Georgia Tech | Research Institute

ANNUAL REPORT
2019

CREATING THE NEXT®

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Welcome
Message from the Director

Hello, and welcome to Georgia Tech Research Institute's (GTRI) 2019 Annual Report. I am thrilled to share with you the many accomplishments from this past year. We are proud of what we do at GTRI, the innovation hub for award-winning and nationally renowned researchers, engineers, and industry professionals who are dedicated to bringing innovative solutions to some of the world's most complex challenges.

The Georgia Institute of Technology's (Georgia Tech's motto), "Creating the Next," means we are in constant search for the next solution or innovation. As the highly regarded applied research unit of Georgia Tech, and as a Department of Defense (DoD) University Affiliated Research Center (UARC), we are a team of more than 2,400 ambitious individuals who take on challenges facing government and industry across the country and around the world. I had the privilege of joining this organization as the new GTRI director and senior vice president of Georgia Tech in September 2019. Together, we are embarking on the next chapter of GTRI.

With GTRI's growing capacity, fiscal year 2019 (FY19) provided the opportunity for us to make an impact on education, the State of Georgia, national security, and society as a whole. During FY19, GTRI recorded research awards totaling $643 million and revenue earned of $504 million. I am honored to present to you the work made possible through those funds, which are making a significant difference for the warfighter, the community, the state, and the world.

Annual Accomplishments

• Developing a prototype telemetry antenna that would allow continued testing of a widely used surface-to-air missile, following the relocation of military frequencies.
• Launching five different types of solar cells fabricated by Georgia Tech research teams for testing aboard the International Space Station (ISS).
• Partnering with the Office of the Secretary of Defense, Strategic Capabilities Office (OSD/SCO), GTRI created ThunderDrone, a competition of some of the world's best drone detection technology companies to zero in on airborne enemies and advance anti-drone technology for the nation's defense.

• Installing a new simulator in GTRI's Huntsville Office to further support GTRI's efforts with the UH-60 Black Hawk helicopter, the Army's primary medium lift utility transport and air assault aircraft.
• Partnering with the Advanced Airlift Tactics Training Center (AATTC), which provides training in defensive maneuvers, countermeasures, and tactics for mobility forces.
• Renovating the toilet to operate without conventional water supplies or sewerage connections, which addresses a global need and could improve sanitation for 2.5 billion people worldwide.
• Supporting a study leading to new guidance for health practitioners on which antihypertensive drugs should be prescribed first for patients with high blood pressure.

To our research sponsors and potential sponsors, to our peers and colleagues across industry and academia, to our military and civilian leaders, and to our men and women in uniform for whom much of our work is dedicated, thank you for your partnership, your support, your willingness to enact change, and your commitment to improving the human condition.

I am thrilled about what the future will bring to GTRI. Our eyes are fixed on the horizon of development — implementing our knowledge, continuing to learn, and recognizing whom we can call on for support. GTRI remains ready to take on your most challenging problems, and we look forward to engaging with you further in future endeavors.
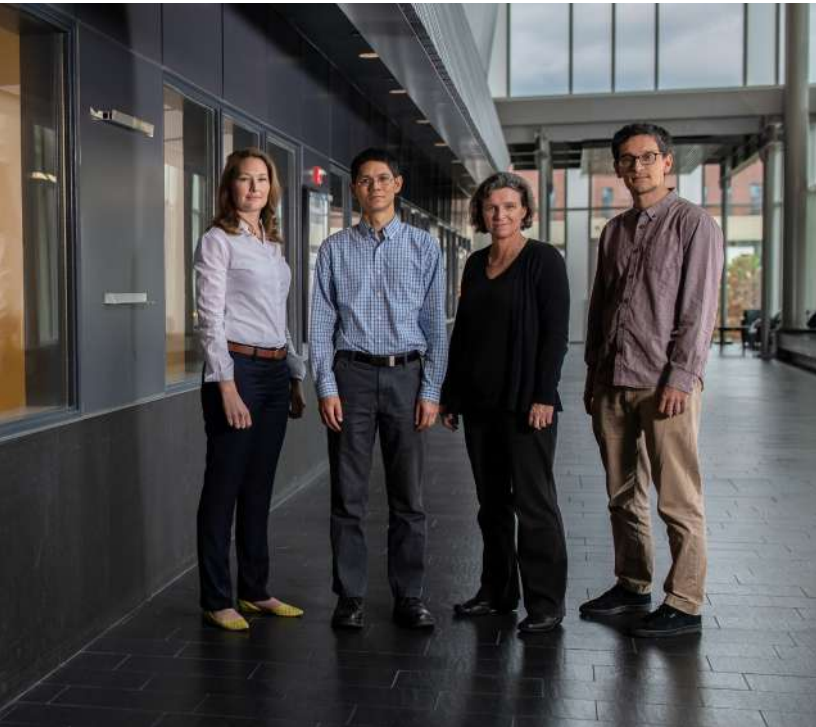
James Hudgens
Director, Georgia Tech Research Institute
Senior Vice President, Georgia Institute of Technology

NATIONAL SECURITY

National Security

With approximately 90% of GTRI's contract awards stemming from the Department of Defense (DoD) and United States military, our organization is heavily focused on defending our nation. GTRI is the Army's largest University Affiliated Research Center (UARC) and the second largest of all 15 UARCs, allowing us to provide breakthrough technical innovation for national security and government application. By maintaining long-term relationships with our DoD sponsors, GTRI strives to always offer our expertise and technical capabilities to defend our nation.

Unleashing DNA's Data-Storing Potential

A new public-private research initiative led by GTRI could help meet the growing demand for archival data storage by taking advantage of DNA — an efficient and robust information storage medium that has proven itself through the centuries. While current archival storage has a limited lifetime, information stored in DNA could last for hundreds of years. The Intelligence Advanced Research Projects Activity (IARPA) has awarded a contract to a team that also includes Twist Bioscience, Roswell Biotechnologies, and the University of Washington in collaboration with Microsoft. The goal is to develop scalable DNA as the basis for deployable storage technologies that can eventually scale into the exabyte regime and beyond.

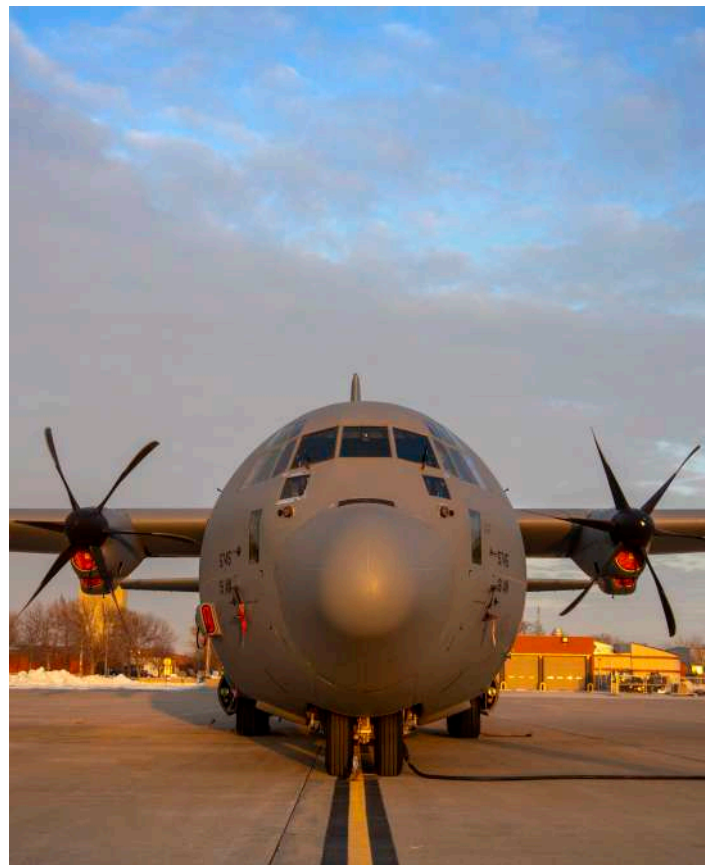# GTRI's UH-60 Black Hawk Simulator Supports Long-Term Army Projects

For many years, GTRI has supported the UH-60 Black Hawk helicopter, the Army's primary medium lift utility transport and air assault aircraft. Now, a new simulator installed in GTRI's Huntsville Office will enhance those efforts on a broad range of issues — including efforts to overcome the challenges of Degraded Visual Environments (DVE). The simulator provides full helicopter controls and can show pilots, researchers and other users visual environments generated by a broad range of sources, including Light Detection and Ranging (LIDAR) and electro-optical sensors. GTRI supports the Army's Program Executive Office — Aviation in multiple project offices, including responsibility for maintaining and enhancing the Army Aviation's enduring fleet.

GTRI Develops and Teaches Tactics to Defend Transport Aircraft

Teaching defensive maneuvers, countermeasures and tactics to service members of the mobility air force is the job of the Advanced Airlift Tactics Training Center (AATTC). Working with AATTC military instructors is a team of experts from GTRI, which for decades has partnered with mobility forces to develop technology to counter the threats that confront the military's transport aircraft. The GTRI team plays a pivotal role, helping students understand the science behind threats, such as heat-seeking and radar-guided missiles, as well as providing foundational knowledge of onboard aircraft systems and the measures used to defeat the threats.

ThunderDrone: Anti-Drone Technology Runs the Gauntlet

ThunderDrone was a buzzing anti-drone Super Bowl, pitting some of the world's best drone detection technology companies against each other in a competition to zero in on airborne enemies and advance anti-drone technology for the nation's defense. Competitors ran through three phases called rapid prototyping events (RPE) — each one more competitive than the previous — and ended in the Game of Drones, the final RPE, in which participants faced off with two types of small drones in real time. GTRI, sponsored by the Office of the Secretary of Defense, Strategic Capabilities Office (OSD/SCO), designed and operated the competition in collaboration with other organizations.
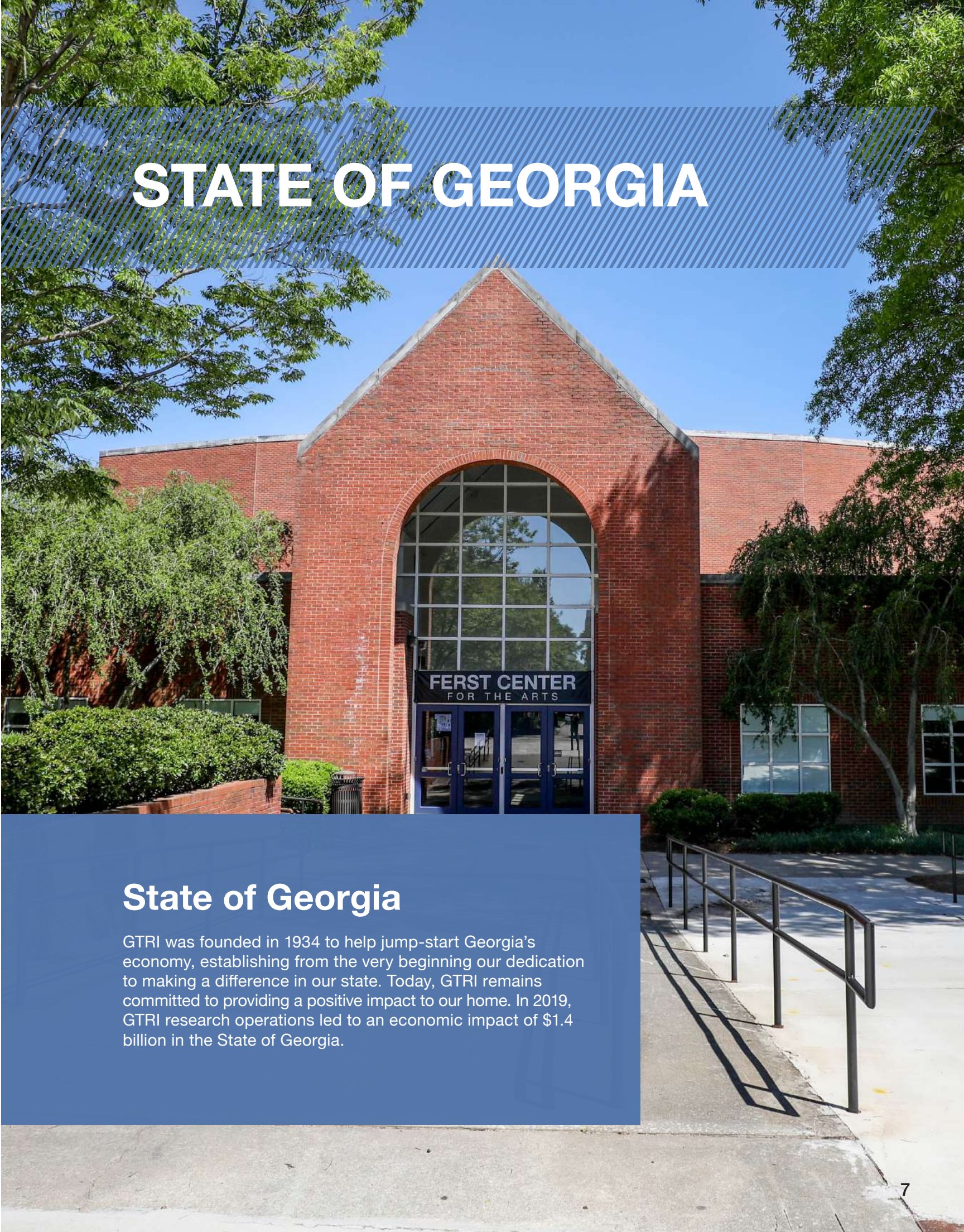
Telemetry Antenna Accommodates National Spectrum Changes

The reallocation of frequencies that had been reserved for military uses for decades has led GTRI engineers to develop a prototype telemetry antenna that would allow continued testing of a widely used surface-to-air missile. The prototype C Band antenna is designed to provide data on flight tests of the RIM-116 Rolling Airframe Missile used by the U.S. Navy.

Researchers paired GTRI's fragmented aperture antenna design technology with a switched beamformer to create a conformal antenna that keeps the downlink of the rotating antenna aimed at a ground station. The research was supported by the National Spectrum Consortium.

STATE OF GEORGIA

State of Georgia

GTRI was founded in 1934 to help jump-start Georgia's economy, establishing from the very beginning our dedication to making a difference in our state. Today, GTRI remains committed to providing a positive impact to our home. In 2019, GTRI research operations led to an economic impact of $1.4 billion in the State of Georgia.

Georgia Smart Communities Challenge Enters Second Year

GTRI researchers are supporting the Georgia Smart Communities Challenge, which helps local governments use intelligent infrastructure technologies to improve the quality of life for their citizens. Four projects were chosen for the program in 2019: Columbus Smart Uptown (Columbus-Muscogee County), Macon Smart Neighborhoods (Macon-Bibb County), Milton Smarter Safer Routes to School (City of Milton), and Woodstock Smart Master Plan and Corridor Study (City of Woodstock). Supported financially by the Georgia Power Company and Atlanta Regional Commission, Georgia Smart connects the communities with Georgia Tech researchers to carry out the projects. The City of Albany, City of Chamblee, Chatham County, and Gwinnett County joined the initiative in 2018.

Testing Virtual Reality in Poultry Processing Systems

Researchers have evaluated the feasibility of using virtual reality (VR) technologies to create frameworks for testing, evaluating, and optimizing various systems in a poultry processing environment. Researchers tested cutting trajectories on VR models, specifically evaluating techniques for responding to variations due to genetic phenotypes — the expressions of individual birds' genotype and interaction with the environment. Using VR technology for initial testing and evaluation of automated solutions eliminates the need to use real product or building and testing actual hardware.

Peanut Plants' Chemical Breath Could Provide Drought and Stress Clues

Peanut growers could someday identify emerging threats, such as drought, pests, or disease by measuring their crop's "chemical breath." Peanut plants emit volatile organic compounds that vary in types and patterns depending on how they respond to various stressors. Growers now rely on indirect monitoring methods, such as soil moisture testing, to assess the health of plants in their fields, but directly testing stress response could be faster and more accurate while offering a wider range of diagnoses for a crop worth $2.2 billion a year in Georgia. GTRI scientists are working with the University of Florida on this USDA-funded project.

Improved Robot Handles Tasks in Poultry Growout Houses

Researchers in GTRI optimized and evaluated a robot's ability to perform broiler and broiler-breeder rearing and management tasks in poultry growout houses. During FY19, the robot hardware was significantly upgraded using a newer, more accurate arm with a suction end effector for egg picking, a new 3D stereo imaging sensor, and more powerful control computer. Software algorithms for detecting chickens and eggs using machine learning were developed and tested with live chickens. The research culminated in a trial lasting several months in which the robot navigated a small test facility and picked up eggs autonomously.

System Uses Audio to Assess Animal Wellness and Well-Being

GTRI researchers have further enhanced the data acquisition and analysis capability of the Growout Monitoring System, designing a hardened system for audio acquisition in a broiler growout house and implementing a software interface to demonstrate the utility of previously developed algorithms for audio processing. The ability to process video was also demonstrated. The project is a first step in creating the next generation of systems to support the management of animals reared in confined environments. Such systems could allow end users to describe and control conditions using not only temperature and humidity but also quantitative descriptors for well-being.

New In-Flight Entertainment System Helps Cut Emissions for Delta

A collaboration with Atlanta-based Delta Flight Products (a wholly owned subsidiary of Delta Air Lines) has produced an enhanced in-flight entertainment system that is expected to initially cut aircraft emissions by more than 1,330 metric tons per year. The savings will result from implementing a next-generation wireless system that eliminates the weight of wire bundles and related support equipment on Delta aircraft. A team of more than 30 GTRI researchers worked with Delta Flight Products staff to develop and test the system, which has now been deployed on several of the airline's fleets.

Click Safe Application Helps Protect Social Workers

Georgia's social workers have a new way to stay safe when their jobs take them to dangerous neighborhoods. GTRI researchers have designed "panic buttons" that Georgia Division of Family and Children Services (DFCS) employees carry with them during their client visits. When pressed, the button on a key fob transmits a signal via Bluetooth to an app on the worker's state-issued cellphone. The phone then silently notifies the agency's call center, where a trained operator contacts the nearest 911 center with details on the alarm, a description of the employee, the location, and a request to rush law enforcement officers to the scene.
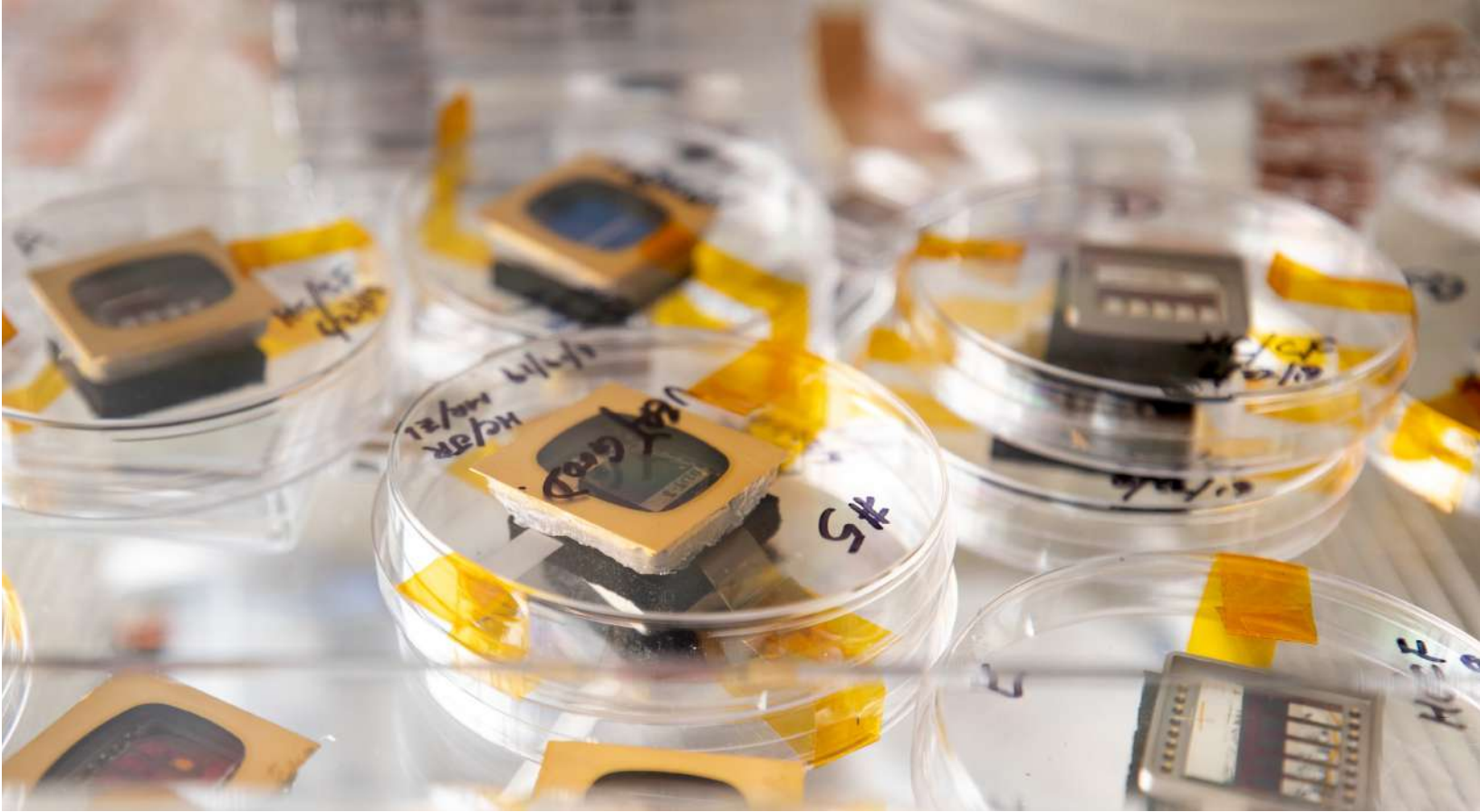
INNOVATING THE FUTURE

Innovating the Future

Improving the human condition is a critical mission for GTRI as we strive to be a global leader known for excellence and innovation. In 2019, GTRI explored improving aspects of healthcare, sanitation, and energy, following our desire to make lasting impressions on the global community. Our innovations on a new toilet alone could improve sanitation for 2.5 billion people worldwide.
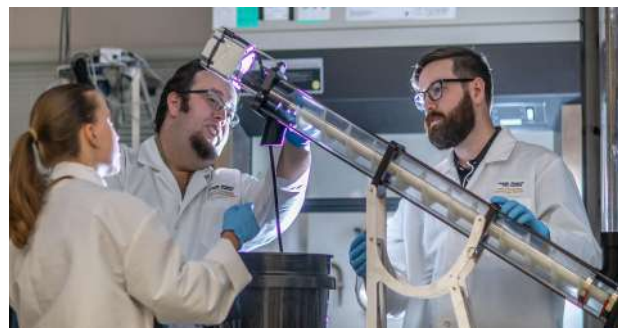
Solar Cells on International Space Station for Testing

Five different types of solar cells fabricated by Georgia Tech research teams are now aboard the International Space Station (ISS) to be tested for their power conversion rates and ability to operate in the harsh space environment. GTRI-designed textured carbon nanotube-based photovoltaic cells will be evaluated for their ability to efficiently produce power regardless of their orientation toward the sun. Other cells made from perovskite materials and a low-cost copper-zinc-tin-sulfide (CZTS) material — along with a control group of traditional silicon-based cells — are among the 20 photovoltaic devices placed on the ISS.

Improving Sanitation Worldwide by Reinventing the Toilet

To address a global need, Georgia Tech has received a $13.5 million award from the Bill & Melinda Gates Foundation to help bring together research teams working on a grand global challenge: reinventing the toilet. The goal of the project is to build prototypes for a 21st-century toilet able to reduce human waste to clean water and benign solids, operating with no plumbing or sewerage connections — and an amount of electricity that could potentially be provided by a single solar panel. GTRI researchers

are supporting the project, which could improve sanitation for 2.5 billion people worldwide.

Designing with the Patient in Mind

For a child with Autism Spectrum Disorder (ASD) — with sensitivity to sounds, touch, and changes in the environment — needing a regular MRI can be an anxiety-producing situation. In surveying families at the Marcus Autism Center, GTRI researchers learned that children with ASD desired control over their environment. With this in mind, researchers revamped an existing MRI training simulator room and implemented a practice of letting the children control the lights in the room and pick from a variety of colors to match their mood of the day.
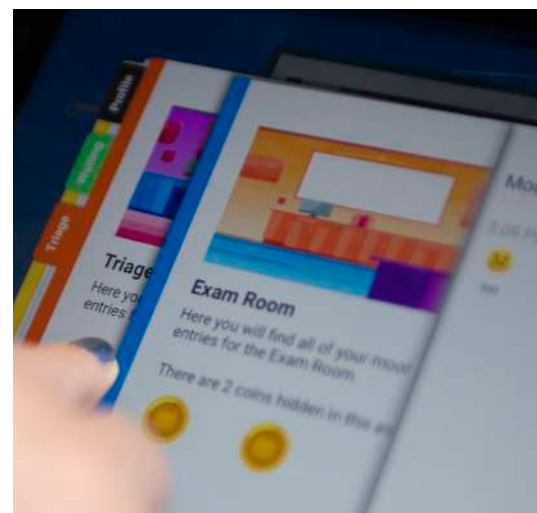
GTRI Scrub For Hub

Central lines are lifesavers for many patients, but if these kinds of catheters are improperly maintained, they can cause life-threatening central line-associated bloodstream infections (CLABSI). GTRI developed easySCRUB, a micro-abrasive melamine foam sponge saturated with isopropyl alcohol. The device more effectively follows "scrub the hub" protocols because the foam conforms to the spaces between the threads to lift and trap bacteria that cause infection. Not only does easySCRUB reduce the time it takes to clean central lines, but it also doesn't require additional training to use. It's single-use to prevent contamination, and it makes a squeaking sound, so the clinician knows when it's used properly.
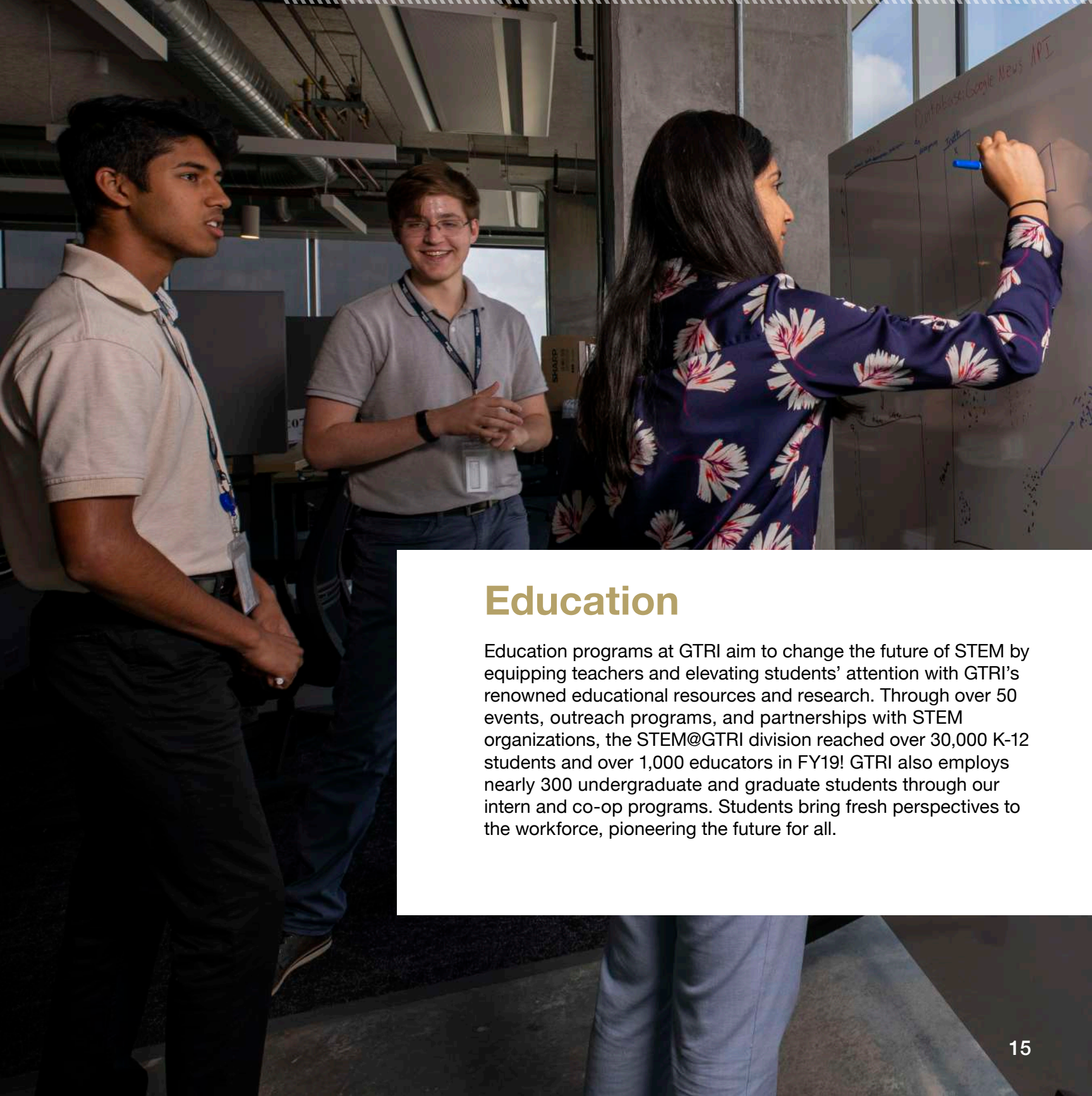
Just ask the Kids

Often pediatric cancer patients go through a complicated process of seeing multiple health care providers for different procedures in different rooms. A "passport" app was implemented in a collaboration between GTRI researchers and the doctors at Aflac Cancer and Blood Disorders Center at Children's Healthcare of Atlanta to gain insight from the patient's perspective. Using the app, members of the care team would stamp the passport at each stage of the treatment, and the patients let researchers know how they were feeling by writing and coloring. The clinic has already begun making changes in its processes and physical environment based on the feedback received from the children.

Study Provides New Guidance on First-Line Antihypertensive Drugs

A study produced using advanced health analytics techniques — supported by GTRI researchers — provides new guidance to health practitioners on which antihypertensive drugs should be prescribed first for patients with high blood pressure. The study factored insurance claim data and electronic health records from 4.9 million patients across nine observational databases, making it the most comprehensive study ever on first-line antihypertensives. Collaborators in the Observational Health Data Sciences and Informatics (OHDSI) network published the paper, produced as part of its Large-Scale Evidence Generation and Evaluation across a Network of Databases (LEGEND) project, in the journal, *Lancet*.

EDUCATION

Education

Education programs at GTRI aim to change the future of STEM by equipping teachers and elevating students' attention with GTRI's renowned educational resources and research. Through over 50 events, outreach programs, and partnerships with STEM organizations, the STEM@GTRI division reached over 30,000 K-12 students and over 1,000 educators in FY19! GTRI also employs nearly 300 undergraduate and graduate students through our intern and co-op programs. Students bring fresh perspectives to the workforce, pioneering the future for all.

STEM@GTRI Intro

The mission of STEM@GTRI is to inspire, engage, and impact students, administrators, and educators in the K-12 science, technology, engineering, and mathematics (STEM) pipeline. Through programs, such as outreach events, technical assistance to schools, and summer and year-long internships in GTRI laboratories, we endeavor to introduce students to STEM disciplines and to ignite their interest in STEM for post-secondary education and careers.

Since 1996, STEM@GTRI has reached educators and students with one mission in mind: change the future of STEM by equipping teachers and elevating students' attention with GTRI's renowned educational resources and research. FY19 was a remarkable outreach year for STEM@GTRI! Through over 50 events, outreach programs, and partnerships with STEM organizations, the division reached over 30,000 K-12 students and over 1,000 educators!

Supporting Educators

STEM@GTRI aims to connect the research conducted at GTRI with K-12 classrooms. GTRI recognizes the main impact on a child's STEM development comes from their educators; thus, GTRI strives to support educators. Programs, such as Direct to Discovery at Georgia Tech (D2D@GT), were developed to connect classrooms with Georgia Tech labs via high-speed video bandwidth, bringing world-class researchers — and their laboratories — to K-12 classrooms. D2D@GT also hosts professional learning events for educators. On Oct. 12, 2019, Georgia Tech, along with GTRI researchers, invited 122 Clayton County Career, Technical, and Agricultural Education (CTAE) teachers to campus. This opportunity showed CTAE educators how the material they teach in their classrooms is used in the field, as well as provided them with tools and techniques they can utilize in the classroom to enhance their learning objectives.

Developing relationships with educators allows GTRI to be an active stakeholder in the future of STEM education. The partnership also provides a venue for educators to recommend interested students to programs GTRI is involved in, such as the Congressional App Challenge, a competition designed to encourage student participation in computer science and coding, and the High School Summer Internship Program.

Inspiring K-12 Students

Through GTRI's involvement with K-12 students, the organization has watched excited STEM students transition into visionary innovators who are motivated to improve local communities and the world. GTRI desires to be present along the way, mentoring and supporting the next generation of students whose bright ideas are lighting our future.

Some of these students included local Girl Scouts. Throughout multiple in-person and virtual meetings, GTRI Research Scientist Barbara Fox helped these Girl Scouts obtain cybersecurity merit badges, which is a new offering from the Girl Scouts of the USA. Fox prepared training, including case studies and role-playing activities, to encourage the girls to explore careers in computer science and cybersecurity while earning their badges.

STEM@GTRI also supports the Games for Change Student Challenge, which excites students and exposes them to work-related opportunities in STEM and game design, engages students and teachers in civic issues impacting their cities and communities, builds capacity for teachers to use game-based learning tools and approaches, and enables students to learn game design as a method for storytelling and 21st-century skill development.

GTRI is also proud to have partnered with the Technology Association of Georgia Education Collaborative (TAG-Ed) for the past seven years to host high school interns in

laboratories and research facilities. Interns work on projects, ranging from piezoelectric systems to the physics of radar emissions, providing them with real-world experiences in science and engineering research. GTRI researchers mentor students with first-hand STEM experience and help bridge the gap in Georgia's STEM workforce.

Learning from College Students

In efforts to exist at the forefront of innovation, GTRI continually seeks to employ student workers who bring fresh perspectives to the workforce. In the past year, GTRI employed 297 student workers, amounting to 12.15% of GTRI's population. With such a vast community, these student workers have the ability to impact the work and research conducted at the organization. Furthermore, GTRI is proud to provide hands-on experience to these students, helping to solidify their career path after graduation.

For the past three years, GTRI has hosted the Undergraduate Research Internship Program (URIP). This 10-week summer program provides Georgia Tech under-graduate students with an opportunity to work with GTRI mentors and other students on tough problems facing government and industry across our nation and around the globe. Students are given a chance to participate in a wide variety of projects, including augmented reality, underwater surveillance vehicles, malware detection with machine learning, and self-sustaining energy monitoring.

Undergraduate and graduate students comprise a large portion of GTRI's com-munity, and we are grateful for the ways in which they help shape our research.

"I was a geek in high school but was doing nothing like what they (GTRI's high school summer interns) were doing. I was amazed that they could take on the project of building an almost professional-quality product, even in the early prototyping stage."

– Reggie Ratcliff, a mentor in GTRI's High School Summer Internship program. Ratcliff, along with mentor Jeff Hurley, helped a group of four students develop a proactive artificial intelligence device to aid the aging population.
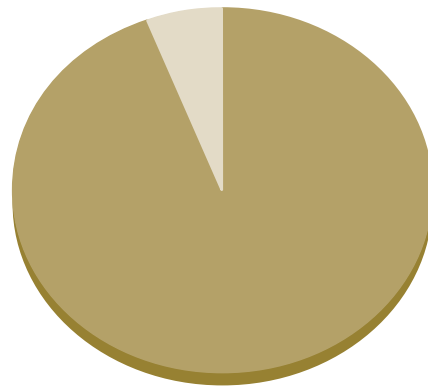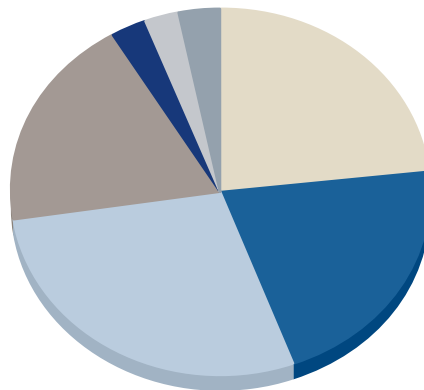
FINANCIAL STATEMENT

503 MILLION
TOTAL REVENUE

- 94.14% Federal
- 5.86% Non-federal

Number of Contracts with Billings in FY19: 850

CUSTOMER PERCENTAGES FOR FY19

	28.24% Air Force	$142.18M
	21.10% Army	$106.22M
	23.24% Other DoD	$116.99M
	18.81% Navy	$94.71M
	2.75% Other Non-DoD Federal Agencies	$13.85M
	2.62% State, Local Govt.	$13.19M
	3.24% Private	$16.31M
	Total Revenue	**$503M**

GTRI BY THE NUMBERS

	GT FY19	GTRI FY19
Sponsored Research Awards:	$1.05B	$643M
Revenue Earned:	$1B	$503M
Economic Impact to State:	$3.35B	$1.4B
Total Employees:	8,295	2,444

Generating high paying jobs. Keeping USG graduates in Georgia. Driving economic growth in Georgia.

Our Community

GTRI's renowned, award-winning team constantly pushes the limits to discover "what's next." GTRI continues to grow, now exceeding 2,400 employees across our 22 locations. Our employees not only bring their expertise to innovating the next solutions at GTRI, but they also influence their surrounding communities, serving through various organizations, receiving awards, and authoring books. As members of the Georgia Tech community, our employees also have an impact on campus, teaching classes and leading student research through vertically integrated projects (VIPs).

OUR COMMUNITY ››››››››››››››››››››››››››

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Colorado Springs (CO) Field Office
Dawsonville (GA) Field Office
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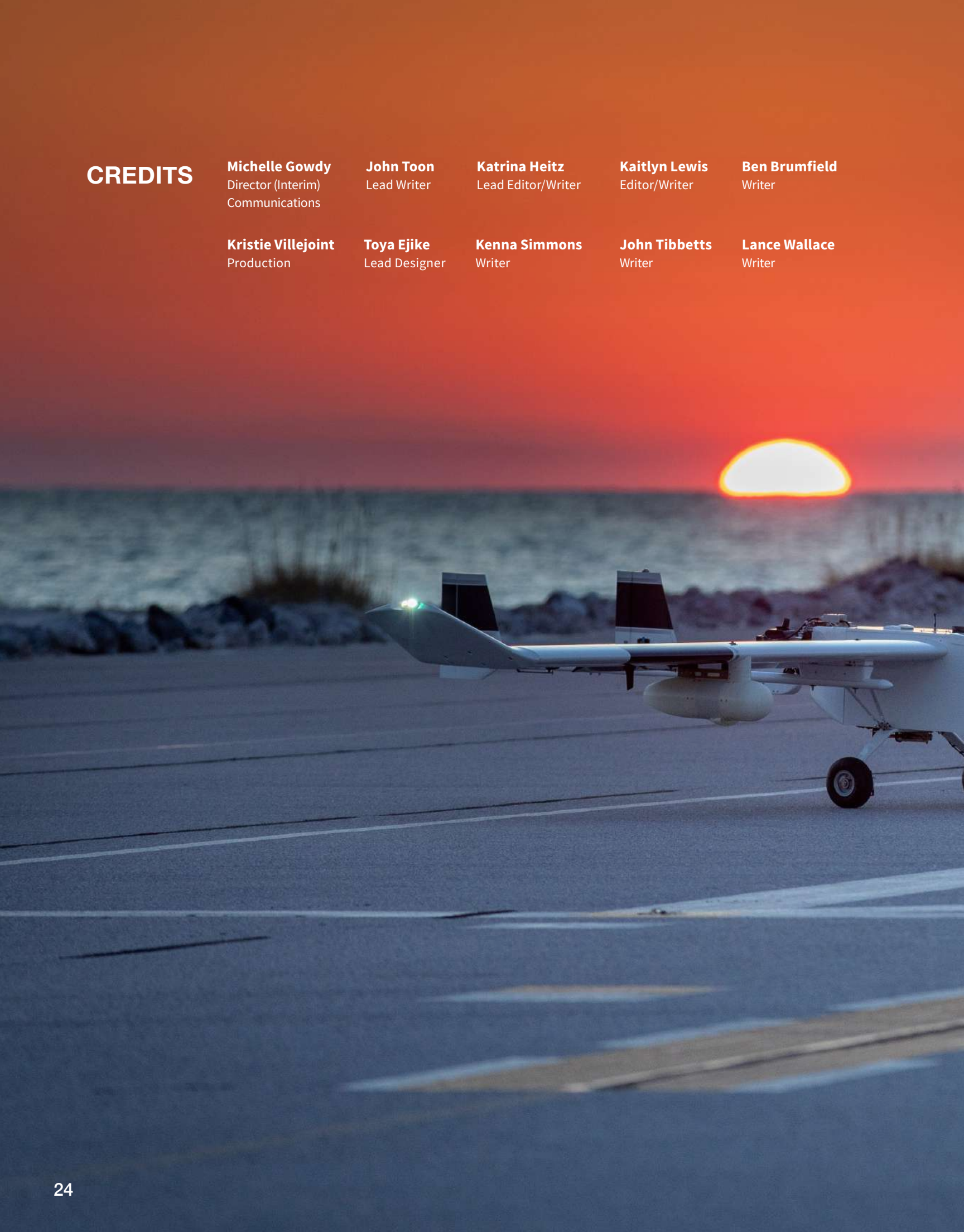Editor/Writer

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