lives

In the battle against cancer, reinvigorating body's own immune system is a big idea w many potential avenues and solutions. Most the efforts in this field have been focused on th physical interactions between cancer cells and immune cells, and therapies in this area can be very effective for about 20 percent of patients.

In comes Johnny Blazeck with a new idea — hoping to improve those numbers by leveraging the chemical interactions instead of the physical ones and working to understand how cellular metabolism affects immune function.

Metabolism in this sense encompasses all of the chemical changes that take place in a cell, from creating new molecules to breaking down others. Cancer cells grow faster than the cells around them, taking in more energy and secreting more waste. Certain metabolic wastes — known as immunosuppressive metabolites — are able to shut down the body's immune response.

"The body's immune system should be able to recognize cancer cells as invaders to target and kill them," says Blazeck, assistant professor in the Schoo of Chemical and Biomolecular Engineering. "Howe cancer cells have lots of ways of 'hiding' — inclu overproducing immunosuppressive metabolites

turn off the immune cells around them, rendering them useless, which is how cancer can often spread so quickly."

To help the body better fight cancer, the Blazeck Lab is using metabolism and therapeutic protein engineering to build stronger immune cells that simply aren't affected by the immunosuppressive metabolites. By retaining more functioning immune cells, the immune system works at a higher capacity and attacks the cancer cells instead of allowing them to spread.

Another cancer-fighting option Blazeck and his team are working on is engineering an enzyme therapy that can convert the immunosuppressive metabolites secreted by the cancer cells into different molecules altogether and ones that don't affect the immune cells in the same way.

From Creating Biofuels to Fighting Cancer

Blazeck's early research focused on using cell metabolism to engineer a strain of yeast that could effectively synthesize biofuels. By using genetic engineering approaches, he rewired the yeast's metabolism to overproduce oils and lipids, which could be used as a replacement for diesel fuel.

"Towards the end of that project, I wanted to work on something that had a more focused application in health care and treating disease," says Blazeck. "In the scientific community, it was becoming more well known that some metabolic alterations could impact how certain diseases, including cancer, progress. So, this research vein seemed to fit well with my previous experience."

When Blazeck joined the School of Chemical and Biomolecular Engineering in 2019 he was excited to work on his groundbreaking ideas with leaders in the field, leveraging the interdisciplinary research that Tech is known for.

"Georgia Tech's College of Engineering has so much renown in the research that goes on here, specifically within the Department of Chemical Engineering," says Blazeck. "I'm lucky to work in such a collegial environment where I can collaborate with biologists, chemists, experts in the cancer field and more."

> **"CANCER CELLS HAVE LOTS OF WAYS OF 'HIDING' — INCLUDING OVERPRODUCING IMMUNOSUPPRESSIVE METABOLITES THAT TURN OFF THE IMMUNE CELLS AROUND THEM, RENDERING THEM USELESS, WHICH IS HOW CANCER CAN OFTEN SPREAD SO QUICKLY."**
>
> Johnny Blazeck

Blazeck's research could be a gamechanger for the 80 percent of cancer patients on whom the other novel immune treatments don't work.

"Because cancer cells work in so many different ways to damage the immune system, our hope is that our approaches can add another standard of care in a host of cancer treatments to improve outcomes for more patients," says Blazeck.

Blazeck's overall research goal of changing the metabolic environment and controlling metabolism could have ramifications beyond immunosuppressive diseases like cancer. In theory, these same tools could be used to impact diseases in which the immune system is too active, such as lupus.

The Blazeck Lab is funded by a Winship Invest$ Pilot Grant from the Winship Cancer Institute at Emory University and by the Petit Institute for Bioengineering and Biosciences at Georgia Tech. In June of 2020, Blazeck also received the Beckman Young Investigator Award, which offers research support to the most promising young faculty members in the early stages of their academic careers in the chemical and life sciences.

▶ KATHRIN HAVRILLA-SANCHEZ

Just Ask Jamel

Today's engineering student prepares for tomorrow by making the most of those college years

This was to be a story of a "rising star," but if you called Jamel Thompson that, you'd get a skeptical look.

No doubt, there's a strong case to be made for his star power. The fourth-year, ISyE major has accomplished a lot at Georgia Tech, building a rich portfolio of campus activities and outside endeavors. And though he doesn't graduate until December 2021, he already has a standing offer from Deloitte for a consulting job.

But talk to Jamel about all that he's packed into his student years, and he'll shrug: "It's college. You do stuff you're interested in."

Jamel is more than a busy guy, doing all the things. He's a model of the modern-day Georgia Tech engineering student, pursuing all kinds of experiences to round out his knowledge and prepare for what comes next.

Five takeaways from these experiences are clues as to the kind of engineer Jamel Thompson will become. They also serve as advice to students who might want to follow in his footsteps.

Just dive in: The summer of 2017 was Jamel's first on campus, and his first time being away from his family for an extended period. "It was rough," he says, recounting his participation in Challenge, an immersive academic residential program for first-years. "You have long days. But they get you to figure out how to plan your time and get your work done."

Pairing first-years with upper-class mentors was part of the experience, and Jamel remembers his mentor introducing him to student organizations. "He got me involved with the SGA cultural and diversity affairs committee and the African American

Student Union," Jamel says. Thus, going into his first fall semester, the new student was already engaged.

Pursue a passion: Jamel's is sports. While a sophomore at Westlake High School in Atlanta — *alma mater* to NFL quarterback Cam Newton and Orlando Magic player Chuma Okeke — Jamel captained the basketball team, which won the state championship that year.

So, it wasn't a stretch that he'd play club basketball at Georgia Tech. "On this team, we're less individualistic than high school teams are," he says. "In high school, you tend to compete against teammates as well as the other team. Here, we learn to play unselfishly."

Then there's the Sports Business Club, which Jamel helped resurrect at Tech. The club attends conferences and brings in speakers from college and pro teams, all to explore how the sports industry works. This fall, Jamel and others will prepare and present an industry case study in a competition sponsored by AMB Sports + Entertainment, the holding company for the Atlanta Falcons and Atlanta United soccer.

Do something different: Last spring, Jamel headed to New Zealand. His mission was to take courses outside of engineering, including one in ethics and another in entrepreneurship. He read and studied "Moby Dick" and visited Hell's Gate, the geothermal mud baths of Rotorura. He also traveled to Australia, dodging Covid-19 outbreaks along the way.

The pandemic cut short Jamel's study abroad venture by a few weeks, but not before he'd experienced a different culture on the other side of the globe.

"The general vibe of New Zealand is so different," he says. "It was more relaxed and chill, whereas here, we're always really busy, and sometimes for no reason." He came to embrace the belief that there's more to life than work.

Work in the world: Three summers of interning at Deloitte brought Jamel to the front lines of consulting. He developed expertise in the software platform SAP and delved into managing cyber risk, putting protocols in place for Deloitte clients. After his summer 2020 internship, Deloitte extended an offer to work there after graduation, which Jamel accepted.

But like other engineering students, Jamel had a co-op gig as well, with cable manufacturer Southwire in Carrollton, Ga. While there, he field-tested his classroom knowledge by playing a key role in restructuring a building plan to improve processes and product management.

"Because of Southwire, I was able to visualize what the textbooks and faculty were talking about," he says. "I could finally connect both the theoretical and practical sides of industrial engineering."

Become self-aware: During his sophomore-year co-op at Southwire, Jamel enrolled in the Truist Leadership Institute, which allowed him to hone his interpersonal skills. "They emphasized how nobody learns the same, nobody teaches the same and you have to bridge the gap," he recalls. "So, it's important to hear people and make sure they understand you."

The science-based program uses temperament sorters, improv techniques and other tools to get participants to deepen their self-awareness as leaders. "I learned how to talk to people more effectively and how to include them and their ideas without getting off topic. Also, it's never your way or the highway."

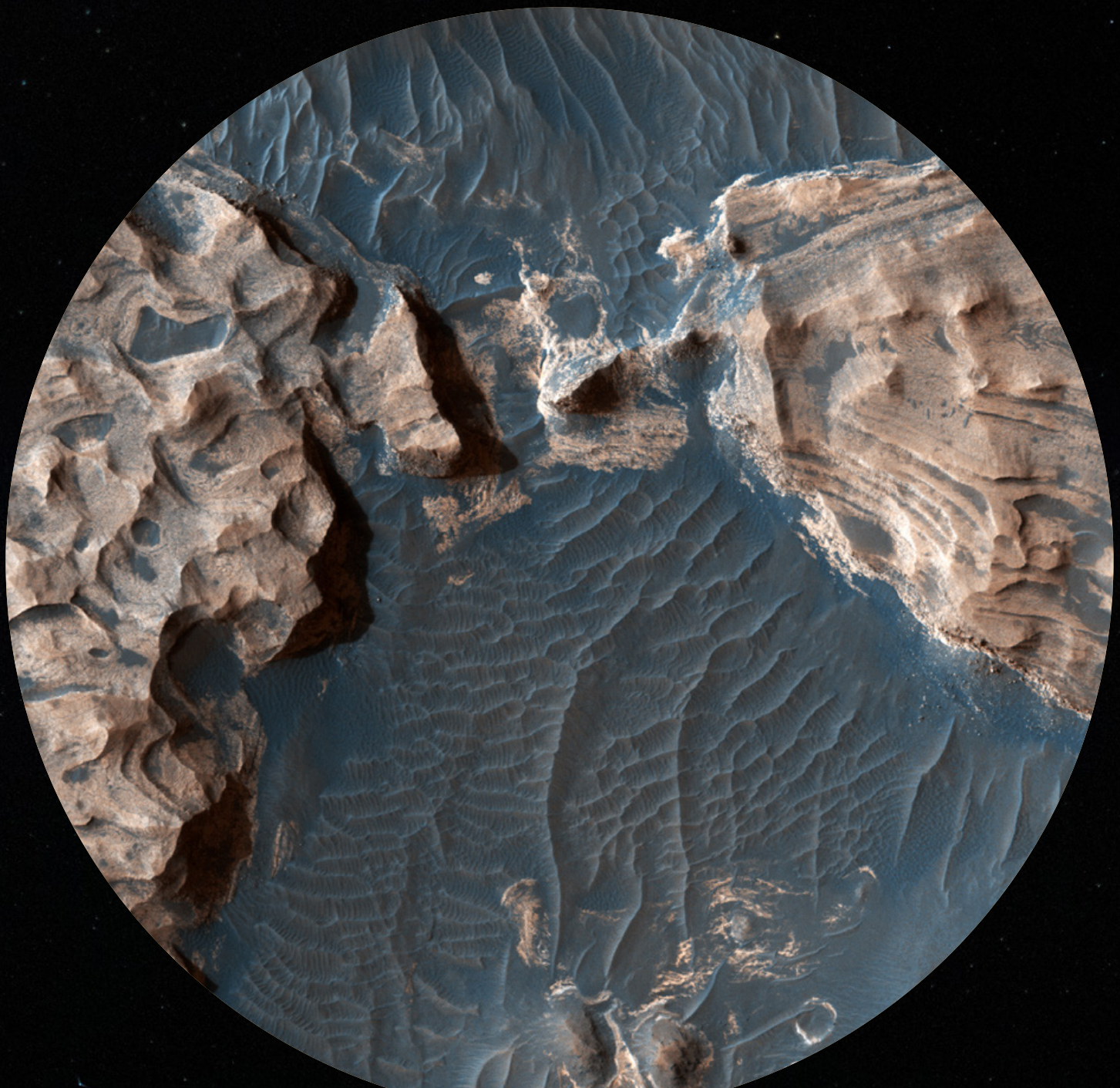
The institute certified Jamel as an emerging leader. Somehow, the prospect of his leading an organization one day doesn't seem hard to imagine.

▶ MICHAEL BAXTER

JUST ASK DAMON WILLIAMS (ABOUT JAMEL)

While Jamel Thompson excels in outside pursuits, he credits his College of Engineering education for providing a strong foundation for the career ahead. Damon Williams, a lecturer and advisor in the H. Milton Stewart School of Industrial and Systems Engineering, taught Jamel in the summer of 2020. Here's what he has to say about the rising star:

"We'll be hearing about Jamel in a few years. He has a presence, and he understands the value of building relationships. He was extremely engaging in dialogue, even in an online class. He wasn't shy about jumping in and being part of the conversation, and that's unique for my students."



WORDS: CANDLER HOBBS
PHOTOS: NASA

PREPARING TO EXPLORE NEW WORLDS

NASA LOOKS TO SEND ASTRONAUTS DEEPER INTO SPACE AFTER 20 YEARS OF CONTINUOUS HUMAN PRESENCE ON THE INTERNATIONAL SPACE STATION

This image from NASA's Mars Reconnaissance Orbiter shows Aram Chaos, a 280 kilometer-diameter ancient impact crater that lies within in the Southern Highlands of Mars.
IMAGE CREDIT: NASA/JPL-CALTECH/UNIV. OF ARIZONA

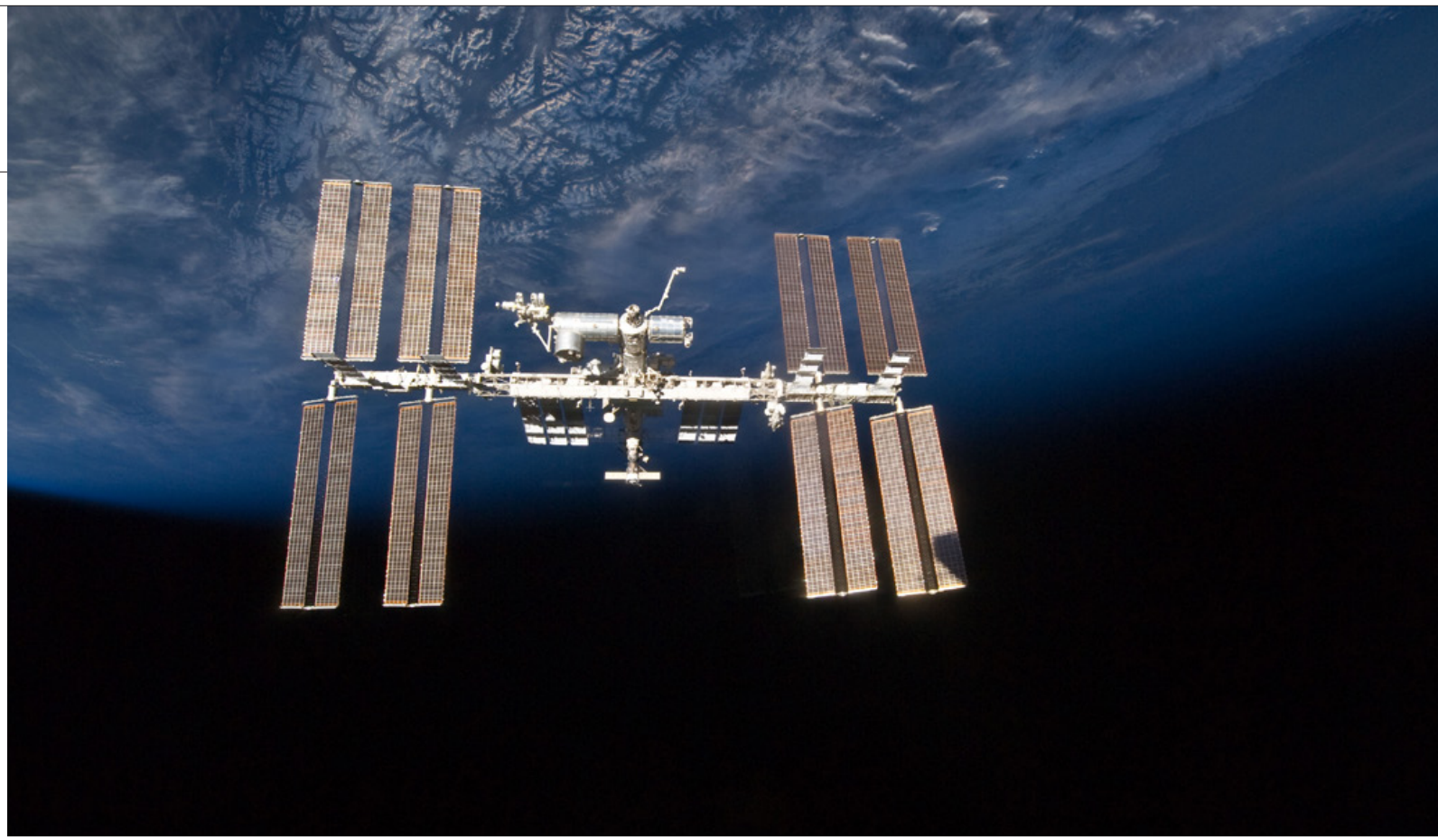
It's a busy time at NASA. The next chapter of human space exploration is underway. It's been more than 50 years since Neil Armstrong took those first steps on the moon and 48 years since Gene Cernan — the last man on the moon —climbed back into the lunar module to return to Earth.

Now, NASA has decided to return to the moon with its Artemis program by 2024, but this time they plan to stay. It's all part of an effort to explore deeper into space, and, more specifically, land humans on Mars. But to go further than the moon, NASA must learn how to sustain missions of much greater distance and duration. Astronauts must also overcome radiation, isolation, gravity and extreme environments to stay healthy. NASA believes developing a sustainable human presence on the moon is the best next step in helping astronauts prepare for making the voyage to Mars.

NASA also plans to leverage the knowledge gained from 20 years of continuous human presence in low Earth orbit aboard the International Space Station to develop a plan for an extended stay in lunar orbit. Coincidently, November 2020 marks the 20th anniversary of continuous human presence on the International Space Station, and Georgia Tech alumna Robyn Gatens (ChBE, 1985) was just recently named Acting Director for the station.

"We're doing a lot of work on the space station today dealing with life support systems," said Gatens. "Learning about these systems is going to be critical, even more so as we break the supply chain from Earth and go on these long duration missions beyond low Earth orbit."

According to Gatens, NASA is working to make life support systems more sustainable and is seeking to better understand the environment for deep space travel. NASA is gaining a lot of knowledge from the International Space Station by using it as a testbed to prepare astronauts for these future exploration missions, such as studying the long-term effects of weightlessness on the human body. When astronauts journey to Mars, it will be a three-year round trip, so NASA needs to understand and mitigate effects on the body such as



"We're doing a lot of work on the space station today dealing with life support systems. Learning about these systems is going to be critical, even more so as we break the supply chain from Earth and go on these long duration missions beyond low Earth orbit."

Robyn Gatens

"Our mission on the space station is discovering what we can do with our technology, engineering and the human body to prepare for Mars."
Doug Wheelock

bone loss, and other issues. As a result, NASA is looking at ways that it can use the International Space Station to practice for sending astronauts to Mars.

Like Gatens, astronaut Doug Wheelock (AE, 1992) is focused on studying the effects of space on the human body and the mind and is currently training astronauts for the Artemis program. Wheelock's credentials are impressive — he has logged 178 days on the Space Shuttle and International Space Station during his career and served as commander of the station during one of his missions.

According to Wheelock, NASA is trying to replicate both psychologically and physiologically an astronaut's absence from Earth in order to see if they can overcome the many physical hurdles from muscle atrophy and bone density loss to the effects of radiation on the human body and disrupted circadian rhythms. For example, astronauts experience a sunrise and a sunset every 45 minutes on the International Space Station, because it's orbiting the Earth every 90 minutes. This is a good training platform for long duration space travel, because it's not possible for an astronaut to look out the window of the space station and understand what time it is. It's helping NASA solve issues as well with sleep patterns and the immune system.

"We also try to extrapolate all that data across the anthropometric range of our space explorers and a cross section of the human race as well," said Wheelock. "As we get more data, we're refining our engineering, exercise countermeasures and psychological support. We're not going to the moon this time to plant a flag and to come back home with some dirt. Our mission on the space station is discovering what we can do with our technology, engineering and the human body to prepare for Mars."

Wheelock further explained that the International Space Station is only a few hours away from the safety of Earth. NASA is now going to expand and take its current studies and testing of systems to lunar orbit. At this location, the astronauts are going to be a few days away from the safety of Earth, which will allow NASA to prove out those systems in a higher radiation field and a more foreign environment for the astronauts, with more psychological weightiness and isolation.

"The space station is sort of like the equivalent of the old explorers that sailed across the oceans when people thought that the Earth was flat, and there was an edge, and there were dragons out there — the great unknown," said Wheelock. "And so our early explorers just set sail, and the space station is kind of like being in one of those early exploring ships, where they go out just far enough, where they can just barely see land, and they kind of play out there and they do some research. You get the storms that come, there's high seas, and there's the waters over your head. And there's sharks and there are dangers, but you're still sort of within view of land."

In 2010, NASA astronaut Doug Wheelock, Expedition 24 flight engineer, uses a ham radio system in the Zvezda Service Module of the International Space Station.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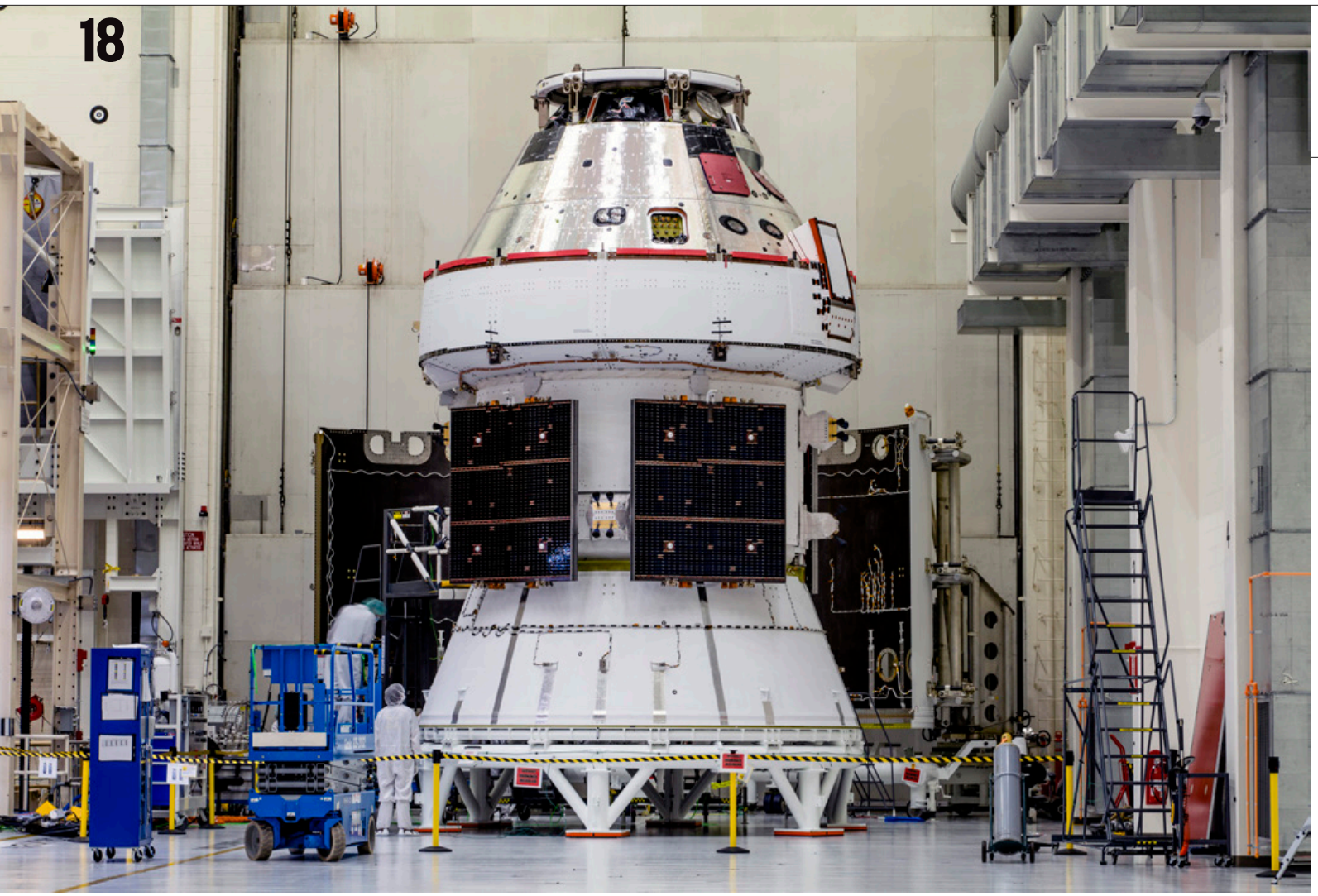
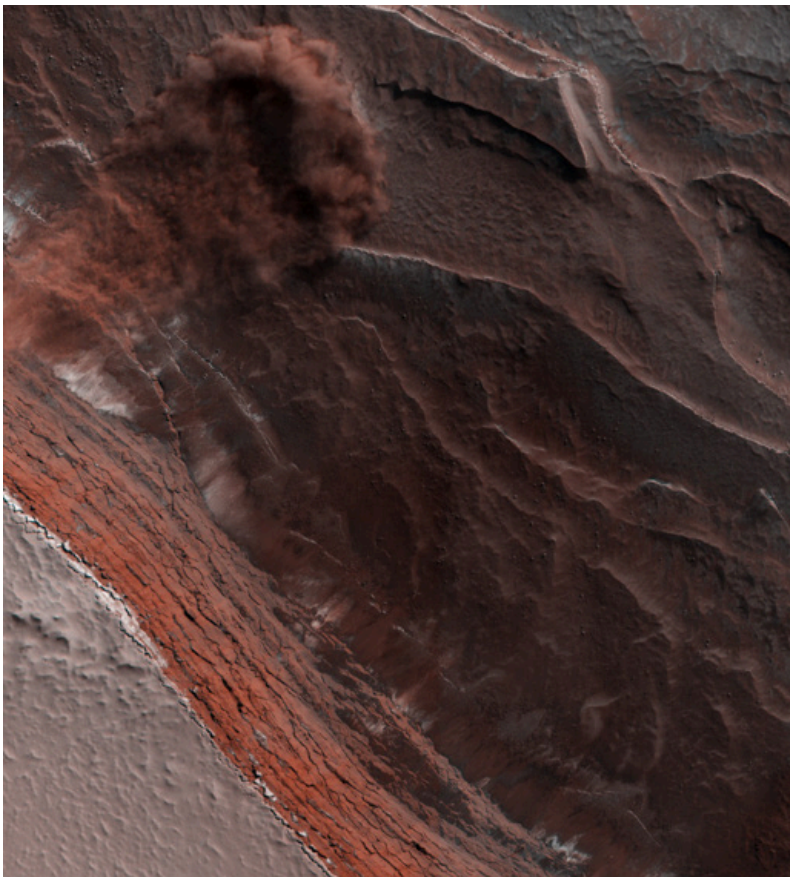




Top: Two of Orion's four solar array wings are exposed and surrounded by the panels that will protect it during launch and ascent. Artemis I will test the Orion spacecraft and SLS as an integrated system ahead of crewed flights to the Moon.
IMAGE CREDIT: RADISLAV SINYAK/NASA

Above: The full moon is pictured as the ISS orbited above the Pacific Ocean. Humans will return to the moon by 2024 as part of the Artemis program.

Left: NASA's Mars Reconnaissance Orbiter captured this avalanche in May 2019. When astronauts journey to Mars, it will be a three-year round trip.

> "We are doing so much with the Artemis program and our commercial initiatives. And the space station is just one part of human exploration. Every day is different and challenging and that's all exciting."
>
> Robyn Gatens

Wheelock says going to the moon is similar, but there will be points when the astronauts can't see Earth depending on where they are on the lunar surface. And then, of course, going to Mars is when astronauts metaphorically set sail, going out beyond the known horizon.

The International Space Station has other key focus areas in addition to enabling exploration. According to Gatens, it establishes the U.S. as a leader in space exploration and is the basis for NASA's international partnerships. NASA is taking that partnership beyond low Earth orbit to the moon and future missions to Mars. Another focus area is research benefits to humanity. NASA allows other government agencies use of the station as well as academic institutions.

"We operate 50 percent of the space station as a national lab," said Gatens. "That's something I think a lot of people don't know. Just like national labs on the Earth, it's available for researchers to use."

The final key area is to enable a commercial economy in low Earth orbit and on the space station. Gatens is focused on utilizing all of these areas at the same time so the space station lives up to its full potential.

It's certain, however, that the International Space Station won't last forever. According to Gatens, NASA has analyzed the structural health of the station and all the components to be operational until around 2030 but is working on extending that analysis to see how far beyond 2030 the facility can go. There are some big pieces of original equipment that would be hard to replace, and NASA does not have similar transporting capability anymore. NASA can retrofit a lot of smaller pieces, and it's doing that all the time and making upgrades. For example, NASA just replaced all the nickel hydride batteries on the space station with lithium ion batteries.

"Eventually we do want to move off the space station, and that's why we're trying to enable companies to build commercial platforms in low Earth orbit that won't be as big or complex as the space station," said Gatens. "But if we can get some commercial platforms in low Earth orbit that we can then transition off of the space station, then that's our plan."

In her new role, Gatens works with administration, Congress and international and commercial partners to develop overall strategy for the International Space Station. "There is a lot going on," said Gatens. "And we are doing so much with the Artemis program and our commercial initiatives. And the space station is just one part of human exploration. Every day is different and challenging and that's all exciting."

After 20 years of service and another decade to come, the space station may be just one part of human space exploration, but it has undoubtedly helped NASA reach this new chapter. The knowledge that NASA has gained over the years about the effects on the human body during extended periods in space is playing a critical role in the organization's strategy to send humans deeper into space and is paving the way for new worlds to be explored. ◂

THE RISING STARS OF ENGINEERING

NINE ENGINEERING ALUMNI TAKE THEIR EDUCATION AND TALENT TO THE NEXT LEVEL

Georgia Tech engineering alumni are catalysts for change around the world and in industries from motorsports to cancer research. Here are just a few Ramblin' Wrecks from each of the nine schools in the College of Engineering who are using their education and talent to drive cutting-edge innovation that makes a difference.

> Daniel Guggenheim School of Aerospace Engineering

TIFFANY DAVIS, B.S. AE '16

Spacecraft Vehicle Engineer, The Boeing Company

After two successful internships with Boeing as an undergraduate, Tiffany Davis was encouraged to apply to the company's exclusive high-potential rotation program after graduating from Tech. For the first two years of her career, Davis worked her way through a variety of departments, from performing structural analysis on defense programs to designing propulsion systems for commercial airlines. Now, she is a spacecraft vehicle manager, combining her engineering work with customer-facing responsibilities for each asset she oversees.

A community service-minded individual from a young age, Davis co-founded a technical outreach program for at-risk students while still at Georgia Tech. She has continued tackling the challenges of STEM retention, especially for minority women, by creating an organization that provides education for children through adults via mentorships, speaking engagements and more.

"When I was young, I always dreamed of going to Space Camp, but my family couldn't afford it," said Davis. "I'm proud to have created the AstroGirls Scholarship Fund to send minority girls on this adventure. Next year, the first two scholarship winners, ages 11 and 13, will attend the camp at NASA's Marshall Space Flight Center free of charge."

> Wallace H. Coulter Department of Biomedical Engineering

MAHDI AL-HUSSEINI
B.S. BME '18, M.S. CS '20

Aeromedical Evacuations Officer, U.S. Army

Right: Mahdi Al-Husseini (left) demonstrates SALUS with co-inventors and fellow Tech alumni Anthony Chen (center) and Joshua Barnett.

As an active-duty U.S. Army medical evacuations helicopter pilot, Mahdi Al-Husseini flies an HH-60M carrying battlefield wounded to nearby military treatment facilities. When these rescue operations are carried out over water, in sloping terrain, or in hostile territory, they are often hoist missions in which the patient is raised carefully into the hovering helicopter — highly dangerous work for all involved.

Along with fellow Georgia Tech alumni Joshua Barnett and Anthony Chen and their company Anti-Rotational Technologies (ART), Al-Husseini invented a novel control technology that stabilizes spinning, oscillating and swaying hoisted loads. The Stabilizing Aerial Loads Utility System (SALUS) uses a reaction-wheel stabilization system more commonly found in spacecraft technology that Al-Husseini and his fellow inventors worked with during internships with NASA. By ensuring better care of patients and higher completion of successful missions, SALUS brings more soldiers safely home to their families.

ART was recently acquired by Vita Inclinata Technologies, with Al-Husseini joining the organization's advisory board.

"Through this new partnership, I will continue to combine my love of machines and desire for a better world by engineering more aerospace and control technology innovations to improve the health and safety of soldiers, search and rescue personnel and aviators," said Al-Husseini.

> School of Chemical and Biomolecular Engineering

SCOTT MCKEE
B.S. CBE '08, M.S. CHEME '09

Professional Staff Member,
U.S. House Committee on Appropriations

Scott McKee's career at the intersection of public policy and science aims to address climate change and help mitigate its substantial economic, environmental and security risk to the future of society. In his previous role on the U.S. Senate Committee on Energy and Natural Resources, McKee played an integral role in moving the U.S. Department of Energy (DOE) Research and Innovation Act into law. This piece of legislation provides policy direction to the DOE based on scientific research, helps foster multidisciplinary research centers across the country to address critical energy issues, and facilitates the movement of these innovative ideas from the lab to the marketplace.

Now, as a professional staffer on the U.S. House Appropriations Committee, McKee manages a portfolio of more than $10 billion in science and energy activities at the DOE, from next-generation nuclear reactors to developing products from captured carbon dioxide to innovations in the electric grid.

"I work to balance political, policy and scientific considerations on how taxpayer dollars should be allocated across many of the programs that were authorized in the law that I helped develop," said McKee.

Scott McKee (center) staffs a hearing on the Department of Energy's role in biomedical sciences, sitting alongside Energy and Water Subcommittee Chairwoman Marcy Kaptur and Ranking Member Mike Simpson.

> School of Civil and Environmental Engineering

GRETCHEN GOLDMAN M.S. EE '08, PH.D. EE '11

Research Director, Union of Concerned Scientists

As a scientist, opinion leader and advocate, Gretchen Goldman is dedicated to advancing the use of science in policy decisions to benefit the public good. In her unique role at the intersection of science, policy, advocacy and mass media communication, Goldman testifies before Congress, appears on major news networks such as CNN and NPR and lectures around the country. Her research analyzing how science is used and misused on topics ranging from hazardous chemical exposure to endangered species protection has improved policy at federal agencies, assisted environmental justice communities,and changed company behavior.

In October 2019, Goldman used her expertise in air pollution and its health effects in Atlanta — acquired during her time at Georgia Tech — to host a never-before-held meeting of experts to help ensure federal air pollution standards protect public health.

"Over the course of the two-day meeting I helped convene, the Independent Particulate Matter Review Panel — a group of 20 independent scientific experts from across the country — produced a comprehensive report to inform the U.S. Environmental Protection Agency's decision on how to best protect the nation from harmful air pollution," said Goldman.

Goldman is also on the leadership board of 500 Women Scientists, through which she leads a team that works to ensure that moms like herself can succeed in science through writings in *Scientific American*, development of policy positions and social media campaigns.

> School of Electrical and Computer Engineering

KENDRICK TREADWELL, B.S. EE '10

Program Manager,
Google Developer Studio, Google

A DeKalb County native, Kendrick Treadwell discovered his talent for planning and organizing at Georgia Tech and sought to create a career capitalizing on this skill in the tech industry. He began working at Google in 2015 as part of a local team responsible for launching and operating the Google Fiber networks in Atlanta and Huntsville. Now, he manages operations of a global team of more than 150 people as a program manager for Google Developer Studio, an in-house creative agency that partners strategically with Google's product areas (e.g. Android, Google Chrome, Google Cloud, etc.) to create content and experiences to educate, inspire and inform software developers around the world.

"I am passionate about diversity, equity and inclusion in the engineering and technology field and invested in keeping Google's culture strong and inclusive," says Treadwell. "For the past four years, I have been co-lead of the Atlanta chapter of the Black Googler Network, an employee resource group that supports Black employees and their allies by fostering success in the Black community at Google and beyond by cultivating Black leaders, empowering communities, and transforming technology."

Treadwell was awarded Google's company-wide Diversity Core Impact Award for outstanding efforts to drive diversity and inclusion at Google and the external communities they serve.

> "I AM PASSIONATE ABOUT DIVERSITY, EQUITY AND INCLUSION IN THE ENGINEERING AND TECHNOLOGY FIELD AND INVESTED IN KEEPING GOOGLE'S CULTURE STRONG AND INCLUSIVE."

Kendrick Treadwell

> H. Milton Stewart School of Industrial and Systems Engineering

STAN CHIA, B.S. IE '05

CEO/Board Director, Vivid Seats

After holding leadership positions at leading e-commerce companies such as Amazon and Grubhub, Stan Chia is now CEO of Vivid Seats, the largest independent ticket marketplace in the country.

"I was attracted to Georgia Tech's industrial engineering program because I thought that systems and process thinking would be broadly applicable in almost any industry and role," says Chia. "Years later, that is still

true, and no matter what problem I'm trying to solve, the tools I gained at Tech remain foundational frameworks."

With Chia at the helm, Vivid Seats has become a strong community contributor in the Chicago area, partnering with Lurie Children's Hospital to bring the resources of the company and employees to aid the hospital's engagement efforts across Chicago. Vivid Seats also supports the ExtraLife initiative of the Children's Miracle Network of Hospitals and local organizations such as Chicago's Honor Flight program, the Mikva Challenge, the Kohl's Children's Museum and SickKids Foundation in Toronto.

Stan Chia

"MY GEORGIA TECH EDUCATION TAUGHT ME HOW TO LEARN, WHICH INSTILLED A FEARLESSNESS TO TACKLE THE PROBLEMS THAT ARE WORTH SOLVING AND THE CONFIDENCE TO START MY OWN TECHNOLOGY COMPANY."

Matthew Smith

> School of Materials Science and Engineering

MATTHEW SMITH, PH.D. MSE '17

Co-founder and CEO, TCPoly, Inc.
Innovation Fellow, Oak Ridge National Labs

While completing his doctorate at Georgia Tech, Matt Smith and fellow Tech alum Thomas Bougher founded TCPoly, a company developing advanced composite materials for the 3D-printing industry. In particular, Smith invented the world's first 3D printing composite that is light, flexible and corrosion-resistant like plastic but conducts heat like metal. The unique property of high thermal conductivity coupled with design flexibility of 3D printing makes the material ideal for a variety of industries, including electronics packaging, mold tooling and heat exchangers in large-building HVAC systems.

As CEO of TCPoly, Smith has helped the company to raise over $1 million in funding from the National Science Foundation, Department of Energy and private investors. TCPoly has customers in over 20 countries and was recently named one of the Top 10 Most Innovative Technology Companies in Georgia by the Technology Association of Georgia (TAG).

"Georgia Tech provided me with the confidence to invent new things and the mindset that most problems can be solved through technology innovation," said Smith. "My Tech education taught me how to learn, which instilled a fearlessness to tackle the problems that are worth solving and the confidence to start my own technology company."

> George W. Woodruff School of Mechanical Engineering

CHRIS GOLDER, JR., B.S. ME '04

Shock Engineer, Hendrick Motorsports

Chris Golder, Jr., acquired his love for automobiles and motorsports from his father, who owned an auto repair shop in Atlanta for over 35 years.

"Growing up, I restored classic cars, raced go-karts, and attended races with my dad," says Golder. "While attending Georgia Tech, we also engineered and built our own racing truck and competed at short tracks in North Georgia, including Lanier National Speedway."

After graduating, Golder began working for Hendrick Motorsports — one of America's premier sports series — in Charlotte, NC, first working solely on the Hendrick Motorsports 9 Team before transitioning to support all four of the company's cars in NASCAR's Cup Series. He uses computer-based modeling, simulation tools and testing apparatus to optimize the performance of the race cars, focusing on incremental gains in areas such as increasing tire grip and downforce by fractional, yet meaningful, amounts.

For the last 16 years, Golder has spent 10 months of each year traveling to races across North America working to deliver cutting-edge technology to Hendrick's team. He has worked closely with some of NASCAR's most well-known drivers, including Jeff Gordon, Dale Earnhardt, Jr., Kyle Busch and Chase Elliott.

Chris Golder, bottom far left

> School of Nuclear & Radiological Engineering & Medical Physics

KELLY KISLING, PH.D. NRE '08

Assistant Professor, UC San Diego School of Medicine, Medical Physicist, UC San Diego Health

As an undergraduate at Georgia Tech, Kelly Kisling shadowed a medical physicist in Georgia to see what life on the job was like using the principles of physics and high-tech science to help people.

"As a medical physicist myself now, my research uses artificial intelligence (AI) to deliver better radiation therapy more efficiently, using less resources, with a special focus on breast cancer, the most common cancer in women in the U.S. and worldwide," says Kisling. "These AI-designed therapies are more efficient and improve on traditional treatment planning."

Kisling also works to improve access to radiation therapy globally. As part of her Ph.D. research, she partnered with two cancer centers in South Africa where these automation tools were being tested. She participates in training programs for radiation oncologists all over the world through the International Atomic Energy Agency and works with a South African hospital to train doctors at a cancer center in Uganda to use these new tools.

> **"AS A MEDICAL PHYSICIST MYSELF NOW, MY RESEARCH USES AI TO DELIVER BETTER RADIATION THERAPY MORE EFFICIENTLY, USING LESS RESOURCES, WITH A SPECIAL FOCUS ON BREAST CANCER, THE MOST COMMON CANCER IN WOMEN IN THE U.S. AND WORLDWIDE. THESE AI-DESIGNED THERAPIES ARE MORE EFFICIENT AND IMPROVE ON TRADITIONAL TREATMENT PLANNING."**
>
> Kelly Kisling

INDUSTRY SECRETS

FOR THESE FIVE ENGINEERING FACULTY, TIME SPENT IN THE PRIVATE SECTOR PROVED TO BE INVALUABLE

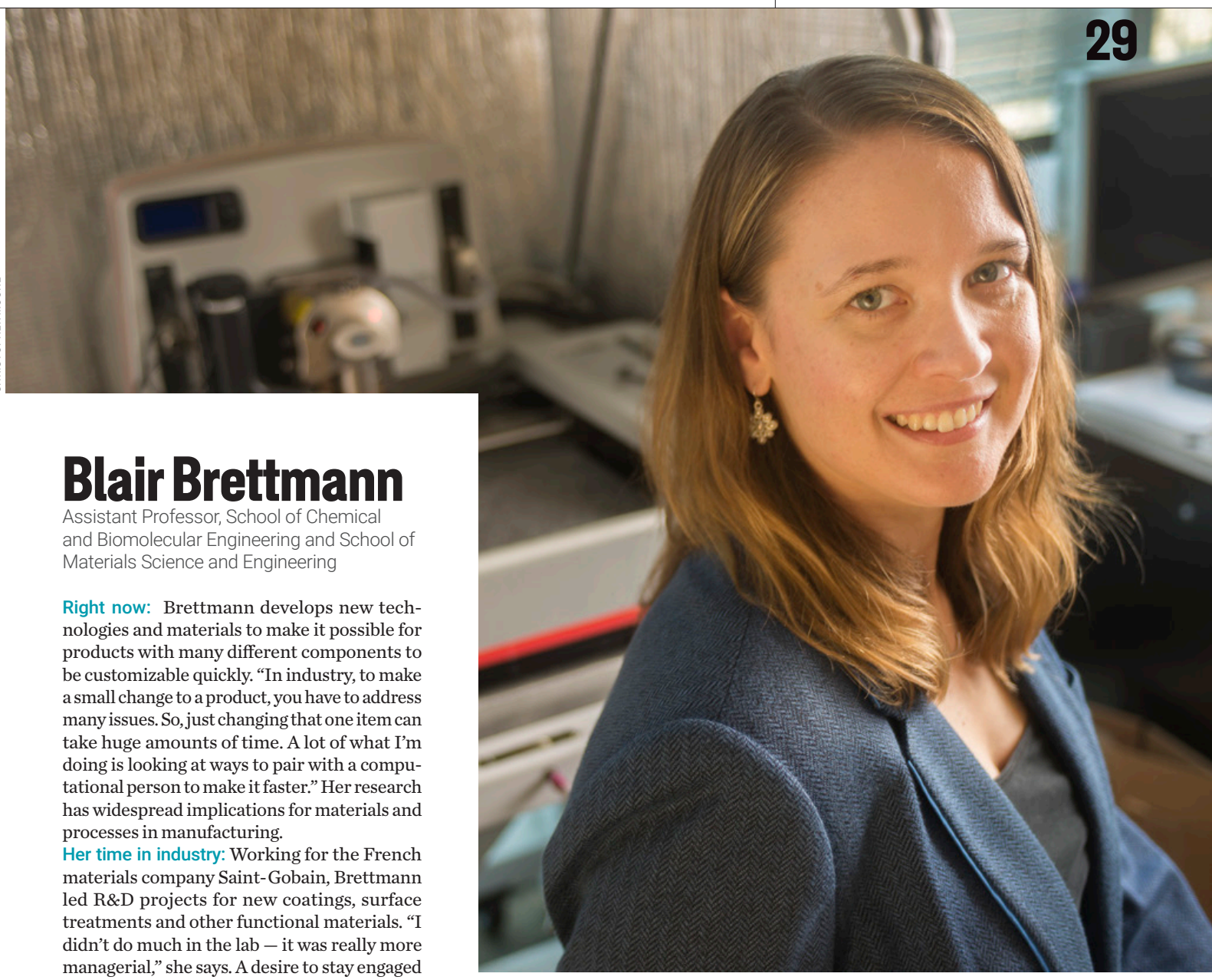
They are two worlds, culturally apart, different as night and day. One is viewed as a calling to the curious, a realm of enlightenment; the other, an answer to marketplace needs, an engine of economics.

Academia and industry. Campus vs. corporate. Exploration for new knowledge — or to move a company or industry forward.

But for many College of Engineering faculty, such shorthand dichotomies are false. Every day, they show up for work to conduct sophisticated research, teach classes, mentor students and serve on committees. They live the life of the scholar-instructor, yet they bring something extra: the experience of working in the private sector, in all its relentless pursuit of fast results and shareholder value.

This experience, they say, generated reward in several forms. Time spent in industry yields valuable lessons to share in classrooms and labs. Here are a few. ▶

WORDS: MICHAEL BAXTER



CHRISTOPHER MOORE

Blair Brettmann

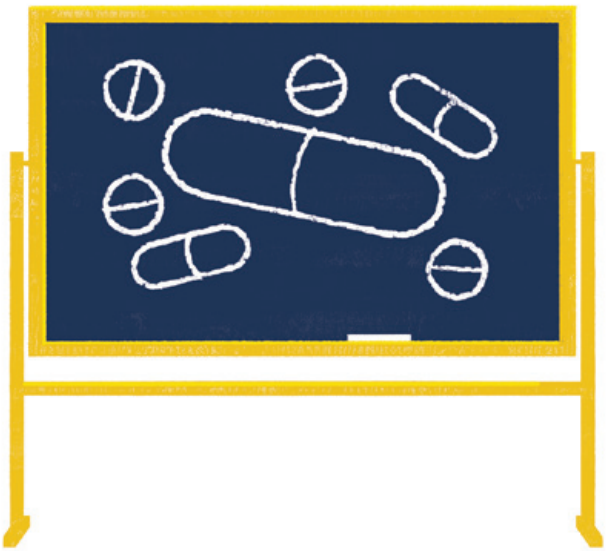
Assistant Professor, School of Chemical and Biomolecular Engineering and School of Materials Science and Engineering

Right now: Brettmann develops new technologies and materials to make it possible for products with many different components to be customizable quickly. "In industry, to make a small change to a product, you have to address many issues. So, just changing that one item can take huge amounts of time. A lot of what I'm doing is looking at ways to pair with a computational person to make it faster." Her research has widespread implications for materials and processes in manufacturing.

Her time in industry: Working for the French materials company Saint-Gobain, Brettmann led R&D projects for new coatings, surface treatments and other functional materials. "I didn't do much in the lab — it was really more managerial," she says. A desire to stay engaged in technical work and to mentor students led her back to campus.

Takeaways from the private sector: "One of the best things to come out of my industry work is project management," Brettmann says. "As a principal investigator, I now have seven different research projects. But as a postdoc I only had to focus on one or two things at a time. My industry experience helped me manage better."

Some say the grass is greener: "I like to joke that when you're in industry, you see academics as rich because of the fancy equipment they have. And academics see industry as rich because they have more money to pay people. Also, university researchers focus on getting their name out there, getting funding, helping students. In industry, there's a lot of time pressure to get a product out the door."



CANDLER HOBBS

David Frakes

Associate Professor, Wallace H. Coulter Department of Biomedical Engineering and School of Electrical and Computer Engineering

Right now: The Frakes Lab at Georgia Tech is brand-new — he arrived at his *alma mater* in the summer of 2020 — but its focus is to explore and model new kinds of medical devices. One noteworthy niche: He aims to design devices that fit and work across a population of patients by testing the devices on thousands of virtual people. "Machine learning is in everything these days," he says. "If you have data, you have a big advantage."

His time in industry: In the early days, it was hedge fund management on Wall Street. Later came a five-year stop at Google, where he spearheaded mobile imaging projects. Most recently, Frakes led an Apple team that developed algorithms driving the camera software inside the iPhone 11. Along the way, he even started two companies.

Takeaways from the private sector: Frakes runs his lab like a startup: with quarterly objectives, "go and no-go" decisions and a sense of urgency. "In academia, there may not be a clear finish line on the calendar or work plan," he observes, "but in a startup, your time is not infinite. You only have so much runway." This entrepreneurial approach to research, he adds, is appealing to students. "It's just fun to have skin in the game in the lab every day."

The 'village in the room': At Arizona State, Frakes helped launch the BRAIN Center, an industry-university research collaborative to develop neurotechnologies. He's applied for National Science Foundation funding to do the same at Georgia Tech. The new center would engage multiple companies with a large group of faculty from engineering and other disciplines. "It takes a village to go after certain problems," he says. "With this center, we'll be getting a lot of subject matter experts in the room to work on problems too big for any one of them to solve alone."

Emily Grubert

Assistant Professor, School of Civil and Environmental Engineering

Right now: Big decisions are made in operating big infrastructure like energy, water and transportation systems. Grubert's research combines decision-support tools with opinion research to improve how those big decisions are made. She generates a deeper, clearer picture of various options, making it easier to compare one against another.

Her time in industry: Stints at McKinsey and Pacific Gas & Electric gave Grubert an up-close look at massive infrastructure systems and helped her develop scenario-based models to guide decision-making. "I chose McKinsey because I wanted to work with refineries, power plants, mining companies and other big infrastructure [entities] in a way that didn't require me to go work for them," she says. "So, in my interview, I let them know I would quit in a couple of years to get a Ph.D."

Takeaways from the private sector: "On the academic side, we tend to under-value process and governance in decision-making," Grubert says. "We focus on a few facts — we'll do an analysis and say, 'option X is 20% better.' But that doesn't mean that the 'better' option will be what someone in industry will choose because there are other considerations. There's a whole lot more to decision-making on the private sector side."

The perfect-fit field: "Interdisciplinary" is an important word to Grubert, and she was glad to find that Georgia Tech embraced a multi-disciplinary view of research. "I view engineering as a way to apply science to help people thrive in the world, and that includes social science," says Grubert. "Once you start working in civil and environmental engineering, it's amazing how important social science is, because you're working with so many people."

AMELIA NEUMEISTER

Mohit Singh

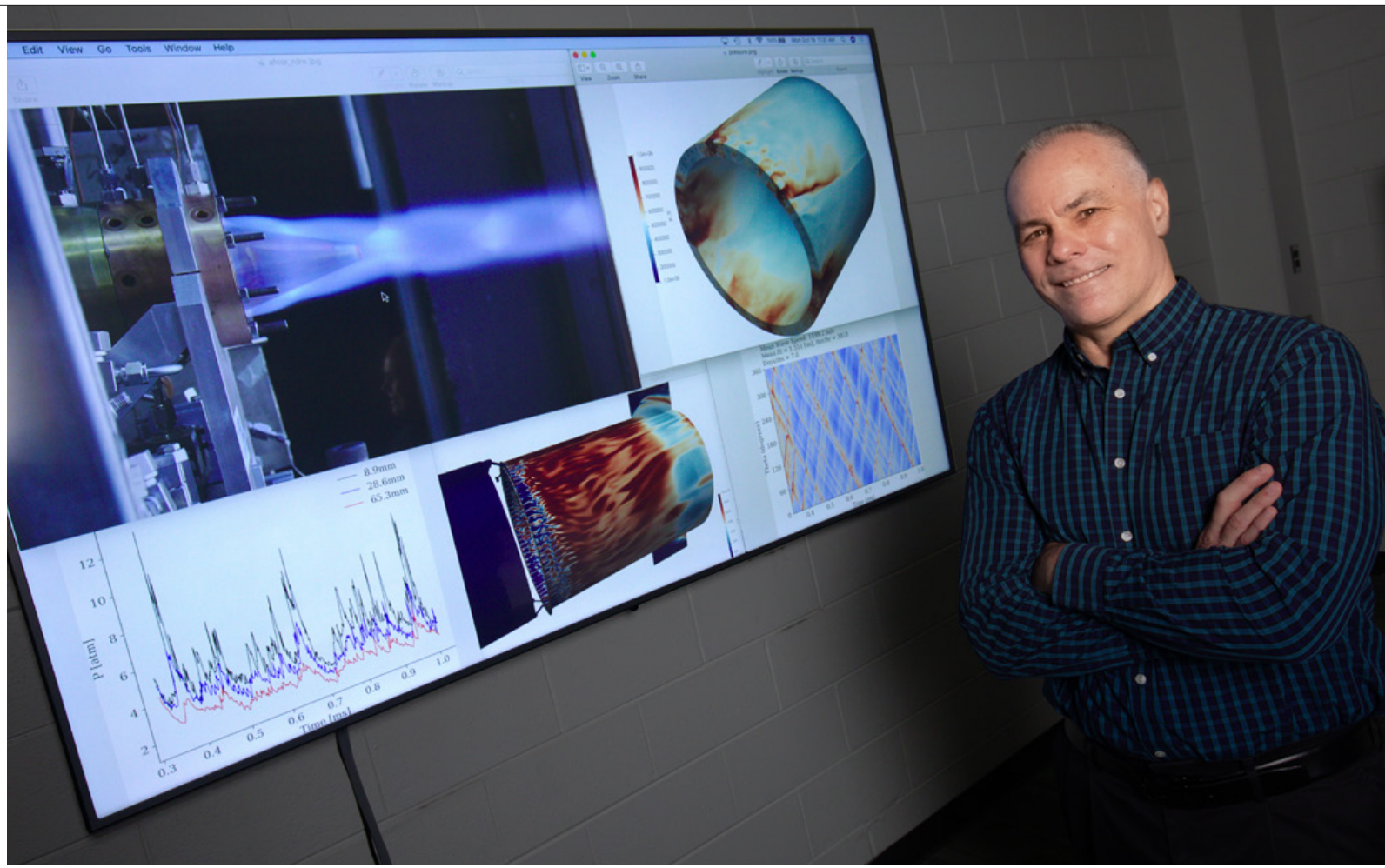
Associate Professor,
H. Milton Stewart School of Industrial
& Systems Engineering

Right now: Singh conducts research to improve decision-making, employing a highly mathematical approach. A large part of his exploration involves designing algorithms to arrive at discrete decisions using fixed variables to decide this-or-that, very quickly. Significantly, he's moving the field into new ways of using open-data variables to inform the algorithms, thus bridging the separate worlds of "discrete and continuous optimization."

His time in industry: In a seven-year stint for Microsoft, Singh worked to optimize the process for deciding how data from cloud computing customers should be distributed across computer servers. Factoring in high-demand times, storage needs and other variables, he helped develop frameworks that determined server access, optimizing for both the client and server performance.

Takeaways from the private sector: Industry inspires much of Singh's research. "I'm currently working on a lot of optimization problems," he says. "And, apart from being fundamental and theoretical in nature, so many of them are motivated by what comes in practice. I want to look at relevant problems."

The difference is the students: A major motivating factor in Singh's decision to come to Georgia Tech was the opportunity to guide and mentor students. Most undergraduates don't do much research, "but you see them grow and develop their own vision." Graduate students can work on problems for several years. However, in industry, "you only have interns, and you don't get to see them grow over time."



Joseph Oefelein

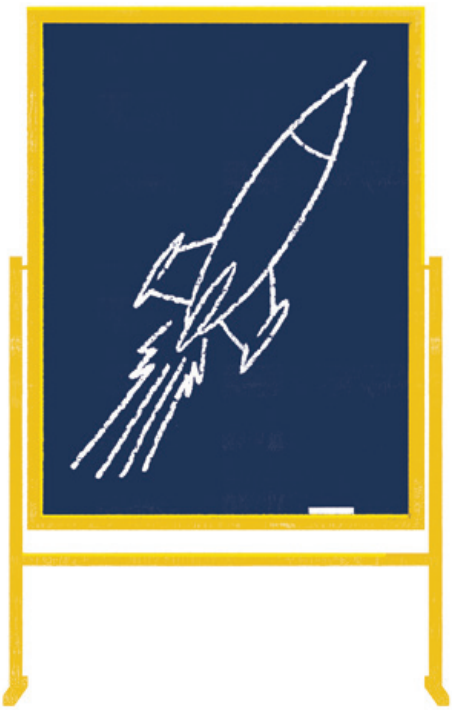
Professor, Daniel Guggenheim School of Aerospace Engineering

Right now: Oefelein uses ultra-powered computing and algorithms to create highly sophisticated simulations of propulsion and power systems such as liquid rocket engines. His simulations and models reveal the interplay between turbulence and the complex physical processes in combustion. The goal is to find new ways to optimize these systems.

His time in industry: Seventeen years with a national laboratory may sound like a government job, but Oefelein's career with Sandia National Laboratories had him in constant partnership with private industry, working with researchers in energy science to improve the predictability of combustion models. During this time, he always kept an eye on how those models could inform the design of different types of piston, gas turbine and rocket engines manufactured for automobiles, trucks and aviation and space vehicles.

Takeaways from the private sector: "In the classroom, a lot of times I can just naturally answer a question like, 'Why do I need to learn this?'" Oefelein says. "Not only can I share real-world experience and observations with students, I can give a perspective right away, and in a natural way." Like the other engineering faculty, the ability to work with students was a motivating factor to return to a campus.

You can't learn if you don't share: Having experienced academia, government and industry, Oefelein has a perspective on how all three can work together to address some of the intractable problems facing humankind. "Understanding comes from sitting down with colleagues in different sectors and being able to appreciate all the pros, cons and constraints," he says. "The more communication that occurs, the better off everyone will be."



in the field

An Elephant Researcher Never Forgets

Andrew Schulz takes an inclusive approach to his innovative research on elephant biomechanics

Q. How do you know when an elephant is leaving on a trip?
A. It has packed its trunk.

Andrew Schulz is dedicated to *unpacking* the elephant trunk. The Ph.D. student in mechanical engineering is scrutinizing the biomechanics of the pachyderm's muscular marvel and translating his discoveries into not only robotic applications but also conservation measures to safeguard African elephants in the wild. Through his research in mechanical engineering Professor David Hu's Laboratory for Biolocomotion, collaborations with Zoo Atlanta, outreach with an elephant sanctuary in South Africa and creation of the GaTech4Wildlife course, Schulz is a role model for research that's equally innovative and conscientious.

"When I started my work, I wanted to avoid the path that a lot of traditional research into large animals has taken, called parachute science," he explains. "It's when a scientist drops into a location, takes up the time of the people on the ground who know the situation best, and then leaves without giving them credit or sharing the results or resources they helped create. It's a big problem. I didn't just want to address it myself, but educate others on how we can take a better approach."

Schulz's fascination with the *Loxodonta africana*, or African bush elephant, began as a high schooler while on a safari in South Africa. "It was sheer awe," he says. "You realize just how large they are in every respect." That includes the trunk, which measures between six to nine feet in length and weighs up to 330 pounds. Scientists are still researching the number of muscles in the trunk; estimates have ranged from 30,000 to 150,000 (humans have around 600). The trunk has no bones or joints but does have a second "finger" at its tip, which works as an opposable thumb for grasping objects and can pick up an object as small and delicate as a tortilla chip without breaking it. Schulz's research strives to understand how the trunk is able to maneuver in such varying and complex ways.

Through his studies of a female African elephant named Kelly at Zoo Atlanta, Schulz discovered that the trunk can elongate 25 percent longer than its hanging length. "That might not seem like much," he says, "but it's the equivalent of growing from the height of actor Kevin Hart, who is 5 feet, 4 inches tall, to basketball player LeBron James, who is 6 feet, 8 inches tall." The secret to the stretch seems to lie not just in the trunk's muscles but also in its folds of slack skin, which appear to provide protection from heavy forces or loads. "This contributes to the trunk's ability to be both flexible and strong," he says. That combination is crucial in the development of "soft robotics" that use materials such as silicone instead of metals.

Schulz's research could also be used to help reduce negative human-elephant interactions in the wild. For example, farmers could install fences at spots that put crops beyond the reach of an outstretched, versus a hanging, trunk. Schulz focuses on creating such research-driven solutions for real-world problems faced by conservationists in GATech4Wildlife, a course he designed and teaches through the VIP (Vertically Integrated Projects) Program. The program brings together undergraduates from various disciplines, years and backgrounds to work with faculty and graduate students on long-term, large scale projects. The GATech4Wildlife students work in teams — in consultation with conservation experts — to develop interventions to aid in the preservation of various species. "We draw together engineers, scientists, business majors and other students from across the Georgia Tech campus to develop these interdisciplinary projects that benefit wildlife conservation," he explains.

Andrew Schulz with team of docents at Zoo Atlanta

This "all are welcome" approach is a core value for Schulz. As a two-term president of the Mechanical Engineering Graduate Association, he has strived to create an inclusive and supportive environment for students of all backgrounds. In his own research as well as his students' projects, he makes a concerted effort to closely work with all the stakeholders on the ground in Africa and elsewhere. His students are currently collaborating with the director of Adventures with Elephants, an elephant reserve in South Africa, to develop additional interventions to reduce negative human-elephant interactions.

"Studying elephants requires a huge team of people, and Andrew is a natural leader of this team," says Hu, Schulz's advisor and director of the Hu Lab. "He's the glue holding this project together."

Schulz and his students have other projects beyond the elephant kingdom. He will translate his research into panda climbing biomechanics into an app that enables panda handlers in China to assess the climbing skills of panda cubs. His class is evaluating the wildlife ecosystem on the Georgia Tech campus and contemplating how the use of camera traps baited with medicated biscuits could vaccinate foxes for rabies. They're also developing inexpensive feeders for gorillas at Zoo Atlanta, where Schulz spends his time not only as a researcher but as a volunteer docent. "The keepers have given me so much of their time," he says. "It's important to me to give back to all of the organizations that help with my research."

The time he spends at the zoo — with not only the animals and keepers but the visitors he educates — further fuels Schulz's conservation mission. "It makes you want to figure out how you can use your skills and resources to help save these species," he says. "For me, that's through engineering. I want to inspire other engineers to apply the tools they've learned through Georgia Tech to help preserve these magnificent animals for future generations."

To learn more about Schulz's research visit schulzscience.com.

▶ KRISTIN BAIRD RATTINI

Growing Guatemala's Craft Beer Industry

Jorge Guzman uses his industrial engineering and problem-solving background to bring craft beer to his hometown

Growing up in Antigua, Guatemala, Jorge Guzman (ISyE '09) was taught the importance of earning a college degree by his mother and father. While his father in particular thought engineering would be a good career choice, Guzman was not really sure what he wanted to do.

Then, during Guzman's first time flying in business class on a stand-by ticket when he was around 11 years old, he sat next to a well-dressed businessman. From across the aisle, Guzman's father encouraged him to introduce himself and ask the man what he did for a living.

"It turns out I was sitting next to Ivan Ochoa, then a vice president for American Express, and a Georgia Tech alumnus who majored in Industrial and Systems Engineering," recalls Guzman. "From that moment on, I had it stuck in my head that this is what I wanted to do, too."

After coming to the U.S. at age 18 to begin college at the University of North Carolina at Charlotte on a tennis scholarship, Guzman could never quite shake that memory of that meeting with Ochoa and the feeling that the path he needed to be on was in Georgia. Two years later, he transferred to Georgia Tech and began his education at the H. Milton Stewart School of Industrial and Systems Engineering (ISyE).

A Strong Foundation for Entrepreneurship

After graduating in 2009 and spending several years in investment banking and consulting in Atlanta, Guzman felt he was ready to take the plunge into starting his own business.

"There is a huge connection between ISyE and entrepreneurship — you're building

"AT THE TIME, GUATEMALA HAD NO CRAFT BREWERIES AT ALL, SO THE MARKET WAS BOTH CHALLENGING AND RIPE WITH OPPORTUNITY FOR GROWTH. WE ALSO KNEW NOTHING ABOUT THE BREWING PROCESS, SO WE WERE STARTING FROM SCRATCH IN A LOT OF WAYS."

Jorge Guzman

upon what has already been built and looking to improve it in some way," said Guzman. "Both of my parents are entrepreneurs — my mother owns a ceramic and tile business and my father owns a Spanish school — and in the Latin American culture there is a strong ambition to make your own business or to improve on something your family has already started. Entrepreneurship has always been a goal for me."

Because entrepreneurship can be a lonely path, Guzman wanted to find a business partner. One of his best friends at Tech, Taylor Virgil (ISyE '09), was working at Lockheed Martin, and they met up every year at homecoming. It was during one of those meetups when their conversation about going into business together began.

The two mulled over what kind of business might suit them, and in 2012 they were in Portland, Oregon, to see about starting a tourism company in Guatemala. They sat down for a craft beer at Deschutes Brewery when Guzman posed the question: Instead of a tourism company, why not start a brewery in Antigua, Guatemala? It was right after that trip that Jack Spehn (ISyE '10), also a friend from undergrad, joined the dream to build a brewery.

"At the time, Guatemala had no craft breweries at all, so the market was both challenging and ripe with opportunity for growth," said Guzman. "We also knew nothing about the brewing process, so we were starting from scratch in a lot of ways."

Shortly thereafter, Guzman happened to meet Glenn Golden, founder of Jailhouse Brewing Company in Hampton, Georgia. Through their friendship, Guzman quit his consulting job to work for Golden at Jailhouse so he could learn everything he could about the brewing process and the business behind it.

In 2017, Antigua Cerveza opened its doors in his hometown, the beautiful colonial city of Antigua, Guatemala, making it the city's very first craft brewery.

"Because the general knowledge of craft beer in Guatemala is limited, we were starting from zero in a way — having to explain the basics of what makes beers different to customers," said Guzman. "We have to be very creative in how we market and distribute our products because small-owned breweries were such a new concept."

Tapping into Growth Opportunities

Since Antigua Cerveza began four years ago, they have doubled sales every year. Guzman owes much of his company's success to the team's dedication and hard work, but also to Georgia Tech — not only through the knowledge gained through his ISyE degree, but also through his connections: 40 percent of Antigua Cerveza's capital investors were Tech alumni, and several of them were classmates.

"Studying at Georgia Tech was one of the hardest things I've ever done, but it was also one of the most motivating," said Guzman. "The competition and camaraderie of those I studied with made me believe I could achieve anything. As we navigated completely unchartered territory of opening a microbrewery, the resilience and decision-making skills I developed at Tech pushed us along to now have the most recognized craft brewery in Guatemala."

Antigua Cerveza's beers — a blonde ale, an American amber ale, an IPA and a stout — can be found at their main beer garden and taproom in downtown Antigua. They are also in two taprooms in Guatemala City and at a host of restaurants and bars throughout Guatemala. The 25-person company plans to expand into other Central American countries, and they are also fielding requests from the U.S., so keep your eyes peeled for an Antigua Cerveza beer the next time you are out on the town or traveling through Central America.

▶ KATHRIN HAVRILLA-SANCHEZ

Decisions, Decisions...

How systems engineering and medical decision-making play a role in public health

Social distancing in the college classroom during the Covid-19 pandemic can be tricky. In fact, with a technique called mathematical optimization, getting to the correct number of students for a room sounds a lot like a math word problem you might see on an SAT test: if a classroom has 5,900 square feet of space and can normally hold 305 students, how many students can the room hold if everyone must be six feet apart?

Lauren Steimle and a team of researchers across a number of disciplines at Georgia Tech are trying to solve this problem, and there is more than just math that must be considered when coming up with the safest spacing out of students.

"In addition to figuring in number of students and square feet of space, you also have to consider the seating areas that are near high activity areas, such as aisles or doors, or the location of the professor," said Steimle, assistant professor in the H. Milton Stewart School of Industrial and Systems Engineering. "So, if you are estimating the number of students who can safely fit in a classroom, it is actually quite lower than you might think based on raw mathematics."

Safely returning to campus for many colleges and universities across the U.S. has been a high-stakes decision — administrators are having to strike a balance between the quality of education and the health of students, staff and faculty. There are the financial implications for institutions as well to take into consideration. Teaching options range from smaller, in-person lectures and labs; hybrid models so the classrooms are never at full capacity; and, of course, fully remote options. At many universities, semesters have been shortened and travel discouraged, asking students to remain on campus to keep everyone safe.

> **"OUR ULTIMATE GOAL IS TO QUANTIFY PUBLIC HEALTH RISKS, RESOURCE NEEDS AND COSTS, IMPACT ON STUDENTS, FACULTY AND STAFF, AND THE REVENUE IMPLICATIONS FOR HIGHER EDUCATION INSTITUTIONS AS THEY EVALUATE SCENARIOS AND CONTINGENCY PLANS FOR RETURN-TO-CAMPUS DURING THIS ACADEMIC YEAR."**
>
> Lauren Steimle

"Our research group has been investigating these questions using a systems approach," said Steimle. "Our ultimate goal is to quantify public health risks, resource needs and costs, impact on students, faculty and staff, and the revenue implications for higher education institutions as they evaluate scenarios and contingency plans for return-to-campus during this academic year."

Steimle's research group, which includes collaborators Dima Nazzal and Natashia Boland within ISyE, as well as researchers in the College of Computing, is using analytics and systems modeling approaches to help colleges and universities make informed decisions about returning to campus. The group has a Github page — a company that provides hosting for software development — that offers algorithmic code and tools for anyone to use to investigate these operational issues for their own campuses.

"It's tough because you can't just rely on the numbers or modeling; rather, you have to make a decision based on so many different factors including human behavior," said Steimle. "Higher ed institutions almost need a pandemic consultant — someone who can go in and say, 'Well, here are all of the decisions that you need to make, and here are the various scenarios for in-person versus hybrid and online learning.'"

Steimle goes on to add that universities have to consider limited resources, such as teaching staff and instructional space, which are generally constrained even in non-pandemic times.

"The number of instructors that can provide in-person instruction and the amount of space you have after adjusting for physical distancing will dictate many of the other decisions regarding course modes and classroom to course assignments," explained Steimle. "The course modes will impact how students register and the number of students that you expect on campus, which in turn will influence the amount of resources you need for public health measures like testing and contact tracing. These decisions are interrelated, which is why a systems approach can be useful.'"

Medical decision-making and public health are what brought Steimle to Tech. In addition to her work with Covid-19 modeling pertaining to classroom safety, she's also involved in modeling

prevention and treatment of diseases, such as vaccine modeling for diseases like norovirus.

"A lot of medical decision-making is about getting the right treatment to the right patient at the right time," said Steimle. "You also have to weigh the benefits of the treatment against side effects, so a lot of factors go into making smart decisions when it comes to healthcare. Mathematical models can help us consider many options and scenarios around treatment decisions to help us better weigh these benefits and harms in a way that considers uncertainty."

For norovirus, Steimle was part of a team that looked at populations who should be targeted for a vaccine. Noroviruses are the leading cause of acute gastroenteritis in the United States. Early results for norovirus vaccines in clinical trials have been promising, but there are still open questions as to the most cost-effective use of these potential vaccinations. Medical decision-making models can help determine which high-risk groups should get the vaccine first — the elderly who are a mortality risk or young children who spread the virus.

"We're looking at the health and economic implications of these decisions to see if it's worth it to vaccinate certain populations," said Steimle. "You're trying to make the most of your resources from a public health perspective, especially when vaccines cost money and you want to use your resources in the best possible way to get the most 'bang-for-your-buck' in terms of health outcomes."

Steimle came to Tech, in part, because Atlanta is known by many as the public health capital of the world. The CDC, Emory School of Public Health, the Atlanta VA, Morehouse School of Medicine, and of course bioengineering at Tech are all prominent organizations that attracted her to the city from her home state of Illinois.

Steimle's passion for public health began because her family was in the medical field. She would often join her mother at the hospital and saw first-hand the way doctors can have an impact on people's lives. So when she left for college, she figured she'd study to become a doctor. But plans changed quickly.

"When I watched my first surgery, I almost passed out after," recalled Steimle. "I wanted to find other ways to contribute to the health of others that didn't involve cutting people open. I knew I liked science and math, and in college I discovered I could merge those interests with healthcare, and here I am."

Systems engineering resonated with Steimle, as well as the psychology of decision-making. So, whether it's novel viruses like Covid-19, the norovirus, or other medical therapeutics, Steimle is game to provide decision-makers with data-driven tools to support their decision-making processes around treatment.

"I've always been very interested in our human decision-making processes," said Steimle. "As humans, we are flawed, and it's interesting to think about how that might translate to healthcare and how some of our biases or mental heuristics can come into play. That's kind of what led me to systems engineering: learning how to make better decisions and then hopefully being able to translate that to a setting that helps people, and healthcare is a great place to do that."

▶ GEORGIA PARMELEE

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10 TO END

10 Questions with Yassin Watson

Co-founder of GT-e Distance Running Team and an Alzheimer's researcher, Yassin Watson holds two undergraduate degrees from Georgia Tech, one in industrial engineering and one in biology. Involved in many labs and clubs across Tech, Watson sits down with *Helluva Engineer* magazine to answer a few questions about his time at Tech.

1 ▸ What about Georgia Tech made you decide to attend? Being a first-generation college student and native Atlantan, I chose to study industrial engineering in the country's top program at Georgia Tech. After my Senior Design project with a medical device manufacturer, I decided to pursue an additional degree in biology to cultivate my passion for the scientific side of healthcare. **2** ▸ Who do you admire? Through my social justice minor coursework, studying people like Harriet Tubman taught me that risking everything, including your own safety, is worth mutual liberation, and I hope to emulate the unmatched strength she had in her selfless commitment to others. **3** ▸ What have been some of your takeaways as a Diversity Ambassador for Georgia Tech? Diversity and inclusion discussions are almost always polarizing to people since they usually involve an individual's personal sense of normalcy. And when our perspective is called into question, it can feel like an attack on who we are. But a core tenet of advancing social equity is the necessity of discomfort...it requires having the patience and empathy to realize that all people are a product of the specific experiences that decorate their individual journey through this life. **4** ▸ How does the intersection of engineering and medicine play into your long-term career goals? I plan to continue my education and work experience in both engineering and the biological sciences to be the first Yellow Jacket astronaut to enter this line of work as a physician specializing in aerospace medicine. I aspire to be a physician who will do absolutely anything and everything required to ensure the health and well-being of my patients. **5** ▸ How has your Alzheimer's research provided you a perspective on what needs to be done to help prevent this disease? Alzheimer's is personally significant to me since my late father suffered from the condition throughout my childhood until his passing. Through my research, I have become very excited about the advancement of Machine Learning, particularly as it is being leveraged to resolve aggregate trends in neurocognitive medicine. **6** ▸ As a teaching assistant, did you enjoy being in the classroom and do you think that you might pursue an academic career? My experience as a TA for a diversity-and-inclusion-themed current events course made me certain that I will further pursue teaching in some capacity. In that role, I made cherished life-long friendships with my instructor, fellow TAs and a few of my students! **7** ▸ Much of your young adulthood has been spent giving back and serving others. What motivated that? When I was 11 years old, I awoke before sunrise on a sweltering Saturday morning to provide food donations to underserved populations in Clarkston, GA with the rest of my Sunday School class. We were fasting in observance of Ramadan, and although we were handing out chilled refreshments all day, we were unable to quench our own thirst. But the gratitude of those we served was more than enough nourishment to sustain my spirit as I learned a lesson that I have carried with me ever since: that even when facing my own challenges, dutiful service to fellow human beings is the rent I will always pay for my room here on this earth. **8** ▸ Tell us about your involvement in Veggie Jackets and the GT-e Distance Running Team. Veggie Jackets is a huge community of students passionate about leading a plant-based lifestyle. The unshakably sacred fragility and inherent value of life in all forms has been apparent to me since a very young age. Furthermore, the GT-e Distance Running Team is a group of ISyE students and faculty dedicated to training for and participating in running events, primarily put on by the Atlanta Track Club. **9** ▸ What does social innovation mean to you and why is it so important? Social innovation, to me, is the collective effort to improve the lifestyle conditions of as many beings as possible. To build something robust, sustainable and just, diversity of every kind is necessary. This is the foundation of true innovation, applicable even beyond social work. **10** ▸ How do you handle all your passions as well as demands of being a student at Tech? From my first job as an industrial engineering intern, I learned to apply Key Performance Indicators to my personal life. As a result, I have kept fine-detailed logs of how I spend my time. And I am a huge fan of calendars!

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parting shot

Ten new Clark Scholars arrived on campus this summer as first-years ready to take on the world.
PHOTO: CRAIG BROMLEY