

we are **engineers**

FALL 2019

▶ **GEORGIA TECH COLLEGE OF ENGINEERING**

What do
**CHICKENS,
TRAFFIC
& ROBOTS**
have to do with
ENGINEERING?

- 
- ▶ **HELPING GEORGIA'S STUDENTS TAKE FLIGHT**
 - ▶ **TECH'S IMPACT ON BIG CHICKEN**
 - ▶ **MAKING NEIGHBORHOODS SAFER**



IT'S A STATE OF MIND

ENGINEERING ACROSS GEORGIA

Friends of the College,

When Georgia Tech opened its doors in the fall of 1888, it was due in a large part to a number of prominent citizens who strongly believed that Georgians needed technical training to advance the state's industry beyond agriculture. That commitment to the state and its industries has never wavered, as you will see in the pages of this issue.

Our motto of "Progress and Service" stretches across the state, enabling communities from Augusta to Brunswick to do great things. But many folks don't associate Georgia Tech with the state of Georgia, especially when it comes to creating or working with local individuals and businesses. In reality, the College of Engineering plays an important role in helping people start new businesses and improve existing operations with technical efficiencies. Our College is an integral part of Georgia's economic growth. Not only are we heavily involved in manufacturing, our alumni are working in areas to serve rural communities and in ways to make the state more "business friendly."

Our research and people have a statewide impact, not limited to economic prosperity and development, but we strive to improve such areas as safety, health, transportation and education for a better Georgia. And while our physical location may be Atlanta, we wholeheartedly embrace our statewide mission to improve the human condition in Georgia.

Steve McLaughlin

DEAN & SOUTHERN COMPANY CHAIR
COLLEGE OF ENGINEERING

@gtengineerdean on Twitter

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Above: Tifton Quality Peanuts facility, overseen by CEO Bill Park (EE, '76).
CANDLER HOBBS



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WE ARE ENGINEERS
GEORGIA TECH
COLLEGE OF ENGINEERING
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Dear Readers,

With a name like Georgia, I've certainly heard my fair share of state-related inquiries — is your middle name Atlanta? Did your parents name you after the state? Was the Ray Charles song about you? And so on. I'm actually named after my grandmother, who was an Italian immigrant (to Georgia), but the connection stops there.

But I will say, I do like sharing my name with our great state of Georgia. There is such a rich history here, and over the years, Georgia Tech's College of Engineering has played a big part in shaping that history. From peanut farming to poultry, our engineers are involved in agricultural initiatives across the state, providing advanced technology that powers industries. You'll also find many of our alums working to move Georgia's economic needle — Ben Turnipseed has brought

thousands of jobs to Augusta with his waste treatment plants. Southwire Company, started by an engineering alum, was the first to bring electricity to much of the state. These are just a few of the stories you'll read in the following pages.

Enjoy as we travel across the state to bring you tales of our exceptional engineers doing amazing things for our metropolis of Atlanta and cities as small as Claxton, Georgia (with a population of just 2,000!).

Happy reading.

Sincerely,

Georgia Parmelee

EDITOR
editor@coe.gatech.edu

There is such a rich history here, and over the years, Georgia Tech's College of Engineering has played a big part in shaping that history.

A Promise to Provide Education for All

Georgia Tech has long been known as a 'best buy' university when it comes to the cost of college. But any price tag for higher education can be a barrier to low income families. A university education is an extremely expensive proposition, with an estimated 95 percent of U.S. colleges being unaffordable for low-income students.

The G. Wayne Clough Georgia Tech Promise Program (Tech Promise) offers a scholarship, based 100 percent on financial need, exclusively to Georgia residents. The program aims to ensure that students from all economic backgrounds have the opportunity to attend college, and it's even opened the door for many first-generation college graduates.

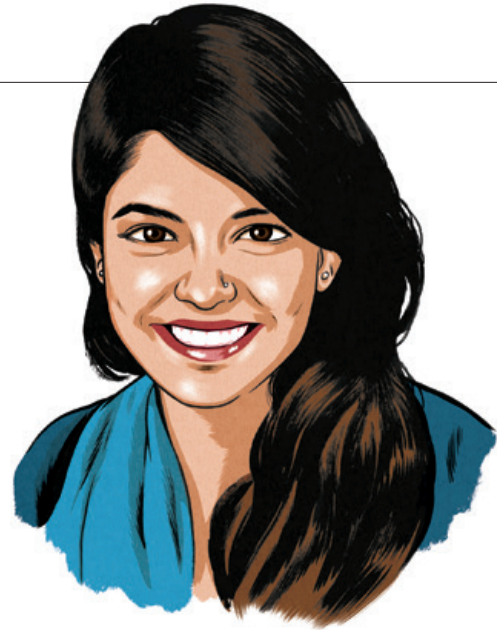


Tech Promise is one of the most impactful contributions of Georgia Tech President Emeritus and civil engineering alumnus G. Wayne Clough (1994-2008), for whom the program is named. It was established in 2007 after Clough attended a national education symposium and heard how high college costs keep some students from enrolling in science, technology and engineering fields. Clough had always felt a kinship with these students — he grew up in a working-class family, and neither of his parents attended college because they couldn't afford it.

Tech Promise provides a debt-free degree to qualifying students from low-income families, filling a gap in the financial aid support system by picking up where other scholarships and financial aid options leave off, covering a student's full cost of attendance.

For some engineering students, the Tech Promise scholarship has made all the difference.

► WORDS: TANYA ROY; ILLUSTRATIONS: JOEL KIMMEL

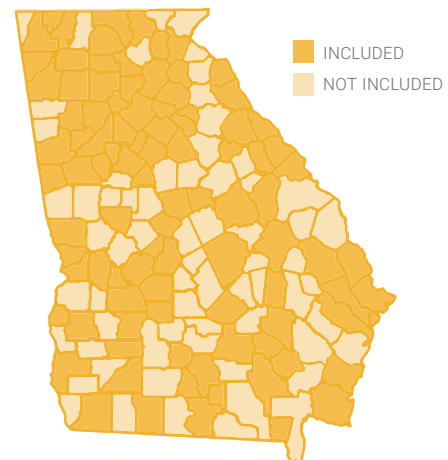


Navila Akther

Industrial and Systems Engineering, 2018
Chamblee, GA
KPMG Associate

“Tech Promise has taken a huge burden off my parents, who are very hard-working individuals, and has given me the opportunity to attend one of the best universities in the nation. Because Georgia Tech believed in me, it made my time there that much more special. The scholarship has inspired me to give back to the community that has given me so much!”

Hundreds of Georgia students and their families representing 89 counties have benefitted from Tech Promise.





Noah Wolfert

Aerospace Engineering, 2019
Douglas, GA

“The biggest thing that weighs down on students on top of the stress of classes is financial obligations. Tech Promise honestly helped a lot to focus more on my studies and be able to enjoy learning without having that over my head.”

Alexandra Jenkins

Chemical Engineering, 2020
Senoia, GA

“Tech Promise allowed me to go to the second [highest university] in the nation for chemical engineering. I wouldn’t have even been able to go to college without it. I’ve really enjoyed seeing more people coming from my background being able to come to Tech.”



David Medrano

Nuclear & Radiological Engineering, 2018
Savannah, GA
U.S. Naval Officer

“Georgia Tech opened up many doors and possibilities for me ... it allowed me to go all the way across the country with a secure job and pursue whatever I wanted to. The scholarship was a big factor for why I chose Georgia Tech, and I think where I am today is because of Tech Promise.”

Statewide Job Growth Through Infrastructure Expansion

Turnipseed Engineers, Inc. completes \$100 million of construction every year, and it's not stopping anytime soon

In 1973, after five years working in the civil engineering industry as a Georgia Tech graduate, G. Ben Turnipseed will never forget a conversation that got him thinking about his future.

"I was working at an engineering firm, and I was in the file room, and the office manager came in mad as a hornet," Turnipseed recalls. "She had been in an argument with the owner and said to me, 'Ben, when you own your own company — and trust me, you will — don't tell the financial people how to run the finances!'"

Turnipseed started considering a jump to entrepreneurship, realizing that he could capitalize on the collective knowledge he'd gained while working at different engineering firms both during his co-op at Georgia Tech and since graduating.

And so, in 1978, he left the firm he was working for at the time and started G. Ben Turnipseed Engineers, Inc., a private engineering firm specializing in water and wastewater treatment systems. He had enough money saved up to make a go of it for one year, promising his wife, Cheral, that if his business wasn't paying the bills at that point, then he would go back to work for another engineering company.

A Basement Startup in Georgia

Turnipseed set up shop in the corner of his house's basement in Atlanta, pulled out a map of Georgia, and decided to go east to begin making business connections. The

city of Harlem was his very first client, and they are still one of his clients to this day.

Repeat business is a big deal for the company, now called Turnipseed Engineers, which today employs more than 35 professional engineers, designers, drafters, surveyors and more and has designed more than 120 water and wastewater treatment plants over the past four decades throughout Georgia and South Carolina. The firm partnered with Columbia County in 1987 to build a new wastewater plant; Turnipseed had already assisted the county in expanding their other two plants twice, and his advice to them was that building a new plant would lead to more growth in the area. Now, Turnipseed Engineers has helped to expand the 1987 plant three more times to meet the county's ever-growing demand; the last expansion alone was a \$20 million undertaking.

Many of the projects that Turnipseed Engineers take on create not only infrastructure improvements, but also major job opportunities throughout the state of Georgia. The firm helped West Point, Georgia, population 3,700, secure federal grant and loan money and create the design for a major water and sewage system expansion, which led to Kia choosing the city as the site for a new automotive manufacturing plant in 2006. Today, this facility is the only Kia manufacturing plant in the United States and the only automaker in Georgia, helping

to employ 14,000 full-time workers along with nearby suppliers.

In 2015, Turnipseed Engineers helped bring hundreds of jobs to Louisville, an east-Georgia town just 50 miles outside of Augusta, by adding a \$10 million water and wastewater system at a formerly abandoned industrial site that served a new poultry processing plant.

Paying It Forward

Turnipseed's connection to Tech continues to run deep as a member of the College of Engineering's Academy of Distinguished Alumni and Hall of Fame. He is also dedicated to helping aspiring Georgia Tech engineers gain the education they need to enter the industry by endowing the G. Ben Turnipseed Scholarship for Georgia residents interested in pursuing civil and environmental engineering.

"I learned so much from a lot of people at Georgia Tech, especially in the civil engineering department, and that helped me start out my business with an eye toward making the right decisions," says Turnipseed. "The combination of the foundation I received at Tech and the willingness to hire the right people and listen to their expertise has contributed to the firm's success over the years.

"I've been a Georgia Tech fan since I was young, and I'm proud to be able to support today's students on their own journeys to success."

▶ KATHRIN HAVRILLA-SANCHEZ



School of Civil Engineering graduate Ben Turnipseed at a treatment facility in Augusta. CRAIG BROMLEY

The Engineer Inside the Physician

Dr. Anne Patterson's Journey into Telemedicine

Telemedicine – the delivery of healthcare via telecommunication technologies – has been around for decades. But it took an engineer to get it just right.

“We were doing telemedicine at NASA in the early '70s, but it was completely ‘unsophisticated’ by current standards,” says aerospace engineering alumna C. Anne Patterson, a board-certified OBGYN and CEO of the Sandy Springs-based Women's Telehealth.

“We used a satellite to provide information about birth control that people in India could watch in between regular television programming,” remembers Patterson. “I was a propulsion engineer working on that satellite. Later, the satellite was re-purposed to send medical information to physicians in very remote areas of the Rocky Mountains. And that was the extent of our ‘telemedicine’ in the '70s.”

Four decades later, the telemedicine that Patterson now practices is much more than a medically-themed infomercial beamed down from a satellite. It is a systematic use of several technologies (including satellites), all with the goal of delivering personalized medical care directly to patients in remote areas. Telemedicine is also removing one of the largest barriers to health care delivery in the rural

South: a chronic shortage of specialized medical practitioners.

Telemedicine technology fully enables the maternal-fetal medical practice that Patterson operates today. Instead of traveling to her metro Atlanta-based office, patients visit a clinic near their home where their consultation with Patterson is conducted via video conferencing on a secure HIPPA-compliant network. Specially engineered medical equipment and cloud-based data exchanges allow Patterson to collect and analyze important data on each client before the session begins. A blue tooth-enabled stethoscope even allows her to track fetal heartbeats hundreds of miles away.

“We've been able to set up clinics in seven southern states,” says Patterson. “We've reached more than 30,000 mostly low-income women – women who would otherwise not have access to maternal-fetal health. This is what modern telemedicine is capable of doing.”

Patterson will readily tell you that the two aerospace engineering degrees she earned at Tech ultimately helped her to build – and optimize – Women's Telehealth.

“As a trained engineer, I was used to looking at a system to see if it could work better, and that perspective helped our practice,” says

“WE’VE REACHED MORE THAN 30,000 MOSTLY LOW-INCOME WOMEN – WOMEN WHO WOULD OTHERWISE NOT HAVE ACCESS TO MATERNAL-FETAL HEALTH. THIS IS WHAT MODERN TELEMEDICINE IS CAPABLE OF DOING.”

Dr. Anne Patterson, M.D. and School of Aerospace Engineering graduate



Patterson. “We’ve gotten the cost of outfitting [clinics] down to around \$10,000, which has really helped us grow. And I don’t code, but I tracked down a developer in Boston who was able to create a form of an HL-7 interface that’s allowing us to get ultrasound data and reports through a cloud-based system.”

Finding her Specialty

Patterson chose her medical specialty — maternal-fetal medicine — in part because it plays such a critical role in Georgia, which has some of the highest rates in the United States for maternal mortality and pre-term delivery, particularly among women of color.

She may never meet any of her patients in person, but, through Telehealth, she can consult with them in a trusted, community setting. Anecdotally and statistically, the results are promising.

“We conducted a study in Albany, Georgia — an area that had preterm birth rates of 18 percent for African-American women, and 16 percent for Hispanic women,” says Patterson. “Those rates were the highest in the state. While it was a tough region to choose, everyone was receptive to trying something new to make a difference.”

Patterson and her team found after bringing telemedicine into the area for 18 months and partnering with the providers, there was a significant difference — for African-American and Hispanic women. Pre-term birth rates dropped to 8 percent and 6 percent, respectively, which is lower than the national average. To date, the rates remain at this level or lower.

Telemedicine is uniquely suited to address the problems faced by the rural poor, Patterson points out. It does not involve high transportation costs, travel time, childcare, or Medicaid. With all of these barriers eliminated, patients are more likely to initiate and maintain contact with the medical system earlier in their pregnancies. Women's Telehealth helps these high-risk patients to manage chronic health problems — like diabetes and hypertension — that could threaten their pregnancies.

In a typical consultation with Patterson, the conversation rarely ends when doctor and patient have checked off all the obvious medical issues, however. Before the video shuts down, Patterson leans into a more motherly consult with her patients, who have likewise relaxed their once-tense postures. At these moments, it's a little easier to understand why Patterson is still seeing patients long past the point when most physicians would have retired.

"I feel like God sent me here for a purpose," she says. "And my purpose is to see that women who are often poor, maybe hardly have gas money to drive across the county, or may even be incarcerated — all get the kind of medical help that they might not otherwise get. Maternal-fetal medicine is about healthy beginnings. I can't think of a more important connection to make."

► KATHLEEN MOORE

THE DOCTOR WILL SEE YOU NOW

With the patient's full permission, we sat in on Patterson's consult with "Susan" (not her real name), a 23-year-old who is 25 weeks pregnant with her first child.

The video pans on a young woman who is staring awkwardly at the floor. Like all Telehealth patients, Susan is accompanied by a medical professional — someone on her end who can answer follow-up questions after the visit — but the next half-hour will be a very intimate one-on-one between doctor and patient.

Susan's chart tells us that she has bi-polar disorder, a seizure disorder, a meth addiction, and attention deficit disorder. She was only recently released from a rural jail, where she was serving time for a minor drug offense.

Patterson starts on an up note.

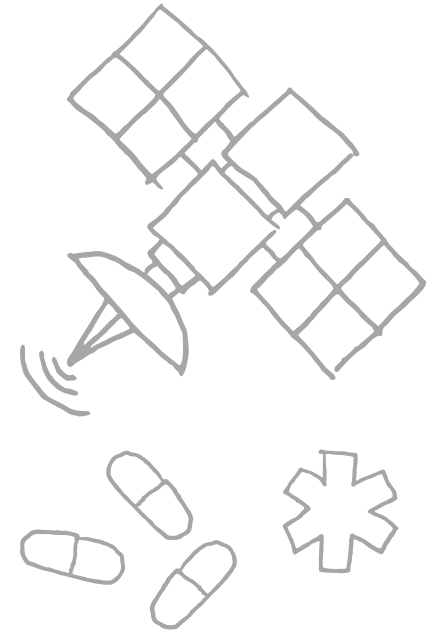
"Well, I'm looking at all of your pictures [sonograms], and I can tell you so far, so good. All of the anatomy we see looks really good. With some of your meds, there would be a concern about a cleft lip or palette, and I can tell you that all looked normal. Baby weighs one pound, 14 ounces and that's good."

Susan picks up on Patterson's obvious concern and begins looking directly into the camera. The doctor's questions cover some tender territory — drug use, mental health, legal issues — but there is clearly something about Patterson's tone — direct, but warm — that relaxes the patient. Patterson weaves in suggestions for finding a drug-free environment when Susan is able to live on her own and for avoiding acquaintances who do drugs. She ends the consult by prescribing a pregnancy belt to address physical discomfort and a referral to a social worker who is both appropriate and accessible to the young woman.

"You have a beautiful life ahead of you with that beautiful baby," she says. "Let's talk about this again in a month."

With that, the video disappears and Patterson turns to another screen to document the visit. There's a lot to write, but, after a few minutes, Patterson pulls herself away to tell her visitors what's really on her mind:

"With a lot of my patients, you have to take a step back and see where they are. All the high-tech in the world isn't going to cure having no place to live, not enough food to eat, or not enough money for medication. There are social programs in place that can help, but the patients have to be connected with them. You have to bring those things up, or you've failed them," concludes Patterson.



“**WITH A LOT OF MY PATIENTS, YOU HAVE TO TAKE A STEP BACK AND SEE WHERE THEY ARE. ALL THE HIGH-TECH IN THE WORLD ISN'T GOING TO CURE HAVING NO PLACE TO LIVE, NOT ENOUGH FOOD TO EAT, OR NOT ENOUGH MONEY FOR MEDICATION.**”

Anne Patterson

The Night the Lights Went **On** in Georgia

Southwire brings electricity to rural Georgia and across the world

Roy Richards, Sr. was a man who wouldn't take no for an answer. And with an inventive engineering spirit nurtured at Georgia Tech, he was instrumental in bringing electricity to the South. As the founder of Southwire Company, Richards built one of today's leading manufacturers of wire and cable used in the transmission and distribution of electricity. In fact, nearly one in two new homes built in the United States contains Southwire products, and the company produces half of the cable used to transmit and distribute electricity throughout the U.S.

Southwire didn't spring up overnight. Richards faced many hurdles and seemingly dead ends on his path to create a successful business, which started at Georgia Tech. After graduating from Tech in 1935 with a mechanical engineering degree, more than 90 percent of his classmates left the South for jobs in New York, a city that paid a much higher wage than those in the South. Richards, however, chose to honor his roots and moved back home to Carrollton, Georgia, to run the family sawmill. By the 1930s, Richards noticed that rural areas in the South were slowly beginning to receive infrastructure for electricity. Seeing opportunity, he began turning out electrical poles at the sawmill and set up a construction company to erect them and install lines. He soon won the





College of Engineering graduate Roy Richards, Sr. consults with factory worker

**SOUTHWIRE OFFICIALLY
OPENED ITS DOORS ON
MARCH 23, 1950, WITH 12
EMPLOYEES AND THREE
USED MACHINES.**

**BY THE END OF THE FIRST
YEAR, THE COMPANY HAD
PRODUCED 2 MILLION
POUNDS OF WIRE AND
\$566,000 IN SALES.**

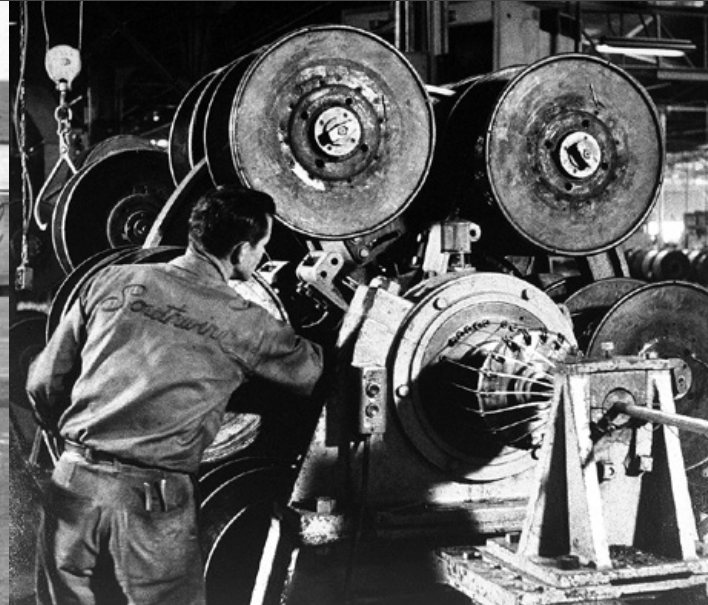
bid to set up power grids in the surrounding community – Carroll County.

By 1939, Richards & Associates ranked second in the nation for number of miles of Rural Electric Authority (REA) Power lines installed. After derailments from WWII service, Richards and his team were ready to start erecting poles and stringing wire again, but there was a problem – no wire was available. In fact, it was estimated that the amount of wire he needed would not be available for another four years. So, Richards decided to simply make his own.

Many told him it couldn't be done. At least not in a small cotton-growing town like Carrollton. The labor pool of the town only consisted of textile mill hands and farmworkers, a far cry from the mechanics and machinists that would be needed to make wire. Nevertheless, Richards decided to press on and remain in his hometown. He borrowed \$80,000 to purchase land and built a small shop. He also hired retired Georgia Tech professor and mentor Major A. A. Case to train local Carrollton farmers on how to operate the wire manufacturing machinery.

Southwire officially opened its doors on March 23, 1950, with 12 employees and three used machines. By the end of the first year, the company had produced 2 million pounds of wire and \$566,000 in sales.

Like a true engineer, Richards continuously pushed his team to make the production lines run faster and more efficiently in order to sell more wire and grow the business. He had heard of an Italian machine that continuously cast lead and zinc rod. In 1953, he went to Milan to buy one of these machines, even though the developer told him it would



not cast aluminum in the size he needed for making wire. But Richards was determined and hired recent engineering Georgia Tech graduate D. B. “Pete” Cofer to find a way to implement the new machine into Southwire’s production line. After a few months of trial and error, Cofer made the Southwire Continuous Rod System a reality, drastically increasing production.

By 1956, Southwire was producing 33 million pounds of rod and cable — 15 times the amount produced in its first year of operation. By 1960, the company employed more than 1,000 people, and in 1963, adapted its Southwire Continuous Rod® system to handle the more challenging properties of copper. Southwire soon added a new plant in Carrollton to produce building wire. The company experienced tremendous growth during the 1970s, moving from \$75 million in revenue in 1968 to \$600 million by the end of the decade.

After Richards passed away in 1985, his sons took over leadership of the family business. Southwire continued to grow over the decades and is now a major global contributor to the wire and cable industry with nearly 8,000 employees and 34 plants. However, the company has not forgotten its roots. The corporate headquarters are still located in Carrollton, and the company is more committed than ever on making an impact on its surrounding communities through various outreach programs such as Project GIFT® and 12 for Life®. It all started, though, with a Georgia Tech graduate that simply wanted to bring electricity to his hometown and found a way to do it.

► CANDLER HOBBS

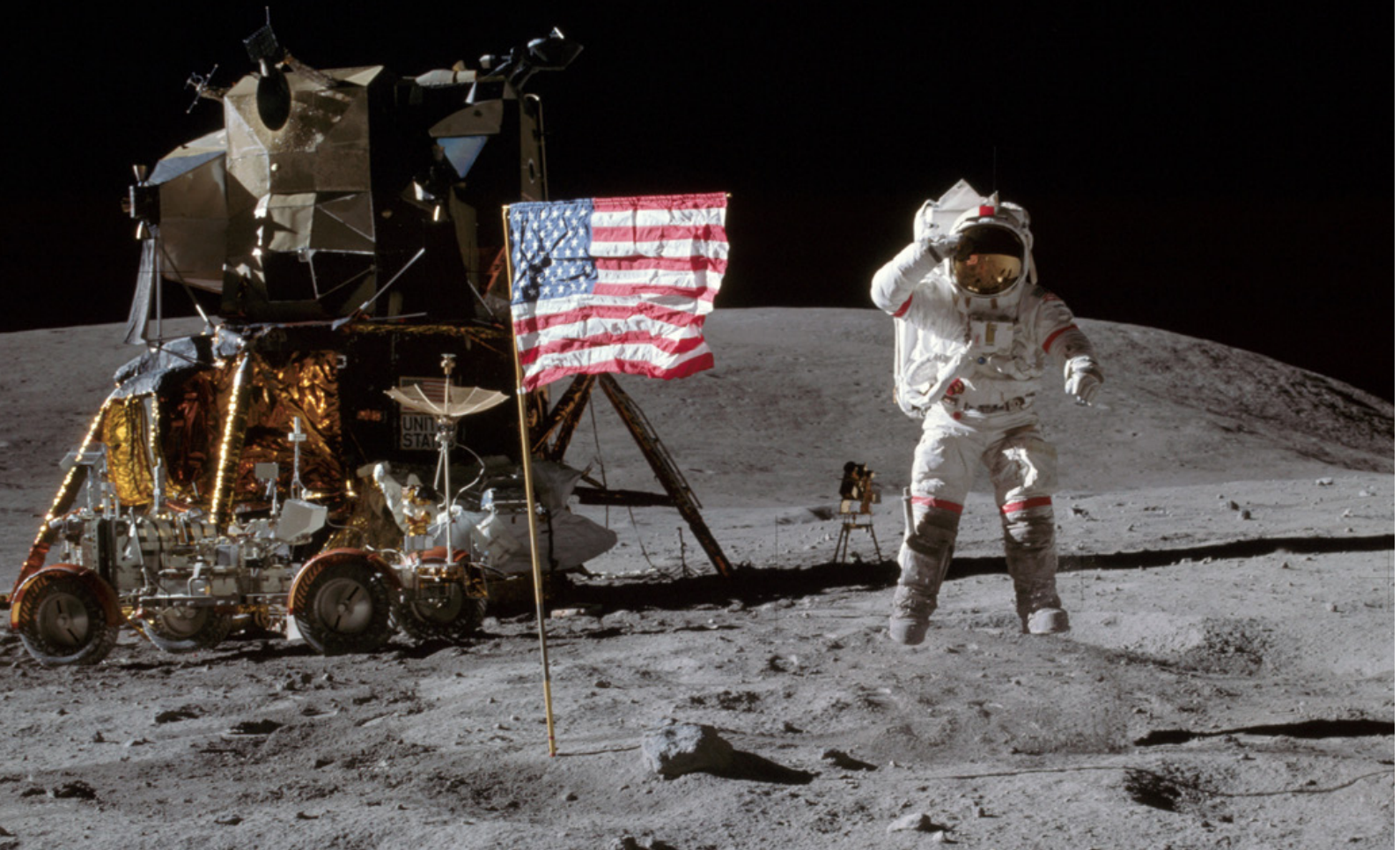
SOUTHWIRE GIVES BACK

In 2005, amidst the devastation left from Hurricane Katrina, Southwire initiated Project GIFT® (Giving Inspiration for Tomorrow), which today involves more than 1,000 company volunteers supporting a wide variety of local projects in their communities, such as disaster relief, Toys for Tots and Back to School.

In addition to these charitable- and service-related initiatives, Southwire partners with local school systems and post-secondary institutions to help address the workforce development needs of the community and the company’s future. 12 for Life®, a signature partnership for the company, inspires at-risk high school students to earn wages by working in a Southwire manufacturing facility while completing high school. In its 12 years of operation, the program has graduated and changed the lives of more than 2,900 students — some of whom have continued to work at Southwire or gone on to higher education, the military or other occupations.

Historical Figures

Engineering Hall of Fame



John Young (1930-2018)

The Most Experienced Astronaut in History

In 1952, John Young earned a B.S. degree in Aeronautical Engineering from Georgia Tech and went on to join the United States Navy and ultimately NASA in 1962. He is prestigiously known for being the only person to go on the Gemini, Apollo and Space Shuttle programs, serving as both pilot and commander. Furthermore, Young became the first astronaut to ever fly six space missions in his 42 years of service to NASA and the ninth person (and only Georgia Tech graduate) to walk on the surface of the moon.



Bobby Jones (1902-1971)

The Most Talented Amateur Golfer From the South

Bobby Jones, a 1922 graduate from the Georgia Tech College of Engineering, is most notably known for dominating the field of amateur golf. He brought home 13 major championships and earned the remarkable achievement of being the only man to win all four major golf titles in one season: U.S. Amateur, U.S. Open, British Open and British Amateur. Jones ended up retiring from competitive golf at the 'old' age of 28 to devote more time to his family and law practice.



Jimmy Carter (Born in 1924)

The Most Renowned Politician From Georgia

Jimmy Carter takes the title of not only the singular Georgian-born elected president in the United States but also one of the few U.S. presidents with an engineering background. Carter started off his education at Georgia Tech in the College of Engineering before transferring to the Naval Academy. After school, he went on to serve two senate terms in the Georgia General Assembly and one term as the 76th governor of Georgia. He was elected as the 39th U.S. President in 1977 after elevating Georgia as a hub for foreign business dealings. In 2002, Carter was awarded with the Nobel Peace Prize "for his decades of untiring effort to find peaceful solutions to international conflicts, to advance democracy and human rights, and to promote economic and social development."



Jesse Jewell (1902-1975)

The Most Powerful Man in the Poultry Industry

As an engineer, Jesse Jewell is widely acknowledged as the pioneer of vertical integration to optimize and streamline poultry production by combining all phases of the business — raw materials, processing and distribution— into one company. Through his remarkable contributions, he transformed Gainesville, Georgia, into the "poultry capital of the world." Jewell was regarded as a key national leader in the poultry business while leading his company, J. D. Jewell, Incorporated, for over 20 years and continues to be a widely renowned figure in northern Georgia.



Mechanical Engineering Professor
David Torello's backyard birds

ENGINEERS COME HOME TO ROOST



**Agricultural technology
finds a place at Tech**

G

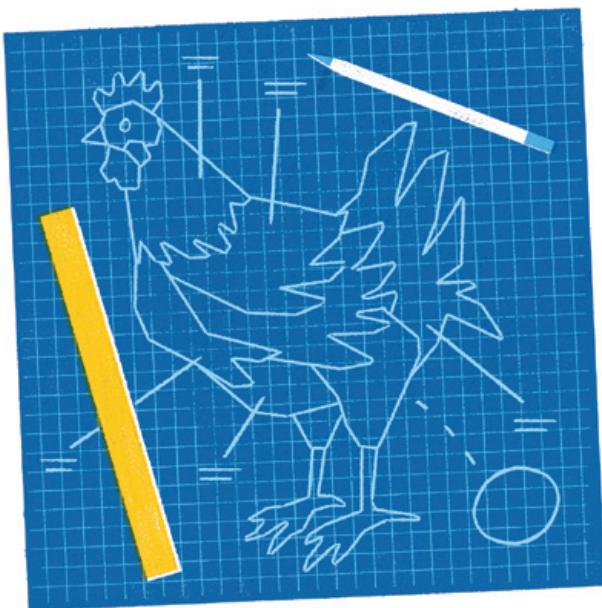
Georgia's homegrown chicken chain, Chick-fil-A, boasts, "We didn't invent the chicken, just the chicken sandwich."

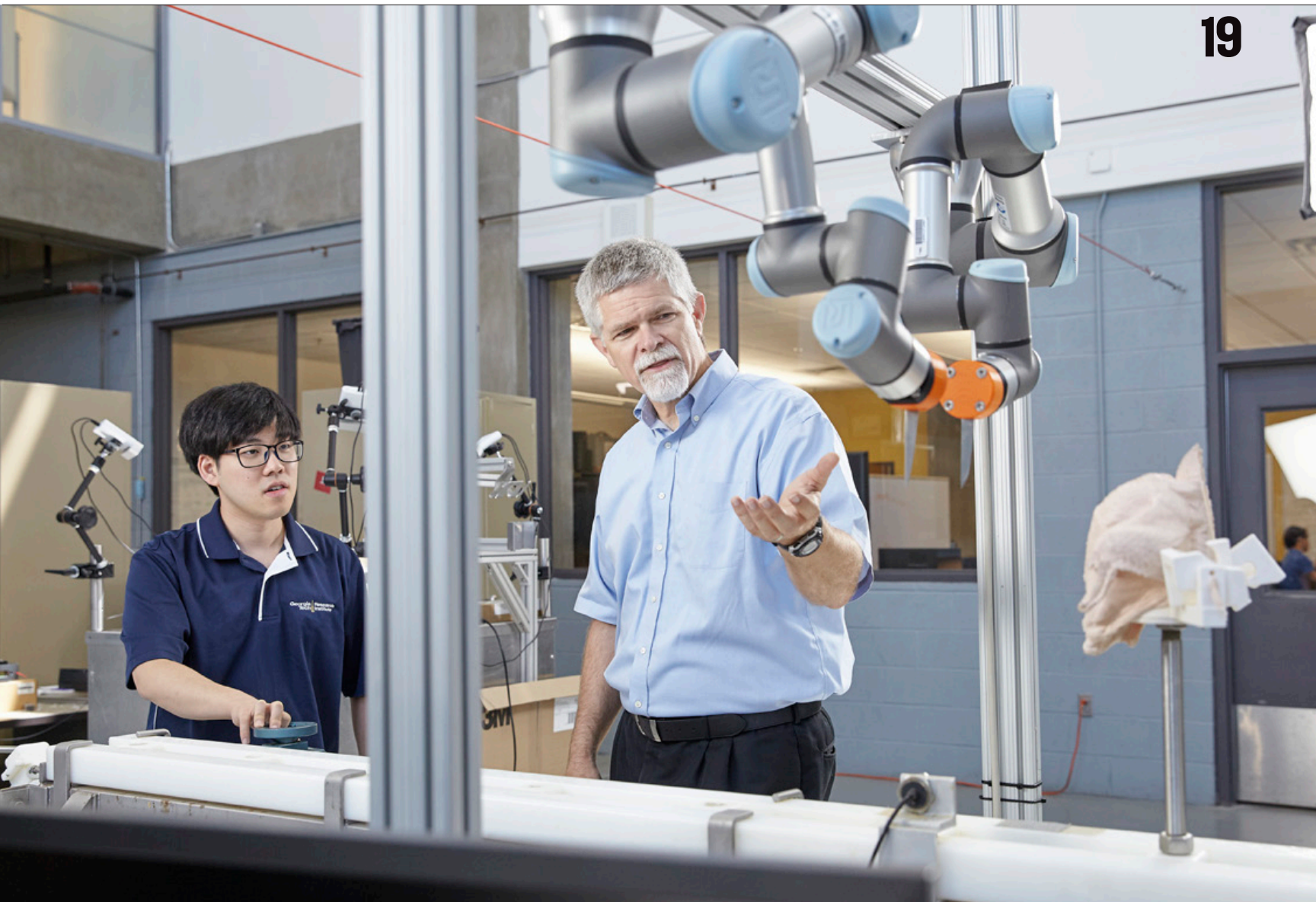
Similarly, the state of Georgia can probably claim that we didn't invent the chicken, just modern chicken production. Georgia is the top producer of broiler chickens, with 26 billion pounds of chicken meat produced daily. The birds bring in \$48 billion to the state economy each year.

That's a lot of chicken sandwiches. And Georgia Tech does its part for one of the state's biggest industries.

Across many engineering research labs on campus, you'll see grad students working on robots that zip through chicken houses to scoop up eggs. Researchers are 3D-printing parts for intelligent cutting machines that dice up chicken with more speed and efficiency. There's even a listening device that can hear when baby chicks are squawking and better respond to their needs. In a state known for Big Chicken, Georgia Tech engineers play an important role.

Tech's friendly rival to the east, the University of Georgia, has long been a crucial player in the poultry industry, from chicken breeding to poultry sciences. But it's Georgia Tech engineers that are working on developing advanced technologies and software to drive the industry forward. Doug Britton heads the \$2 million Agricultural Technology Research Program at the Georgia Tech Research Institute (GTRI), and is also an engineering graduate from Tech's School of Electrical and Computer Engineering.





Doug Britton works with graduate students on chicken processing robotics. CRAIG BROMLEY

“As engineers, we are developing tools to improve efficiency, safety, yield and environmental impact, all while optimizing operations at farms across the state,” said Britton. “We view what we are doing at Tech as not just helping the poultry industry, but truly disrupting it through innovation.”

Backyard Beginnings

In the early 1900s, Gainesville, Georgia, came to be known as the poultry capital of the world thanks to Jesse Jewell, a civil engineering graduate from Georgia Tech. He pioneered vertical integration within the poultry industry, combining all phases of business, such as raw materials, processing, and distribution, into a single company. J. D. Jewell quickly became the largest integrated chicken producer in the world. An innovative, engineering mindset from Tech enabled Jewell to capitalize on and create a booming business in the south.

Georgia Tech jumped on the poultry band wagon in the 1930s when they established a helpline that took

“As engineers, we are developing tools to improve efficiency, safety, yield and environmental impact, all while optimizing operations at farms across the state.”

Doug Britton, School of Electrical and Computer Engineering graduate and head of the Agricultural Technology Research Program at GTRI

“There’s been a big shift in industry because of technology. The plants previously full of people doing all the work are now loaded with highly technical equipment.”

Jerry Lane, Claxton Poultry



telephone calls from farmers. Technical experts from Tech would answer and troubleshoot engineering problems. Many of these farmers raised chickens, and Tech became an integral part of the industry, providing on-demand expertise.

Britton recalls the history of this poultry helpline and notes that, to this day, Tech is still seen as the go-to experts for technical issues in the industry. And folks are still calling, like Jerry Lane, president of Claxton Poultry and a Tech graduate. He has reached out to Tech when he’s run into waste processing problems at his farm.

“Tech was the only resource we could get that would come in and help us with the engineering problems at the farm,” recalls Lane. “After reaching out to GTRI, so many projects have now morphed out of those early questions, like ‘how do we modernize and improve operations in our facilities?’”

But now, it’s not just farmers calling, it’s big businesses like Tyson, Monsanto and Marel that are looking to Tech engineers for help. Tech engineers are heeding the call, inventing and evolving the types of technology these companies need to respond to market change and demand.

Leveraging Technology to Shape the Industry

The Labor Problem

The poultry industry presents plenty of complex challenges for GTRI to tackle, and the robotics division is developing tools and processes to bring more automation to problem areas such as labor and animal welfare.

Working in a processing plant involves extremely repetitive and fatiguing manual labor. Finding workers willing to do jobs such as deboning a chicken or cutting up tenders has become increasingly difficult. Matt Brass, mechanical engineering graduate from the College, works as a project engineering manager at Marel, an equipment company that designs and supplies much of the equipment that goes into the poultry processing facilities.

“Technology has taken labor out of the plants, creating much more efficient operations,” said Brass. “If you

COUNT YOUR CHICKENS

Poultry by the Numbers

\$48B

Contribution of the poultry industry to the state economy in 2018

1.2M

Pounds of chicken produced per year in Georgia

289

Number of eggs a hen lays each year

22K

Number of people who could be fed in a year from just one poultry farm's production

196,114

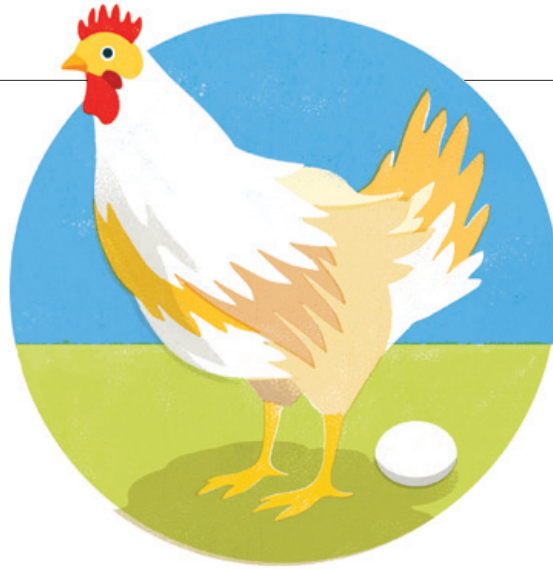
Number of jobs created in Georgia by the poultry industry in 2018

93.8

Pounds of chicken per capita consumed by Americans last year

1967

Year S. Truett Cathy opened the first-ever Chick-fil-A in Atlanta



go back and look at the prices of poultry in the 1950s, it was considerably higher than today due to the number of people involved in getting the chicken from assembly line to grocery store.”

Brass is excited about technology like the Intelligent Cutting Project, which reimagines the best way to cut up a chicken before it's packaged for the grocery store. Historically, cutting up joints and pulling the meat off the bird was a manual task. The poultry cutting machine automates that process, while at the same time optimizing the amount of meat collected.

“Our machine is able to scan and scrape the chicken to gather even more meat than the manual process,” said Britton. “Even just a one percent yield change in the amount of meat produced in the processing plant equals \$1 million in additional revenue. We can really measure the ROI this machine is giving companies.”

Workers are still important to poultry production, though, and there won't be a shortage of jobs any time soon. The required skill set is just different.

“There's been a big shift in industry because of technology,” says Lane of Claxton Poultry. “The plants previously full of people doing all the work are now loaded with highly technical equipment. You still see many workers, but they are monitoring and inspecting as opposed to doing the manual hand work.”

Birds of a Feather

Other innovations coming out of Tech are more focused on animal welfare with an added business bonus of creating smoother operating processes. A listening tool developed by Brandon Carroll (PhD, electrical engineering, 2018) records an audio track

of the chickens in the grow-out houses. Britton notes that it's been five years in the making and expected to be commercially available soon. The device listens for anomalies in chicken sounds and records them. To regulate and improve bird welfare, the device listens and maps noise that could signify distress. Farm operations can then be adjusted accordingly. For example, if there is squawking at 1 a.m. because a heater malfunctions and the chickens are cold, the device can notify workers that there is a problem.

The Grow-Out robot is another innovation from Tech engineers that travels throughout the grow-out house — where the chickens live — to monitor the birds. It also has an arm that collects eggs.

“Hens have a mob mentality,” explains Britton. “If one hen lays an egg, all the other hens will do the same. We want them laying in the houses so the eggs are protected, not on the floor. So, if an egg lands on the floor, the robot quickly scoops it up so the others don't follow suit.”

The Grow-Out robot also checks for diseases throughout the house, which can be highly contagious. Farmers can easily spread germs to other houses, just from the bottom of their shoes. But if each house has their own robot, there is zero cross contamination, creating greater bio security and healthier, happier birds.

Coming Home to Roost

One of the keys to maintaining success across Georgia's poultry industry is sustainability. Recent projections from Cargill estimate that global meat consumption is expected to increase 7 percent by 2023, with more than 70 percent of that growth potentially coming from poultry. And engineers like Britton and Lane are hyper aware that the industry needs to adapt to that demand in a sustainable way.



“At Claxton, sustainability is critical to what we do,” says Lane. “If we can’t sustain our own operations and those of the industry as a whole, then we have a problem. Our company has been here for 60 years and intends to stay at least another 60, but it will depend on how well we take care of our environment.”

Additionally, consumers are increasingly looking to purchase foods that are produced in a sustainable manner. People care more about the environment a chicken is raised in—is it cage free or free range? They want meat that is free from antibiotics and steroids. And they are willing to pay top dollar.

John Starkey, president of US Poultry and Egg Association and Georgia Tech environmental engineering graduate, said that he has seen humane housing systems and sustainable practices improve in recent years.

“In my grandmother’s lifetime, it took four to five pounds of feed to make a pound of chicken,” Starkey said. “Now, it’s two pounds of feed to make a pound of chicken. Think about the impact on the acres of corn, fertilizer and tractor runs all having to do with creating feed for chickens. At the end of the day, what we have created is a much more sustainable industry than it was when I stepped into it back in 1982.”

Civil engineers are reimagining what farm systems look like, ensuring waste is disposed of in a responsible manner, creating a healthy bird habitat. Industrial engineers are optimizing the poultry supply chain, getting birds from point A to point B in the most humane way possible. And of course, mechanical engineers are building the robots that monitor bird health and make plant processes as efficient as possible.

“As partners to the poultry industry, we must be the thought leaders that help industry adapt to changing consumer demands and drive technology innovations that impact the bottom line,” says Britton. “Agricultural robots. AI. Advanced imaging. These are all potentially positive disrupters to the industry. And as engineers, we must be on the front lines exploring and facilitating this change.” ◀



Left: John Starkey, president of U.S. Poultry and Egg Association, and avid chicken tchotchke collector



Above: Robotics created at Tech roam the grow out houses in Athens, GA

Right: The Grow Out Robot enables farmers to check for disease and remove eggs with very little human involvement.



GO NUTS, GEORGIA

**TECH ALUMNI AND ENGINEERS CREATE INNOVATIONS
FOR THE STATE'S \$2.2 BILLION INDUSTRY**





he next time you grab an afternoon pick-me-up candy bar, a protein shake packed with peanut butter powder, or even a classic PB&J, chances are that you're helping one of Georgia's biggest sectors thrive.

The state produces about half of the United States' peanuts, roughly 2 million tons each year, making Georgia the biggest peanut producer in the U.S. Peanuts have been growing in Georgia's soil since before the Civil War, and as farming technology has evolved, many researchers, students and alumni at Tech have contributed to innovation that increases yield, streamlines the production process and improves the bottom line. And some of them are even peanut farmers themselves, growing and producing the quality product that gives the state its reputation.

He's a Helluva Farmer

Originally from quaint Waycross, Georgia, Bill Park (electrical engineering, '76) spent his summers cropping tobacco on his grandparents' farm. After working as an engineer for more than 25 years, Park became the president and CEO of Tifton Quality Peanuts in 2006. These days, he uses his farming background, as well as his business acumen, to run the successful peanut company.

"Tifton Quality Peanuts was just starting up at the time, and they were looking for someone to help them solidify their business," recalls Park. "At my previous job, I did a lot of project planning and business case analysis, and now I'm lucky to have a really great team, so I can make sure we have the right people with the right skills in the right place."

Tifton Quality Peanuts employs 140 growers around the state of Georgia who all own stock in the company. For every unit of stock a grower owns, they're obligated to bring in a ton of peanuts annually, which equals between 103,000 and 110,000 tons of product.

The basic supply chain for Tifton sees farmers bringing their harvested peanuts into one of seven buying points located throughout the state. There, they are dried and cleaned, as well as graded by the Georgia Federal-State Inspection Service to ensure uniformity and quality. The peanuts then make their way to the company's shelling plant, located in Tifton, Georgia, where they are separated from their hulls and skins before being

Bill Park

EE '76, President & CEO,
Tifton Quality Peanuts





“We’re only a 5% player in the peanut market. Because we’re smaller, we have to stay at the top of the curve, and one of the ways you do that is to keep up with what’s new and leverage technology the best that you can.”

Bill Park

sent off to various food manufacturers, from big names like Hershey’s, Smucker’s and Planters, to store brands.

“We’re only a 5 percent player in the peanut market,” says Park. “Because we’re smaller, we have to stay at the top of the curve, and one of the ways you do that is to keep up with what’s new and leverage technology the best that you can.”

Over the last 13 years, Tifton has automated their bagging system, so now employees are no longer manually handling 2,200-lb tote bags filled with product. And, they have automated their color sorting procedure, checking for properly ripe peanuts and damage using infrared technology instead of manually.

“Our farmers understand sustainability and the necessity to improve efficiencies and production methods to produce higher quality and yields at lower costs,” said Park. “Most of that is achieved through technology developments and taking advantage of new seed varieties that also offer drought and disease resistance.”

Park indicates Tifton is essentially a zero-waste facility, marketing edible and nonedible peanut production, as well as the hulls and skins removed in processing. The company is also considering bringing the oil manufacturing and pelletizing processes in house, as well as working to increase the demand for peanuts overseas, and hence increase the need for more peanut production (and jobs) across the state.

The Diversification of the Peanut Industry

Don Koehler, executive director of the Georgia Peanut Commission for the past 33 years, knows better than most how the innovations created at Georgia Tech have impacted the peanut industry.

“When I started three decades ago, peanut growers were working with two-row combines and diggers and a 14-foot wagon for harvesting,” recalls Koehler. “Now we’re talking 12-row pickers, 8-row diggers, and semi trucks for hauling. We’re producing twice what we used to — mainly due to breeding technology.”

The Agricultural Technology Research Program (ATRP) at Tech develops some of these innovative solutions for the state’s food processing industry that Koehler has seen come into play. ATRP works collaboratively with university and industry partners on projects involving robotics, advanced sensors, environmental treatment, and worker and food safety technologies to enhance the productivity of Georgia’s agribusiness.

“Our goal is to transition the technologies we create from concept to commercialization as quickly and economically as possible,” says Doug Britton, program manager and senior research engineer at ATRP.

While much of the work at ATRP is on the poultry industry, they are looking at several innovations for the peanut industry with support from the Southeastern Peanut Research Initiative and other national organizations.

“With the kinds of sensors being developed at Georgia Tech, they could feasibly alert a farmer when the plants are a week out from perfect harvest time — and it would likely be more accurate, too.”

Don Koehler

“Through our partnership, we have peanut physiologists studying the effect of different kinds of stresses on peanut plants,” explains Britton. “By examining the volatile organic compounds (VOCs) they emit — basically what the plants ‘breathe’ out — we want to see if the crops can give us an early alert about water stress, pest damage, nutrition challenges and more. With this technology, we could fix small issues before they take down a farmer’s entire crop.”

Koehler sees a big benefit to this work with VOCs: While the technology is mainly a diagnostic tool at the moment, he sees the potential in the future for it to help farmers know exactly the right moment to harvest their crop for the ultimate yield.

“Now, growers have to go into the field, pluck a few pods, and examine the internal color to see how mature the crop is — it’s time-consuming and a lot of work,” Koehler says.

“With the kinds of sensors being developed at Georgia Tech, they could feasibly alert a farmer when the plants are a week out from perfect harvest time — and it would likely be more accurate, too.”

The ATRP is also looking at the peanut buying point — the supply chain stage at which farmers bring their

products in to have them graded and assessed. Through the regulations set forth by the Georgia Federal-State Inspection Service, peanut production companies have human graders in the buying point room who measure quality aspects — such as rot, mold and decay (RMD); size; and the presence of aflatoxins or foreign materials — to help classify the peanuts into the appropriate grade.

“Because having people in charge of this process naturally makes it subjective, we’re partnering with industrial processing machinery manufacturer Lewis M. Carter, the USDA’s Agricultural Research Service, and others to discover how we can automate this stage through image processing, moisture sensors, automated cleaners, and more,” says Britton.

When Agriculture Meets Technology

For Koehler, the interdisciplinary nature of science and engineering at Georgia Tech is a huge benefit to the peanut industry as a whole. Rather than only employing agricultural engineers as they might have in the past, peanut growers profit from the input of thinkers and innovators with backgrounds in electrical, industrial, environmental, manufacturing and more.

“I’m very proud of the way we have embraced technology programs with Doug at the ATRP and all throughout Georgia Tech, and a lot of it had to do with the state’s Commissioner of Agriculture, Gary W. Black. He wanted the peanut industry to get out of the rut we were in and discover engineers with different areas of expertise who could offer something to agriculture, from smartphone apps to building more efficient equipment.”

By continuing to partner with Georgia Tech, Koehler hopes to capitalize on the expertise of the innovators on campus to explore new avenues for advancement in the industry.

“One of the biggest things for the peanut industry is that we need more and more investment in engineering technology,” says Koehler. “Farmers today want to be able to process their own product and add their own value to the marketplace by producing new products and selling directly to the consumer — like flavored oils or peanut flour — and we want to have the ability to get them there. The microbrewery industry did it, so there’s no reason the peanut industry can’t do it, too.” ◀



Above: Researchers Judy Song and Daniel Sabo install air sampling equipment used to collect volatile organic compounds from peanut plants. BRANDEN CAMP



Left: Analyzing the compounds of peanuts could indicate when the plants are under stress, allowing farmers to adjust growing conditions. BRANDEN CAMP



IN THE
WAY OF



TRAFFIC

Three Georgia Tech engineers work to speed mobility – and slow an obstacle to growth

We've all been there. Driving along at posted speed, or a little above, coming up on the lights. Red. They could be traffic signals or brake lights; we might have spied them in the distance or been surprised at the bend. And then we are stopped. Then we move a little. Then stop. Move. Stop. *Wait.*



Science has not rendered a full picture of what happens to us when we engage in this sequence again and again. But studies show it takes a toll — respiratory ailments, mental stress, even incidence of domestic violence. What is certain is that time in traffic is forever lost. To be stuck is to surrender minutes in a commute, hours in a week, days in a year, weeks and months in a lifetime.

And it's an oddly deceptive experience. Three out of four of us are alone in the vehicle. Traffic is about the masses, but it feels solitary. In reality, road congestion is the product of exquisite interconnectedness and interdependence: What happens in one place affects all the others.

That perfectly describes what it's like to solve traffic congestion, too. From vast highway projects to the placement of a single sign — and all the strategy and policy in between — reducing congestion requires minds that can break apart a problem and work through complexity. In other words, the minds of good engineers.

Tech engineers Meg Pirkle, Jacob Tzegaegbe and Angshuman Guin work every day for the sole purpose of relieving Georgia's clogged roadways, particularly in the Atlanta region, now ranked 11th in the nation for bad traffic. While their roles vary, a common thread runs through their work: Each must unlock the intricate, interconnected pieces and people in order to move our growing region and state toward greater mobility.

In the years ahead, as you get around Atlanta and further-flung Georgia locales, your experience will have been influenced in some way by these three Georgia Tech engineers. Traffic will never disappear, but your encounter with it will change — and for the better.



Jacob Tzegaegbe
Senior Transportation Policy Advisor
City of Atlanta

The Orchestrator

JACOB TZEGAEGBE

B.S. and M.S. in Civil Engineering, '11, '13

Known as: Senior Transportation Policy Advisor, City of Atlanta

Which means... He develops the processes needed to analyze and solve complex issues in mobility.

Fighting traffic: Tzegaegbe (pronounced zeh-guy-BEH) was tapped by Mayor Keisha Lance Bottoms in fall 2018 for a big assignment: help coordinate the prioritization of infrastructure projects to be paid out of a city bond referendum and TSPLOST sales tax increase. Voters had approved the projects and two funding sources in 2015 and 2016 — thought to be \$940 million worth of improvements, mobility included — but only \$540 million in funding ended up being available.

Tzegaegbe was integral to engineering a process that supported the “re-baselining” of work. It involved sound

technical analysis of projects and creating a financial model driven by scenarios, then sharing the resulting information with the public in eight community meetings, as well as with Atlanta City Council. In March 2019, the City Council voted unanimously to adopt the re-baselining plan that resulted from the effort.

Mayor Bottoms asked Tzegaegbe to lead another big initiative — exploring how to combine the city’s three transportation divisions into a single department. Officially created in summer 2019, the city’s new DOT will streamline planning, building and financing to improve mobility throughout the city. When fully operational by the end of 2020, the department will “make my role redundant and obsolete, which is the goal,” Tzegaegbe says.

Engineering connections: “A week doesn’t go by where I don’t have a conversation with someone from the Atlanta Regional Commission, GDOT, MARTA and the ATL (Atlanta Regional Transit Link Authority),” Tzegaegbe says. “Transportation is a team sport, involving different jurisdictions. And traffic is like fluid. It moves to the place



Meg Pirkle
Chief Engineer
Georgia Department of Transportation

of least resistance, but you always have to be aware that fixing a problem in one place may create a problem in another.”

An alternative view: A professor once told Tzegaegbe that traffic is not always a bad thing. “When you think about it, if you drive down the street and see one restaurant with no one in it, and another with 15 people waiting to get in, which is better?” Tzegaegbe asks. “Of course, we always need to work to reduce congestion, but we have to remember that congestion is a symbol of growth and the economy doing well.”

Worth noting: Tzegaegbe describes the “triple convergence theory,” which holds that widening roads actually adds to congestion. “People start taking that route again because the road is wider,” he explains. “And then people who were using other modes of transportation start taking it, too. Then the new roadway attracts new development, bringing even more vehicles. That’s the triple convergence.”

The Chief

MEG PIRKLE

M.S. in Civil Engineering, '97

Known as: Chief Engineer, Georgia Department of Transportation

Which means ... She makes sure the engineering gets done on roadways and infrastructure.

Fighting traffic: Weeks after Pirkle was appointed in 2015, the Georgia General Assembly passed the Transportation Funding Act, a piece of legislation designed to help the state catch up on projects to improve traffic congestion and infrastructure. From that act was born a massive initiative, the Major Mobility Investment Program (MMIP): eleven initial projects totaling an investment of \$11 billion, all with the goal of being completed or underway within 10 years.

The MMIP involves much more than road expansion. Express lanes are a key concept; GDOT had great results adding reversible express lanes to I-75 and I-575 that reduced rush hour by over one hour in both morning and evening commutes. Commercial vehicle lanes are another approach. On I-75 north of Macon, a critical freight corridor, they'll be used exclusively by trucks carrying freight.

By 2030, the MMIP is projected to reduce traffic delay in Georgia by 5 percent, a figure that accounts for expected population growth in the state. "It doesn't sound like much, but if your commute is an hour, that's a half-hour saved every week," Pirkle says.

Engineering connections: GDOT's work isn't done in isolation — quite the opposite. Pirkle recounts how leadership of the region's five transportation-related organizations sit down each month just to stay in touch. The department's partnerships with industry are growing stronger as well. "A lot of contractors bring us good ideas in the procurement process," she says. "So, we get to see which of these innovations will save us money." Sometimes that involves private financing through what are known as P3s, or public-private partnerships. "On the I-285 and GA 400 project, the developer building the project ended up financing a lot of it through leveraging private resources. That saved the state almost \$370 million."

A day in traffic history: In March 2017, Pirkle was in the stands at Grady High School watching her daughter's lacrosse match when she noticed smoke in the distance. A call came in from a colleague letting her know that a bridge section of I-85 was on fire. Ten minutes later, Commissioner McMurry called her. "The bridge has collapsed," he said.

Pirkle left the stadium immediately. For the next few days, GDOT staff moved at lightning speed to redesign support beams, develop project specs for repair, secure federal funding and hire a contractor. "We were also bombarded with calls from the national news media and anyone else you can imagine," she recalls. "At the same time, NTSB started its investigation, so we had a lot of information gathering to do, too."

Pirkle credits teamwork inside the department and collaboration outside of it for completing the new section of highway in six weeks, a month faster than anyone expected.

Worth noting: Pirkle is the first woman to serve as Chief Engineer.



The Pioneer

ANGSHUMAN GUIN

M.S. in Civil Engineering, '99, Ph.D. in Intelligent Transportation Systems, '04

Known as: Senior Research Engineer at Georgia Tech
Which means ... He explores and develops technology for connected vehicles (CVs)

Fighting traffic: Guin's phone rang in 2018 after transportation officials in Gwinnett County won a grant from the Georgia Smart City Challenge. They knew he was the man to help them shape a plan for connected vehicle technology, which allows vehicles to communicate with infrastructure and each other to improve mobility and safety. Their target: A 20-mile stretch of Peachtree Industrial Boulevard, from the ultra-congested intersection of Holcomb Bridge Road in the south all the way up to the Hall County line.

Though CVs are being evaluated in the Atlanta region — test beds are up and running in town, and GDOT has a \$2.3 million grant to add CV infrastructure to 1,700 signals — they're a long way from providing everyday benefit. The main reason is uncertainty over technology. Should short-range radio communications be added to vehicles? Or a newer technology that will work with high-bandwidth 5G?

Thus, Guin's work for Gwinnett currently centers on equipping emergency vehicles on Peachtree Industrial.

He's exploring how current traffic flows through the road's 30 intersections — and how adding on-board units to fire trucks will assure faster and safer responses.

Engineering connections: When vehicles connect and communicate with the world, the implications are huge. The road will tell drivers that accelerating or slowing down will get them there faster while using less fuel, given existing traffic and signal patterns. “Just by having this technology deployed, we can reduce car crashes to near zero,” Guin says.

What CV tech offers: Apart from the obvious safety benefits, a network of connected vehicles can deliver mobility benefits such as priority access and preemption at traffic signals. Priority means the signal changes for you to improve mobility for everyone; so, a transit bus running late or five trucks stacked up at a traffic light might be allowed through if doing so increases traffic flow. Preemption automatically changes a signal to let a vehicle through. Everyone would love to have preemption, but it's likely to be reserved for emergency vehicles.

Then there's this: In summer 2019, Georgia Tech researchers released a report that showed the catastrophic gridlock that could occur if hackers were to break into connected vehicle systems.

Worth noting: Guin also co-founded InstaData Systems, which collects, interprets and analyzes big data.


What they say: “As the lead developer of InstaData, Angshuman provides us with a software app that pulls info from thousands of traffic detectors from across metro Atlanta and visualizes it in real time. It starts with massive spreadsheets and databases and translates those into graphs and curves that populate in real time. So, for example, if we decide to change the time of ramp meter, we can use this tool he developed to see how traffic responded in real time as soon as we make the change. Before, it took weeks of work.” — Andrew Heath, State Traffic Engineer, GDOT ◀



Angshuman Guin
Senior Research Engineer
Georgia Tech







JUST ADD ENGINEERS TO THE MIX

FOR THE STATE'S FOOD MANUFACTURERS,
A GEORGIA TECH PARTNERSHIP IS THE
SECRET INGREDIENT TO GROWTH

You would expect a building where vinegar is made to have a sour smell, highly pungent, perhaps with a whiff of apple. World Technology Ingredients (WTI) smells nothing like this. Their manufacturing facility, off a county two-lane in Jefferson, Georgia, has a vaguely mineral aroma. More dry than dank, and not altogether unpleasant.

Maybe that's because the vinegar made here isn't destined for grocery store shelves, but for food preservation. It's called buffered vinegar, an all-natural additive that protects meats and other products from microbes. WTI makes a lot of this vinegar, more than they used to in fact, and that's partly because of Damon Nix.

On this Friday afternoon, Nix is taking a visitor through WTI's plant, pointing out its sectors and stations. Here's the wet vinegar, seven titanic tanks and even more smaller ones, emitting a hiss-and-motor chorus of mechanized blending. Over here's the powdered version, mixed in towering contraptions on chalky floors (that will later be cleaned), then heated, blended and bagged.

Nix stops at a white board with dry-erase markings that tell another story of what's going on inside the plant — one of continuous improvement. Sketched out are five days of the work week, four areas of focus (safety, performance, schedule, issues) and an assortment of metrics. One of WTI's workers happens by, and after glancing at the white board, Nix congratulates him.

"I think y'all are doing great," he says. "These are good numbers."

Nix doesn't work for WTI. He's an industry manager for the Georgia Manufacturing Extension Partnership, or GaMEP, a Georgia Tech-based, engineering-centric program that helps small and mid-sized manufacturing companies in the state perform better. As the partnership's food and beverage point person, Nix applies his industrial engineering education from Tech to help manufacturers up their game and lower their costs.

"What I really do is facilitate problem solving," says Nix (B.S., ISyE, '01). He is careful to emphasize the facilitation part. He doesn't arrive as the dreaded efficiency expert, handing down mandates and new processes to those on the floor. Rather, he operates as the quintessential engineer — conducting research, listening to people, and fostering ownership of change. When he introduces new knowledge, such as time-tested principles of lean manufacturing and quality control, it's more as a coach guiding a player who's motivated to improve.



World Technology Ingredients (WTI) is a leader in the food safety and ingredient industry, working closely with food processors to enhance product flavor and boost product quality. PHOTOS COURTESY WTI



“In organizations that really succeed, teams are empowered by top management,” he says. “The team has to own the process. I could go to a meeting and offer a bunch of ideas, but half of them wouldn’t be nearly as good as what people inside the company put forward and act on.”


Rise of an engineering partnership

Georgia Tech has been in the game of helping small and mid-sized manufacturers for a long time. A century ago, the idea of creating an engineering counterpart to America’s agricultural experiment stations was being debated in Congress. But the Georgia General Assembly didn’t wait for the debate to conclude — it voted in 1919 to launch an “engineering experiment station” (EES) at Georgia Tech.

Curiously, lawmakers didn’t fund the new enterprise. It wasn’t until 1934, midway through the Great Depression, that EES got its first state allocation of \$5,000 and was assigned an acting director, Harry Vaughn, who described the experiment station as “Georgia’s first agency designed to aid in a comprehensive development of industry.”

In 1960, the General Assembly ratcheted up Georgia Tech’s assistance to industry, passing a bill to form an Industrial Extension Service as part of the earlier EES. That authorized Georgia Tech to create field offices around the state to provide “technical advice and assistance to local development groups and to establish(ed) business and industry.” The new service was the forerunner of today’s GaMEP. The partnership sharpened its focus on manufacturing in 1988 after Congress passed a national program, the Hollings Manufacturing Extension Partnership. The Industrial Extension Service later designated GaMEP as one of 70 MEP affiliates.





Driving much of the food and beverage industry's growth in Georgia are companies of 50 or fewer employees. These are the makers of local craft beers, hometown jellies and artisan mustards.

(EES, by the way, later became GTRI, the Georgia Tech Research Institute.)

GaMEP, which turns 60 next year, is today housed inside Georgia Tech's Enterprise Innovation Institute — a good fit, given its economic development focus. With 10 offices throughout Georgia, it now has a solid track record of helping small and mid-sized manufacturers grow. One of these is Dalton-based Precision Products, which manufactures a wide range of parts to order and has achieved two crucial ISO certifications that opened the door to new customers and industries. Sales grew by more than \$3.5 million. And Goldens' Foundry and Machine Co., a 130-year-old enterprise, wanted to strengthen employee communication and problem solving. GaMEP helped them introduce a management system designed to bring company conversations to the plant floor and improve information flow.

Packaging insight into food processing

One area historically underserved by GaMEP is the food and beverage industry. "It's the state's top manufacturing sector," Nix says, "yet it had not been our number one customer." So, in 2016, he was assigned to develop an initiative to broaden and deepen partnerships with businesses in the industry.

Driving much of the food and beverage industry's growth in Georgia are companies of 50 or fewer employees. These are the makers of local craft beers, hometown jellies and artisan mustards. Nix says about eight of 10 food processing companies fit that size profile, though they are dwarfed in sales by the other 20 percent, the larger manufacturers.

So he developed a market analysis and concluded that super-sizing a commitment to food and beverage would





be a good fit. The demand was there, too. Food processing employs nearly 70,000 Georgians and accounts for \$12 billion of the state's GDP every year, according to a 2016 report from Georgia Power. Since GaMEP stepped up efforts to serve the industry in 2017, the average number of projects with food and beverage companies more than doubled, from 20 to 45.

When asked to describe the greatest problems facing these manufacturers, Nix quickly cites compliance with safety regulations, which, to a small food business, run from complex to bewildering. "If you're in a business of 10 to 20 people, you may not have a food scientist on staff," he says. "So, you've got to figure out compliance on your own, or else bring in consultants."

Safety, he notes, is more than just following protocols in production. It involves attending to details in reporting and paperwork, all the way down to the product label. Nix shares the cautionary tale of an Oregon maker of seasonings that neglected to include hazelnuts in its list of ingredients on the label. "Of course, nut allergies are a huge issue," he says. "That one mistake could have ruined their entire product distribution. The damage to the brand, and the cost of bringing back the brand, is so significant."

While GaMEP knew it could help food companies in an array of ways — from process management to energy usage to business growth — leaders found they had a gap in food science expertise. Food science determines the safety profile of every jar, tin, box and bag of product. So they brought in a food manufacturing safety whiz, Wendy White, who had experience overseeing a portfolio of food products. White is now leading a new GaMEP program on safety, funded by a three-year grant totaling nearly \$1 million.

For the ingredients company WTI, the primary challenge has not been safety but improving processes and efficiency. When asked what impact he's seen from GaMEP's help, Stephan Georg, the company's director of strategic sourcing, recounts a conversation between a shift foreman and consultant in front of one of the Gemba white boards.

"The foreman said the plan was to make two batches of a product," Georg says, "but the consultant answered,

When asked to describe the greatest problems facing these manufacturers, Nix quickly cites compliance with safety regulations, which, to a small food business, run from complex to bewildering.

"Well, I think you can do five batches. The foreman thought that was unrealistic. So we brought in Georgia Tech, and the first thing Damon does is conduct time studies. It gave us that baseline information we needed. After that groundwork, we determined that three batches would be a good goal."

Since then, Nix has visited with workers from WTI's round-the-clock shifts and consulted with management. Together, they work through improvements born out of lean manufacturing, which are processes engineered to reduce waste and improve customer satisfaction. The goal is to reach 40 percent overall equipment effectiveness for producing buffered vinegar, a metric built on several components of the manufacturing process.

More recently, Nix introduced a new tool to these efforts: A software platform called Impruver, developed out of Georgia Tech's Advanced Technology Development Center (ATDC). It's designed to help small and mid-sized manufacturers of consumer products spot trends in metrics, track performance and monitor ongoing issues. "It's great to have another entity inside ATDC working with us and our clients," Nix says.

While all of GaMEP's contributions are welcomed, Stephan Georg has special praise for the non-engineering side of Damon Nix. "While he looks at the facts and explains things in a scientific way, he also treats people here with respect," Georg says. "They see that he's not here to get them fired. He's the guy who's here to help." ◀

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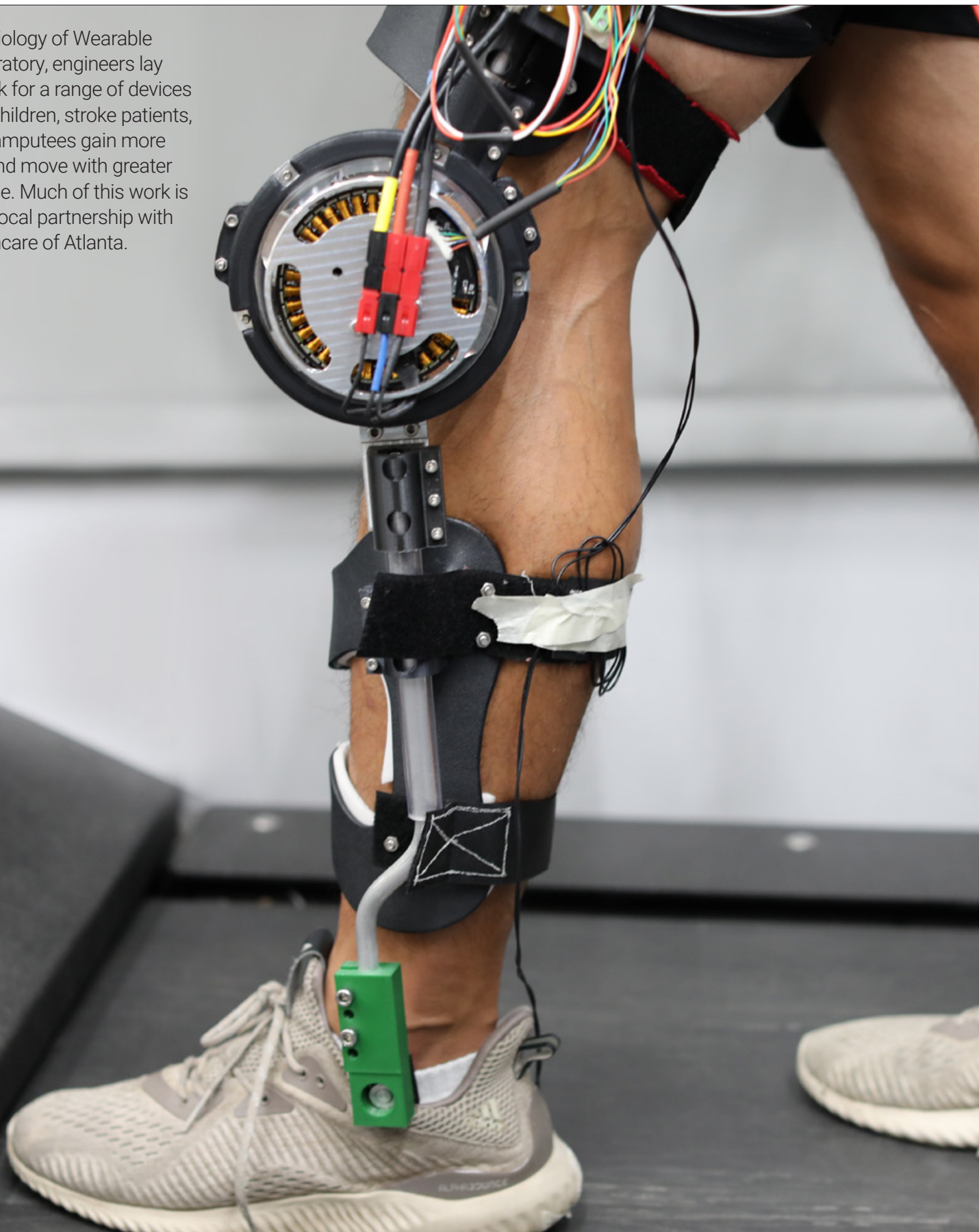
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in the field

Inside the Physiology of Wearable Robotics Laboratory, engineers lay the groundwork for a range of devices that could help children, stroke patients, the elderly, and amputees gain more independence and move with greater comfort and ease. Much of this work is done through a local partnership with Children's Healthcare of Atlanta.





Swinging Through the Fields

Engineers are building a new type of robot, and it's going to revolutionize farming



Ai-Ping Hu

Awoman stands in a soybean field in Athens, Georgia, baking in the summer sun as she leans down to measure the angle at which a leaf wilts toward the earth. She's a graduate researcher trying to determine which of the soybean varieties planted in the field are most resistant to the oppressive heat and lack of rain. She wipes sweat from her brow and continues down the row. This is the seventh time this summer she has made her way through this soybean field, meticulously taking measurements.

She's researching soybean phenotypes — the outward expression of each plant's genetics. Researchers plant various strains of the same crop, like soybeans, and then meticulously study acres of plants in order to determine which strain is most drought resistant. Hopefully, this will be one of her last summers manually monitoring the plants — advances in automation are just around the corner. Georgia Tech robotics engineers are in the final stages of refining technology that can automate the tedious and time-consuming process of examining crops.

"Since [researchers] have all these genetic varieties, the only way they can tell which ones will thrive in arid environments and propagate is to do testing like this," said Ai-Ping Hu (MS and PhD, Mechanical Engineering), the principal investigator for this project and a researcher in the Food Processing Technology Division of the Georgia Tech Research Institute. "It's basically in vivo testing. Whatever the natural soil conditions are, whatever's in the air, that's



The brachiating robot team shown during testing in a soybean field. (L-R: Jonathan Rogers, Georgia Tech; Ai-Ping Hu, GTRI; Adam Garlow, Mechanical Engineering undergraduate; Evan Davies, Robotics Ph.D. student; Siavash Farzan, Robotics Ph.D. student; Zenglu Li, University of Georgia; Clint Steketee, University of Georgia Plant Genetics Ph.D. student. AI-PING HU

all taken into account. You can't replicate that experiment in an inside laboratory."

Georgia Tech engineers have come up with what they think is the perfect way to automate phenotype studying: a robot that swings on cables suspended above the fields. It might sound like something from the future, but the swinging robot is very real. It moves via "brachiation," which is the technical term used to describe the ways primates swing from tree to tree. Brachiation is an entirely new form of robotic movement, and Georgia

Tech researchers are the first in the world to develop a robot that brachiates on flexible cables. Researchers say it is more energy efficient and adaptable than other forms of robotic movement.

Hu and his team are developing the robot in partnership with the UGA Soybean Breeding and Molecular Genetics Laboratory to more efficiently conduct field research. However, Hu speculates that the robot could become a valuable asset to farmers as a persistent, rather than intermittent, tool to monitor crops.

In the center of the brachiating robot is a small platform that houses sensors, such as thermal detectors or 3D cameras. Two arms extend from the platform, each bearing a grasper with the ability to precisely sense where the cable is and when to clamp around it. The movement of the machine is reminiscent of a child swinging on a jungle gym; it swings from one arm until it has enough momentum for the other arm to reach up and catch the next portion of the cable.

Mechanical devices such as unmanned aerial vehicles have begun to be used to survey fields. However, these drones must be flown by humans and only for short periods of time. In comparison, the brachiating robot uses very little power and could use small solar panels to charge during the day and independently traverse the fields via wires at night. Plus, nighttime monitoring would be advantageous, because plants exhibit some of their most distinctive behaviors after the sun sets, such as respiration and opening of the leaf pores.

One of the challenges in developing the brachiating robot has been designing specific electronics and software for the hardware components of the machine.

“We have inertial measurement units that allow us to determine how fast the different linkages are moving, how fast the body is moving, and where they are in space,” said Michael Bick, an undergraduate student in mechanical engineering. “We use all of that information, constantly updating as we swing to try to follow the ideal path that uses the least amount of power required.”

The robot is unlikely to entirely replace farm workers any time soon. They still must carefully determine whether fruit and nuts are ripe before picking them. However, the robot may be able to augment the workforce where labor is lacking. A Georgia immigration law in 2011 caused laborers to leave the state, and the state lost \$140 million of crops that were left unpicked. With the brachiating robot as a tool for persistent monitoring, farm owners may be able to better determine which plants are ripe, and which may need more attention.

The robot is far from finished. The most recent development in the project was the addition of “wrists” for the robot that would allow it to turn 90 degrees and swing onto an adjacent parallel wire. Instead of traveling along a line, the brachiating robot could cover the entire 2D plane of a crop field.

In the not-so-distant future, instead of graduate researchers trudging through a field of soybeans, you might see primate-like robots swinging around on wires above fields, making sure plants are healthy and Georgia families are fed and full.

► POLLY OUELLETTE

**THE SWINGING
ROBOT MOVES VIA
“BRACHIATION,” WHICH
IS THE TECHNICAL TERM
USED TO DESCRIBE THE
WAYS PRIMATES SWING
FROM TREE TO TREE.**





QUENTIN LUENINGHOENER

Enhancing Security through Technology

Two Tech alumni use machine learning and better equipment to make neighborhoods in more than 400 cities in Georgia and across the country more secure with Flock Safety

A Flock Safety camera securely captures images while the proprietary machine learning algorithm identifies a vehicle fingerprint, including license plate, vehicle type and vehicle color.

In 2017, Garrett Langley noticed an uptick of burglaries and break-ins in his new Atlanta neighborhood over the winter holiday season. Concerned for his safety and that of his neighbors, he called the local police to ask for some help and discovered that with little concrete evidence, not much could be done to find the perpetrators.

“People have a false perception that grainy surveillance footage will help detectives find criminals,” says Langley, a 2009 electrical engineering alumnus and a HOPE scholarship recipient. “But in reality, they need at least a license plate number to make any real moves.”

In order to capture license plate information that the local police could use, Langley thought

about buying and installing security cameras, but they each cost \$25,000. Why, he wondered, was it so expensive to provide quality safety and security services when affordable, first-class camera hardware is so ubiquitous today?

Langley called up his friend and fellow alumnus Matt Feury (Computer Science '11) so they could brainstorm ways to build a less expensive, more effective security solution. Combining off-the-shelf components with the latest in machine learning, the duo had the beginnings of a viable product.

“Within 60 days, our cameras helped make an arrest by helping the police obtain the actionable evidence they needed to find the perpetrator,” Langley remembers. “So Matt and I

thought, ‘What if we spend more than a couple of weeks on this project — how big can we go?’”

HELPING POLICE AND CITIZENS WORK TOGETHER

And so, Flock Safety went from great idea to new company and is currently in use in 34 states across the U.S., helping solve a crime five times every hour. In more than 100 cities from Jersey Village, Texas, to Richmond, California, it is the primary source used by police departments to solve non-violent crimes.

Using an automatic number-plate recognition (ALPR) system that securely captures images, Flock Safety’s proprietary machine learning algorithm identifies a vehicle fingerprint, including license plate, vehicle type, and vehicle color. Data is stored securely and privately in the cloud and is easily searchable by both police and citizens through a footage portal.

Flock Safety is making a big impact here in Georgia — after the Marietta Police Department installed a trial license plate reader in a local neighborhood, crime rates dropped 34% over an eight-month period, leading them to make moves on purchasing 10 additional Flock Safety cameras.

Marietta police spokesperson Chuck McPhilamy calls the Flock Safety cameras an important part of “a combined package [that] has led to a decrease in crime.”

Likewise, Sandy Springs residents Carren and Stone Sellers were happy that Flock Safety cameras had recently been installed in their neighborhood when someone broke into their daughter’s car while it was parked in their driveway, stealing a laptop and other valuables. The Sellers asked Flock Safety for help, and the Crime Team helped them through the entire process, from reporting the incident to local police to letting law enforcement know that they could access key footage of the burglar’s vehicle leaving the neighborhood.

“The rule of thumb is that non-violent crime — break-ins, theft, smash and grabs — are crimes of opportunity and convenience, and statistically you only have a one-in-10 chance of getting caught,” explains Langley. “Criminals think, ‘It’s easy for me to break into your car and not get arrested, so I’ll do it.’”

Flock Safety takes the smartphone supply chain and builds software on top of it to help



WITHIN 60 DAYS, OUR CAMERAS HELPED MAKE AN ARREST BY HELPING THE POLICE OBTAIN THE ACTIONABLE EVIDENCE THEY NEEDED TO FIND THE PERPETRATOR.”

Garrett Langley

cameras interpret what they’re seeing. So instead of just seeing a blurry picture of a car, the camera acts like a detective and can determine that it sees, for example, a blue Honda CRV with damage on the passenger side door and a GA license plate from Fulton County.

TAPPING INTO GEORGIA TECH CONNECTIONS

When working on taking Flock Safety from an at-home project to a full-fledged business, Langley made a call to his senior design project mentor Steve Chaddick, a fellow electrical engineering alum and mentor capitalist at Ridgewood Advisors.

“When we first got started, I hadn’t touched a circuit board in 10 years,” recalls Langley. “Steve played a critical role early on, giving us both technical and business advice to help us stay on top, since so many tech companies fail in the beginning stages.”

As they look to the future, Langley sees partnerships popping up in even more cities and states, as well as facilitating larger deployments with municipalities around the U.S. As police departments begin using Flock Safety, they can partner with the public to purchase their own cameras and help expand the coverage area.

“Flock Safety wouldn’t work nearly as well as it does if it was solely consumer or solely police,” says Langley. “Law enforcement is a challenging industry, and Flock Safety is a force multiplier that helps municipalities do their job better by streamlining the resources they use. In our experience, the safest scenario is a 50/50 split between police and citizens installing and using our cameras. The more we work together, the stronger we are.”

Langley credits his time at Georgia Tech with instilling in him the know-how and inquisitiveness to make Flock Safety a reality.

“Georgia Tech teaches you curiosity, which led Matt and me to question, ‘Why is the incumbent solution of standard home security systems so expensive? Should it be or is this a market opportunity in disguise?’ Because of this line of questioning and the foundation of knowledge we gained at Tech, we have developed a far superior product that is less expensive, does a better job, and has shaken up the home security marketplace.”

► KATHRIN HAVRILLA-SANCHEZ



CRAIG BROMLEY

Stephen Ruffin
Director, GSGC

Helping Georgia's Students Take Flight

How the Georgia Space Grant Consortium is supporting the state's aerospace industry and helping students shoot for the stars

Thirty 14-year-olds stand in a rural Georgia field about to launch a high altitude balloon 100,000 feet into the sky. For the past three weeks, their physics class has been learning how to use this massive inflatable to measure the weather, calculate the data, and track air pressure.

For a number of these students, this is the first time that science and engineering make sense and feel exciting. And it's all due to the Georgia Space Grant Consortium (GSGC), which provides the resources and support for young students to obtain an insider's view of the aerospace industry — and maybe even kickstart a few career ambitions along the way.

FLYING HIGH IN GEORGIA

Housed under Georgia Tech's Guggenheim School of Aerospace Engineering — home to one of the oldest and largest aerospace programs in the country — GSGC is a NASA program dedicated to increasing the number of Georgia students who are interested in science, technology, engineering, and mathematics (STEM) fields. The Consortium aims to

support space and aeronautics programs today and well into the future.

Every year, GSGC provides STEM education and hands-on activities at schools and science centers to 10,000 Georgia residents and supports professional development of more than 4,000 K-12 educators across the state.

“Our goal is to reach out to all parts of the state – both metropolitan and rural – and touch as many populations as possible,” says Dr. Stephen Ruffin, director of GSGC. “Half of the people we interact with are women – which far exceeds the overall aerospace industry percentage of 25 percent – and 40 percent are underrepresented minorities.”

GSGC offers everything from summer and academic year science programs for K-12 students, to college internships at NASA and local aerospace companies, to funding for science centers and planetaria across the state, to hands-on teacher trainings.

BRINGING AEROSPACE TO THE CLASSROOM

In June 2019, GSGC sponsored several K-12 teachers for LiftOff Summer Institute, an aerospace-focused workshop held in Texas that emphasizes STEM learning experiences by incorporating different NASA mission areas.

“When I was accepted to LiftOff, they put me in touch with GSGC to help with funding,” says Miranda Fritchman, a sixth-grade science teacher at Clarke Middle School in Clarke County. “We’re a small, Title 1 school, so having GSGC pay the entrance fee made it possible for me to attend.”

Along with her fellow K-12 teachers from around the U.S., Fritchman spent weeks at Johnson Space Center learning from NASA personnel, including Apollo 11 and 13 astronauts and engineers. With more of an earth science background, Fritchman was pleased that LiftOff helped her supplement her aerospace knowledge, as well as provided some hands-on learning elements so students can connect better to the material.



HALF OF THE PEOPLE WE INTERACT WITH ARE WOMEN – WHICH FAR EXCEEDS THE OVERALL AEROSPACE INDUSTRY PERCENTAGE OF 25 PERCENT – AND 40 PERCENT ARE UNDERREPRESENTED MINORITIES.”

Stephen Ruffin

“Students are enthusiastic about STEM, but they’re also scared of it,” says Fritchman. “Sixth grade is the first time they have dedicated science classes, so now is the time to help them learn how to think like a scientist, answer questions and test hypotheses.

“I also met a lot of people from NASA who came up through unconventional pathways. Many of my students feel like they can’t have an amazing career because they don’t come from the right neighborhood or background, so now I can show them with real examples that you can do it – everything is within your reach.”

GSGC AT GEORGIA TECH

As the leading institution and affiliate of GSGC, Georgia Tech has strong connections to the program. GSGC supports Tech’s Ramblin’ Rocket Club, which recently won the Spaceport America Cup competition with Sustain Alive, a 13.5-foot, 110-pound rocket that reached an altitude of 28,140 feet. GSGC also provides paid research fellowships to Georgia Tech graduate students to work closely with faculty, as well as sponsors programs that provide hands-on engineering internships to Atlanta-area high school students.

“So much of engineering is teamwork, and we infuse that into courses at Tech and in the programs through GSGC,” says Ruffin. “We support innovation by offering a strong STEM background, as well as fostering creativity and an environment in which students feel heard and have the confidence to speak up.”

Looking ahead, GSGC will sponsor more educational opportunities for teachers, such as at the ninth annual Georgia NASA STEM Conference, which provides more than 100 Georgia educators with hands-on activities and presentations by NASA Education Specialists and other NASA program members. In addition, GSGC continues their outreach into Georgia’s school districts with new K-12 programs, including Georgia Outreach Team for Space, which leverages students from Tech to build a STEM network across the state through presentations, demonstrations and mentorship.

► KATHRIN HAVRILLA-SANCHEZ

Aerospace is big business in Georgia: The state ranks eighth in industry employment in the U.S., and nearly **200** aerospace companies operate out of Georgia, from Lockheed Martin to Gulfstream to Boeing, as well as the world’s busiest airport. Aerospace products are Georgia’s primary export, totaling **\$9.1 billion** annually, according to the Georgia Department of Economic Development.

10 TO END



10 Questions with Fred Cook

Carpet means big business in Georgia, and Tech professor Fred Cook has been instrumental in bringing cutting-edge textile and polymer chemistry research to the industry. Starting in the 1970s through research and consulting, he helped the likes of Shaw Industries create today's carpet capital of Dalton, just 90 miles outside of Atlanta. Cook is an alumnus and professor emeritus in the School of Materials Science and Engineering (MSE). Outside the halls of academia, he has also served as an expert witness in high-level patent court cases. He also makes time to take care of his horse and cattle farm in Jackson.

1 ▶ Where are you from? Jackson, Georgia. **2 ▶ When did you graduate from Georgia Tech?** In 1971, I got my bachelor's in textile chemistry. Back then, it was the School of Textile Engineering. Today, it's the School of Materials Science and Engineering. In 1975, I was the forerunner of the Textile Engineering Ph.D. program, but, officially, I earned my doctorate in organic polymer chemistry. **3 ▶ What is your role at Tech?** I am professor emeritus in MSE and retired three years ago. **4 ▶ What got you interested in textile research?** It actually goes back to when I was in high school. I'd already been accepted into chemical engineering at Tech. A group of faculty came by the high school, recruiting for what was then the school of textiles. There was one guy, Gerald Fletcher, who gave me a quote I never have forgotten. He said, "Chemical engineering goes up and down, depending on what the oil market is doing. But as long as we don't go nude, people will always need clothes." That made good sense to me. **5 ▶ Why is Dalton, GA, the carpet capital of the world?** Well, the whole industry developed out of Dalton, Georgia. The forerunner to it was the chenille bedspread industry. In the early 1900s, a woman in the mountains of North Georgia came up with this idea of tufted chenille bedspreads, and her sons formed an industry around the concept, developed the machinery and automated it, and started producing chenille bedspreads for the masses. After WWII, they had the idea of using a cheaper nylon fiber that could be tufted and glued to create a carpet floor covering that the public could afford. Up until then, carpet was woven from wool yarns and very expensive. The cheaper tufted carpet essentially made the floor covering available to the general public. By adapting and modifying the chenille bedspread machinery, tufted nylon carpet with woven backing gave us today's modern floor covering. The bottom-line, Dalton is the carpet capital of the world because about 90 percent of the tufted carpet that's made in the U.S. is made within about 60 miles of downtown Dalton. **6 ▶ What is Tech's role in the carpet industry?** Well, it's been two-fold, historically. First,

we've supplied the industry with world-class graduates. As the industry literally exploded starting in the '50s and '60s, they needed solid technical people to come in to grow and expand the industry. What better place to look for engineers and scientists than Georgia Tech? Shaw Industries especially took the lead in hiring Tech folks. That's how Shaw Industries became so prominent. They did wondrous things. Second, through joint research and development projects, Tech made contributions to new technologies for the industry. **7 ▶ How has your research helped to improve the carpet industry in our state?** By 1975, The School of Textile Engineering was already starting to supply the industry with a significant number of graduates. We also became the fundamental research arm for the carpet industry. We had the contacts; we had our graduates there; and there was just tremendous synergism that we were able to develop. Though companies like Shaw are very, very successful, even they can't set up a fundamental, ground-up, Ph.D.-driven research operation. **8 ▶ What do you see as the number one innovation that Tech has been a part of within the carpet industry?** Definitely stain-resistant topical finishes for nylon carpet. These fluoropolymer finishes gave the carpet stain-proof resistance to spills of liquids like grape Kool-Aid and coffee. As an example of how we partnered with the industry, I developed a process that sprayed powder fluoropolymer directly into the carpet tufts, followed by a melt stage to coat the surface. This process not only protected against stains, it saved energy and cut down on pollution, as it was a totally dry application. **9 ▶ What was it like being an expert witness in court?** I was involved in some large trials. For example, two Taiwan-based companies entered into a patent war over seam technology in men's and women's dress shirts. I served as an expert witness. We gave our side guidance, testified in the court case itself, and plotted strategy. It was high stakes drama with multi-million-dollar implications. **10 ▶ What is your favorite fabric?** Tufted carpet. It's the epitome of engineering and design.

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Once again, Georgia Tech is graduating more female engineers than any other institution in America. #TheFutureIsFemale #HelluvaEngineer

