2005
ANNUAL REPORT

GTRI

Creating Solutions through Innovation since 1934

Georgia Tech Research Institute

www.gtri.gatech.edu




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Director's Letter

This has been another exciting and productive year at the Georgia Tech Research Institute (GTRI). As an integral part of the Georgia Institute of Technology, we contribute directly to Georgia Tech's well-deserved reputation as an innovative research university that transforms ideas into application. In this letter, I'd like to explore two questions with you: "What is innovation?" and "How do I know it when I see it?"

What is innovation?

The *Merriam-Webster Online Dictionary* defines innovation as "the introduction of something new... a new idea, method, or device." A more practical and insightful definition comes from Sam Palmisano, the CEO of IBM, who describes innovation as "invention plus insight." Palmisano and Georgia Tech President Wayne Clough led the National Innovation Initiative for the Council on Competitiveness (www.compete.org/nii), which is widely referenced by those seriously interested in sustaining our national scientific, technological, and educational priorities. So what is innovation? To quote Wayne Clough, innovation at Georgia Tech is the natural by-product of "a 'can-do' culture of entrepreneurism and creative problem solving."

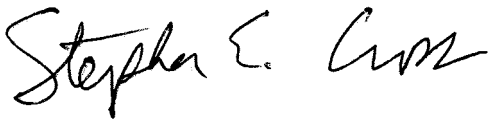
How do I know it when I see it?

The answer to this question is simple, and you can find great examples in this annual report! GTRI has spent seventy-one years creating solutions through innovation. This slogan represents our core purpose, and in fact our passion. We demonstrate innovation every day in everything we do. Through the integration of our engineering expertise and insight into challenging problems, our inventive "can-do" spirit, and our creation of leading-edge technologies, we create, deliver, and sustain solutions for many stakeholders in Georgia, across the nation, and throughout the world.

This report provides a snapshot of the exciting work done in the past year by the women and men of GTRI and through our partnerships with our university colleagues and our many stakeholders in government and industry. It surveys important contributions for defending our nation, securing our homeland, protecting our health and environment, educating our people, and building our economy. It has truly been an exciting year at GTRI, which even included articles in *Rolling Stone* and *Fortune* magazines—both firsts for GTRI (see page 35).

Thank you for taking the time to read this report and for your interest in GTRI and Georgia Tech. Please feel free to contact me at anytime at cross@gatech.edu. I'd love to hear from you.

You can also review Georgia Tech President Wayne Clough's State of the Institute presentation, titled *Disruptive Innovation*, at http://www.gatech.edu/president/soi/.



Stephen E. Cross
Vice President,
Georgia Institute of Technology
Director, Georgia Tech Research Institute

Creating Solutions through Innovation since 1934

The Georgia Tech Research Institute (GTRI) is a nonprofit applied research organization that operates as part of the Georgia Institute of Technology, a top-ranked academic and research university located in Atlanta, Georgia. GTRI conducts world-class research, delivering leading-edge, real-world solutions and training to industry and government organizations in Georgia, across the nation, and throughout the world.

Chartered by the Georgia Legislature in 1919, the State Engineering Experiment Station (EES) was formed to support industry in the state of Georgia by providing high-quality engineering research. EES began with three researchers, a $12,000 annual budget, and an entrepreneurial spirit focused on service. The Station was expected to help develop the resources, industries, and commerce of Georgia, while assisting with national programs of science, technology, and preparedness.

In 1934, EES began operation. Seventy-one years later, the organization—whose name changed to the Georgia Tech Research Institute in 1984—continues to meet all of those needs and many more. In fact, GTRI's focus has moved far beyond simple engineering research and experimentation into a broad spectrum of activities combining engineering, science, economics, policy, and technical exploration. Today GTRI conducts groundbreaking research, educational programs, and economic development initiatives that advance global competitiveness and security for both U.S. and international sponsors.

In 2005, GTRI's nearly 1,300 employees include many of the nation's leading scientific researchers who spend each day helping make the world a better and safer place.

GTRI has established an international reputation for excellence in many areas of science and technology. A changing nation and changing world have resulted in greater diversification of GTRI's research programs, which benefit clients with projects that span multiple disciplines. GTRI researchers are also frequent participants in consortia that perform research for small and large business internationally. It is common for the Institute to work with more than 200 industrial customers at any one time.

GTRI's research activities are conducted within eight laboratories that have focused technical missions linked to one another by coordinated program thrusts. Interaction among these units is common, and joint teams can readily be formed in areas of mutual interest to combine expertise to provide clients with the right mix of talent and experience to satisfy their needs and exceed their expectations.

The GTRI Mission:

Serve the university, the state, the nation, and the world by maturing selected technologies and developing innovative engineering solutions to important and challenging problems of society.

Illustrating Technology Options for Future Combat Vehicles

A concept vehicle known as the ULTRA Armored Patrol (AP) is helping the U.S. military evaluate multiple science and technology options—including ballistic and mine protection—that could improve the design of future military combat vehicles.

Research and development for the ULTRA AP has been conducted by the Georgia Tech Research Institute (GTRI), which led a unique team of research engineers from both GTRI and the automotive industry. Combining proven vehicle technologies with advanced materials and engineering concepts, the research initiative has been sponsored by the Office of Naval Research (ONR).

"By bringing together experienced commercial vehicle designers with experts in advanced materials and cutting-edge engineering, we are providing a test bed for evaluating technologies that can help the military develop true 'leap-ahead' concepts," said David Parekh, GTRI's deputy director. "By including persons with high-performance automotive engineering and NASCAR expertise as part of our team, we were able to root this advanced-concepts project in real-world vehicle design."

The ULTRA AP emphasizes high-output diesel power combined with advanced armor and a fully modern chassis. The design matches the best of modern commercial automotive technology with racing experience, explained Gary Caille, a GTRI principal research engineer.

In the ULTRA AP, the GTRI/industry team has made improvements in two key areas by taking a systems approach to survivability and safety:

Survivability: This factor involves a vehicle's ability to shield occupants from hostile action. The ULTRA AP features novel design concepts and research advances in lightweight and cost-effective armor to maximize capability and protection. The new armor was designed at GTRI in partnership with the Georgia Tech School of Materials Science and Engineering.

The vehicle also incorporates a "blast bucket" designed to provide ballistic, blast, and enhanced roll-over protection. New vehicle designs must incorporate dramatically increased resistance to explosions caused by mines and improvised explosive devices, Caille noted.

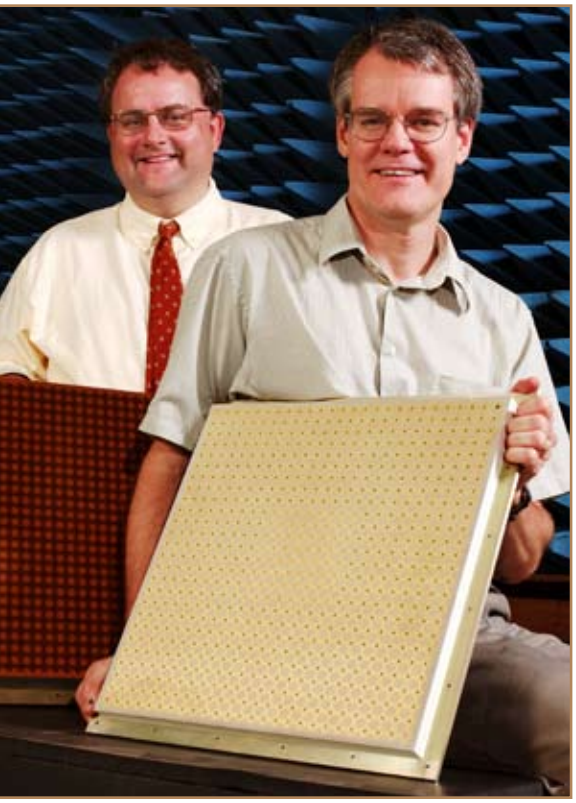
Safety with Performance: The ULTRA AP design explores the use of on-board computers to integrate steering, suspension, and brakes to provide an unparalleled level of mobility and safety, Caille added. The new vehicle's integrated chassis represents an advancement over the most advanced current production vehicles.

The ULTRA AP project has been supported by the ONR as part of its mission to investigate and assess new technologies for military use. By providing the ULTRA AP concept vehicle for the U.S. Marine Corps and U.S. Army to study, ONR expects to spur innovative thinking and gather feedback on the ideas being demonstrated.

The ULTRA AP concept vehicle was built to evaluate science and technology options that could improve the design of future military vehicles. A key feature is the "blast bucket" designed to protect crew members.

Reducing the Number of Military Antennas

Today's military aircraft, vehicles, surface ships, and submarines must carry a complex set of antennas to handle the broad range of frequencies required for communications, radar, and other tasks. The antennas



GTRI researchers James Maloney and Paul Friederich display prototype antenna panels.

take up valuable space and add both weight and complexity to military systems.

To address that problem, researchers at the Georgia Tech Research Institute (GTRI) have developed a new ultra-wideband design that could allow a single flat antenna to replace as many as five conventional antennas. Connecting antenna elements in a revolutionary way—and using a unique backplane structure—the researchers have already produced a planar antenna with 33-to-1 bandwidth and believe they can ultimately reach a 100-to-1 ratio.

The best conventional antennas can achieve no more than approximately a 10-to-1 bandwidth.

Key to their success was taking advantage of electronic coupling that takes place between the elements of an antenna array. Designers had long been taught to avoid the coupling.

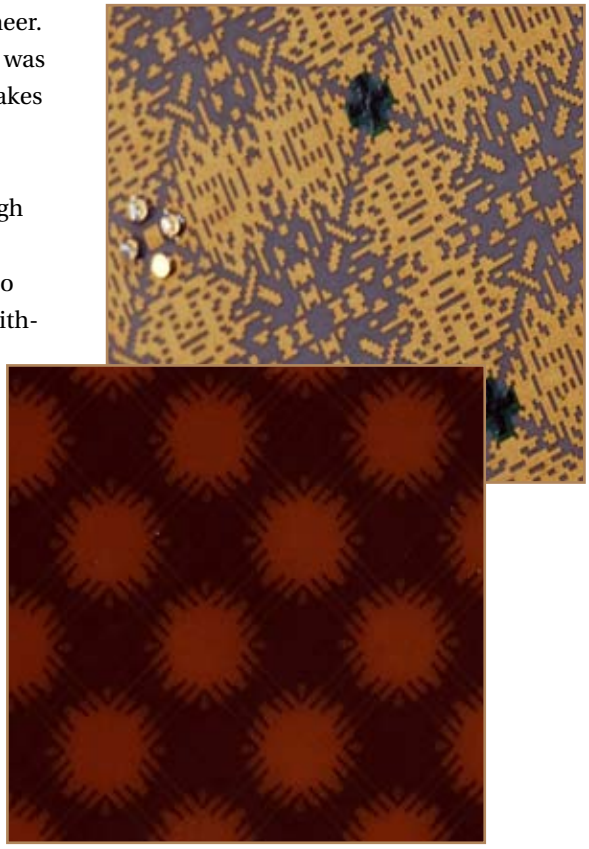
"Instead of trying to avoid mutual coupling, we designed it into the antenna where it actually provides a lot of benefits, including allowing us to have an extremely wide bandwidth," explained Jim Maloney, a GTRI principal research engineer. "What everybody used to avoid was actually the silver bullet that makes this work."

Learning to take advantage of the coupling came about through advanced computer modeling, which allowed the researchers to evaluate design performance without actually having to build the devices. The modeling also led to development of a broadband screen backplane, a multi-layer structure composed of foams and partially conductive films that prevents reflected signals from degrading performance.

"We had to make the backplane compatible with the extreme bandwidths," explained collaborator Paul Friederich, a GTRI principal research engineer. "These laminate foams and partially conductive films do that in an optimal way."

With their design a success and the skeptics in the antenna community becoming believers, the researchers are now tuning the antennas for specific customer needs and working with a major defense contractor to integrate the devices into larger systems. They are also examining potential commercial applications, as well as military uses for the technology that may not require large bandwidths.

Examples include aesthetically-pleasing flat antennas that could be used on buildings and wearable antennas that could be woven into soldiers' jackets or conformed to helmets to replace conventional whip antennas.



Connecting antenna elements in a revolutionary way could allow a new ultra-wideband antenna to replace as many as five conventional antennas.

Helping Leaders Make Better Decisions under Pressure

Research into how people make decisions while under pressure could help the U.S. military improve training for its commanders and lead to better decision-support systems.

Studies have shown that when people process information, they develop unconscious strategies—or biases—that simplify their decisions. Studies done by the Georgia Tech Research Institute (GTRI) have revealed how these biases affect people when they're dealing with lots of information and have little time to form conclusions.

"The immediate application for this research is to develop training programs to improve decision-making," said Dennis Folds, a GTRI principal research scientist. "Yet our findings could also help design new types of decision-support systems."

The research indicated how nine different kinds of bias can lead to errors in judgment when people are dealing with a lot of information. The work also showed that subjects trained to spot conditions that lead to decision-making biases were better at detecting false-alarm opportunities.

The Army Research Institute funded Folds to conduct a series of experiments that combined a high volume of data with time pressures, simulating the changing reality of military decision-makers. Commanders today communicate more directly with personnel in the field, which has increased the amount and variety of information available for making decisions, but the result can be ambiguous, disjointed information rather than integrated, organized reports.

"This puts far greater pressure on leaders, who must make faster decisions while sifting through more data," Folds noted.

In the experiments, GTRI researchers considered previous research on specific biases—such as persistence of discredited information, false perception of causal relationships, or seeming consistency among data sources—that affect individuals who must wrestle with large amounts of data.

To test the effects of these biases, Folds had experimental subjects view a computer inbox containing a variety of text messages, maps, photographs, and other information. They were instructed to report certain military situations, such as incidents of sniper fire or acts of suspected sabotage, but not to report other events, such as accidents unrelated to enemy activity.

To decide whether or not an event should be reported, subjects reviewed a series of messages that contained both real evidence as well as false information created to trigger biases. Subjects were allowed to spend an average of twenty seconds per element, plus one additional minute for reporting. They were also asked to attach information that supported their decisions.

By studying the information each subject reviewed and how often they referred back to it, the studies also revealed what kind of information was meaningful to decision-makers.

Research into how people make decisions under pressure could improve training and lead to development of new decision-support systems. Here, Carl Blunt and Courtney Lessl participate in the GTRI research study.

Advancing Military Sensor Technologies

From landmine detection to underwater acoustics, the Sensors and Sensing Systems Information and Analysis Center (SENSIAC) aims to be the go-to center for military sensing technologies.

Housed within the Georgia Tech Research Institute (GTRI), SENSIAC is one of the newest information analysis centers serving the U.S. Department of Defense (DoD). It replaces IRIA, a center that was initially founded at the University of Michigan's Willow Run Laboratories and operated there under various ownership for nearly fifty years until Georgia Tech won the contract in December 2004.

"Although IRIA focused primarily on infrared technologies, SENSIAC has a much broader mission and scope," said Ann Batchelor, SENSIAC's deputy director. "We provide information on any sensing-based technology related to defense activities, including laser, radar, electro-optical, aroma, and chemical sensors."

In addition to being a clearinghouse for information, SENSIAC conducts research and educational programs. The Center draws upon experts across the Georgia Tech campus, as well as seven other universities that serve as subcontractors.

Winning the DoD contract gives Georgia Tech national recognition in the military sensing arena, observed David Shumaker, SENSIAC's director. "This places us in the center of the military sensing community," he explained. "We touch everyone in one way or another."

SENSIAC supports the defense department and other government branches, including intelligence agencies like the FBI and CIA. In addition, the Center helps government contractors and university researchers engaged in activities for national defense or homeland security.

Continuing education is an important component of SENSIAC's mission, with seven courses available in fall 2005 to government agencies and their contractors, including classes on hyperspectral imaging, target acquisition modeling, and military laser principles. In the coming months, the curriculum will be expanded rapidly to more than forty courses.

SENSIAC also manages the defense department's Military Sensing Symposia (MSS). These annual conferences, which began in 1956, enable government and industry experts to gather together and share best practices about classified projects in a protected environment. Proceedings of the meetings are archived and made available to those with appropriate security clearance.

Because of a unique contract provision, SENSIAC can conduct research on an expedited basis for DoD agencies and contractors. What's more, the Center is also launching a technology transfer program, which will be led by Edward Reedy, GTRI's retired director. The idea is to move emerging technology out of universities and into military sensing applications more quickly.

"SENSIAC is an enabler of military sensing technology," Shumaker observed. "We help others do their jobs faster, cheaper, and more efficiently."

SENSIAC provides information to U.S. Department of Defense agencies on sensing technologies used in a variety of platforms.

Managing SENSIAC are director David Shumaker and deputy director Ann Batchelor.

Taking a Generic Approach to Critical Aircraft Support Tasks

Many of today's U.S. military aircraft entered service decades ago, and keeping them mission-ready can be a challenge.

HAWKEYE, a software tool aimed at supporting complex electronic and mechanical systems, was recently completed by Georgia Tech Research Institute (GTRI) engineers. The tool focuses on mitigating the effect of parts obsolescence on system availability.

"HAWKEYE allows users to initiate and maintain their own system configuration, inventory, and repair data," said Jeff Smart, a GTRI research engineer involved with the project. "It lets them update databases as often as they want and construct different 'what-if' scenarios themselves."

HAWKEYE is generic, out-of-the-box software with a basic module called the HAWKEYE Loader-Controller. The Loader-Controller is designed to manage a customer's parts list and to work with a library of modules, one of which is the HAWKEYE Diminishing Manufacturing Sources and Material Shortages (DMSMS) Model.

GTRI has traditionally provided custom software for those wanting a turnkey approach to technology insertion analysis. GTRI's custom software and research covers many factors, including obsolescence, reliability, operating costs, and mission readiness. GTRI engineers extract and process logistics and maintenance data manually, then transfer their work to custom software that automates the analysis and modeling of data and helps program managers track their situation more clearly.

GTRI researchers got the idea for HAWKEYE from discussions with potential commercial customers at meetings and conferences. Using independent research and development funds, they decided to develop a generic approach to resolving logistics and supportability issues.

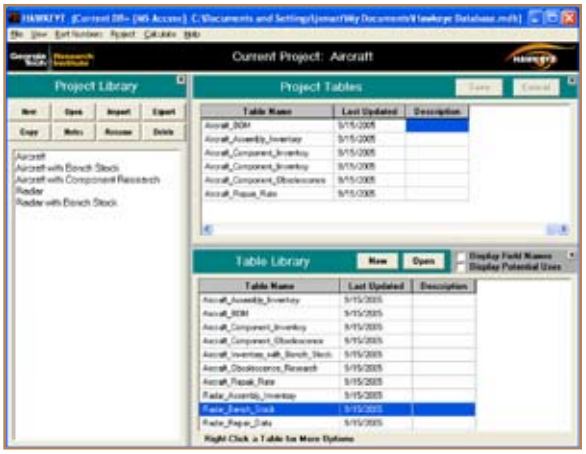
This move was founded on the perception that many contractors and others in the logistics and maintenance community are reluctant to let outsiders view the information they gather. Moreover, contractors often prefer to do database upkeep themselves, unlike custom software clients, who typically contract with GTRI to refresh their databases on a quarterly basis.

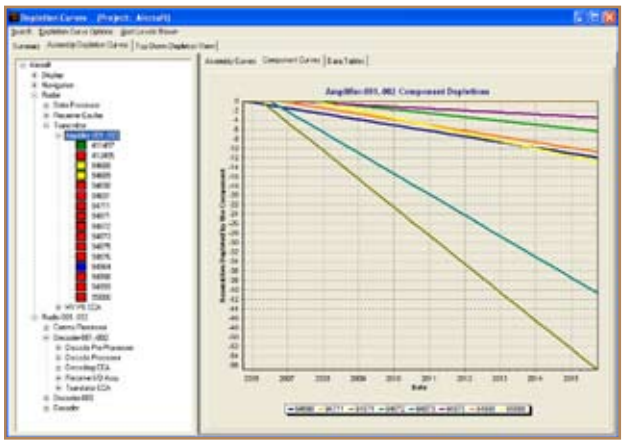
HAWKEYE's developers say that the generic design of the new software is meant to appeal to the U.S. military services, as well as private contractors and the foreign military.

"With HAWKEYE, the customer has absolute control of his system bill of material, inventory information and repair actions, and his obsolescence status," said Powers Garmon, a GTRI research scientist who worked on the project.

In addition to HAWKEYE software, GTRI will continue to offer turnkey custom technology insertion software and services.

The HAWKEYE program takes a generic approach to critical aircraft support tasks.





Shown above is the program's bill of material manager and shown at left is a plot of component obsolescence.

Integrating Aircraft Defensive Systems

Georgia Tech Research Institute (GTRI) engineers are helping U.S. military aircraft to avoid enemy missiles and anti-aircraft fire, and to respond with effective defensive measures if attacked.

GTRI develops substantial components of the software that operates the integrated defensive avionics—a complex system of radar and missile warning sensors, signal-jamming devices, and other defensive equipment—on two main Air Force aircraft, the C-130 Hercules transport and the MH-53 helicopter. GTRI is also involved with integrated defensive avionics development for the Air National Guard's F-16 and A-10 aircraft.

"Our work first involves situational awareness, to make sure aircraft avoid the areas where they could be engaged by missiles or anti-aircraft guns, and the second part involves assisting the crew in employing countermeasures to protect themselves," said Joe Brooks, a GTRI research engineer and a leader on the MH-53 program.

GTRI's responsibility focuses on defensive system integration, connecting the sensors that detect enemy threats to the cockpit displays that inform crews about those threats. GTRI's software integrates reports from multiple sensors to reduce crew workload and reduce ambiguous reports, and provides automated threat-response strategies that can be programmed to operate with or without crew interaction.

Such software gives an aircrew early warning about potential threats at long distance. If the crew cannot fly around enemy threats, GTRI's software either helps the aircraft in responding automatically to avoid incoming missiles or ground fire or it alerts the crew to take manual countermeasures to thwart the attack.

Of course, aircrews only employ their defensive systems when actually flying over enemy territory. To prepare crews for possible real-world encounters, GTRI has also developed a Virtual Electronic Combat Training System that uses simulated threat systems and actual cockpit displays to simulate attack scenarios on the aircraft. This system provides aircrews with a real-world training experience that includes not only threat warnings, but also accurate responses to countermeasures and aircraft maneuvers.

GTRI is currently taking part in a major program to improve the workhorse C-130 transport, under a subcontract to Boeing Aircraft Company in Long Beach, California. The C-130 Avionics Modernization Program will put a new digital cockpit and flight-related electronic equipment on the venerable aircraft. The upgrade includes new mission computers that integrate the aircraft communication and navigation systems, radar systems, defensive systems, and flight management functions into common cockpit controls and displays.

GTRI has a long history of delivering operational flight software to U.S. military forces and U.S. allies. GTRI's Electronic Systems Laboratory has been independently rated as a Software Engineering Institute Capability Maturity Model® Level 3 organization for software quality.

GTRI researchers develop substantial portions of the software that operates the integrated defensive avionics systems for the C-130 Hercules transport (above) and the MH-53 helicopter (below).

Tracking Critical Electronic Countermeasure Systems

Georgia Tech Research Institute (GTRI) engineers based at the Warner Robins Air Logistics Center (WR-ALC) are combining engineering skills with powerful software tools to help ensure the safety of the F-16 fighter and other Air Force aircraft.

Engineers develop broad-based reports called roadmaps to give the Air Force detailed schedules for system sustainment and enhancement. GTRI's work at WR-ALC involves electronic countermeasures devices such as the radar-jamming pods that shield U.S. aircraft from enemy attacks.

"GTRI's method for developing a roadmap is to break a system into components, analyze them, and then document all known deficiencies," said David Brown, a GTRI research engineer. "We look for deficiencies in cost, reliability, obsolescence, or capability, and give recommendations on mitigating those deficiencies."

GTRI has already produced roadmaps for the ALQ-131 and ALQ-184 radar-jamming pods used on the A-10 and F-16 aircraft. GTRI engineers are pursuing work on roadmaps for electronic countermeasures systems on other U.S. military aircraft.

In developing the road maps, GTRI engineers analyze four areas:

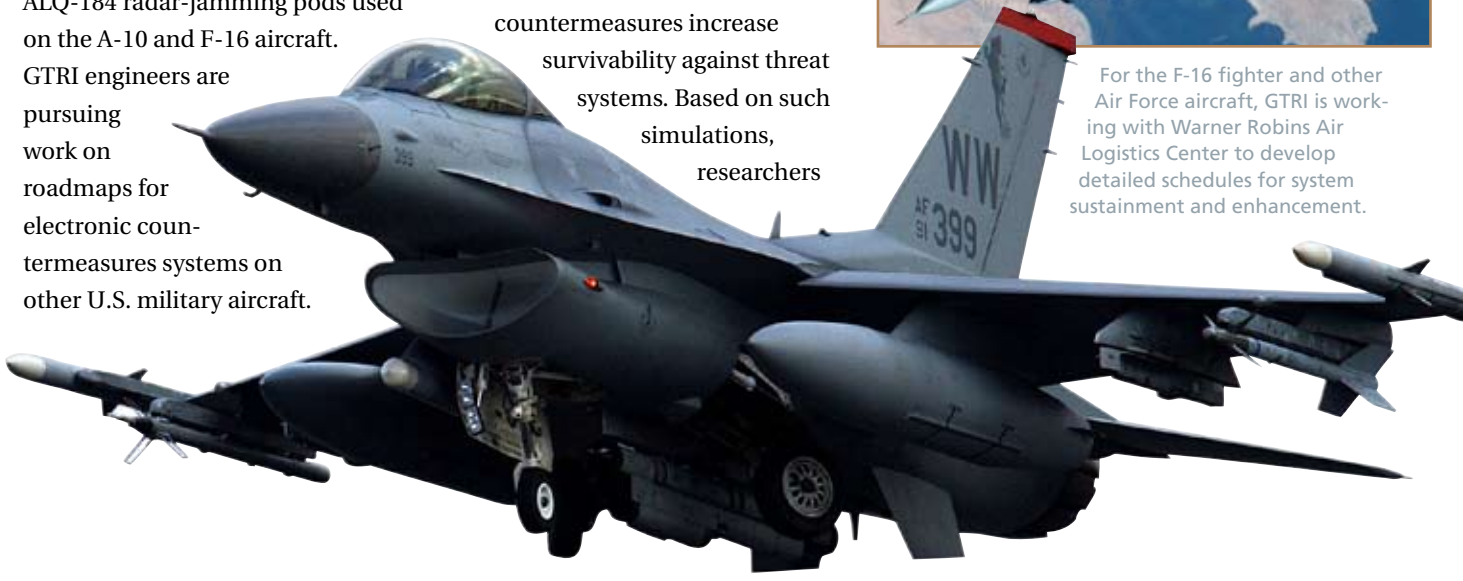
- sustainability: detailing the repairs, costs, and availability of components needed to keep a system combat-ready;
- threat susceptibility: assessment of the jamming pod's capability to deal with current threats, pinpointing areas that need improvement;
- functionality: engineering better functionality into the system, a process guided by customer suggestions as well as engineering analysis; and
- intelligence/political issues: assessment of threat proliferation in countries of interest, leading to a time line of needed capability improvements.

In charting sustainability, engineers use the GTRI-developed SUSTAIN software tool. SUSTAIN integrates data to report current parts inventories and predict future parts availability.

To analyze threat susceptibility, researchers use the GTRI-developed Self-Protection Analysis Mode (SPAM) program. This simulation software allows engineers to examine how well a pod's electronic countermeasures increase survivability against threat systems. Based on such simulations, researchers derive measures of effectiveness, such as "reduction in lethality," used to categorize the jamming pod's effectiveness.

Engineering judgment is critical to effective use of software tools such as SUSTAIN and SPAM. For instance, intelligent human analysis can pinpoint an obsolescence problem and then find a way to integrate a capability fix in the same solution.

Talking with the customer—especially air and ground crews—is key to functional analysis, making the system work more smoothly as well as more effectively in daily use. Roadmap engineers also look at current intelligence to predict when unfriendly countries might upgrade their threat systems. Researchers use this information to devise a timeline for ensuring U.S. systems are ready to deal with coming threats.



For the F-16 fighter and other Air Force aircraft, GTRI is working with Warner Robins Air Logistics Center to develop detailed schedules for system sustainment and enhancement.

Steering Munitions with Synthetic Jet Actuators

Large-scale smart weapons such as laser-guided bombs have helped reshape modern warfare. Georgia Tech Research Institute (GTRI) scientists are taking an analogous approach with smaller-scale munitions by helping to develop self-guided projectiles.

The Self Correcting Projectile for Infantry Operation (SCORPION) project involves embedding projectiles with tiny devices that squirt out jets of air strong enough to influence trajectories.

"What we're demonstrating here is that a technology called microadaptive flow control can produce forces that can move a projectile enough to be used as a steering system," said Jim McMichael, a GTRI laboratory director and SCORPION project director. "We've taken it all the way from basic research to the creation of a system concept…to the test and demonstration of that system," he says.

GTRI has demonstrated the utility of this Defense Advanced Research Projects Agency (DARPA)-supported technology, testing it successfully on a forty-millimeter projectile fired from an M-203 grenade launcher. The program has been developed jointly with Peter Plostins and his team at the U.S. Army Research Laboratory in Aberdeen, Maryland.

GTRI derived the tiny steering devices, called synthetic jet actuators, from the work of Ari Glezer, a professor in Georgia Tech's Woodruff School of Mechanical Engineering. Synthetic jets consist of a minute vibrating diaphragm driven electrically by a piezoceramic element. Embedded in the projectile's surface, the synthetic jets emit tiny air vortices, forming a jet locally without the support apparatus conventional jets need.

By turning on a synthetic jet for a few milliseconds, researchers can create an asymmetry in the airflow around the projectile. As the jet wraps around the projectile's tail, its effect is multiplied by a phenomenon called the Coanda effect. That in turn produces air flow changes strong enough to alter trajectory.

Small-scale, self-guided munitions could be useful to the infantry soldier in several ways. Like large-scale munitions, their increased accuracy would allow those in combat to carry out missions more effectively and efficiently. A highly accurate, steerable round could improve battlefield safety for infantry units as well, allowing them to be effective at greater distances from an enemy.

To control SCORPION's synthetic jets, GTRI scientists supplied the forty-millimeter test projectile with electronics that they hardened to withstand the heavy forces generated during the successful launch tests.

The current SCORPION prototype lacks payload room and a full guidance system. Future phases could add room for explosives and also let operators dictate the projectile's exact detonation point.

A second SCORPION phase is investigating gas-generator actuators, which use minuscule explosive charges to create stronger steering forces, allowing use of faster projectiles.

The Self Correcting Projectile for Infantry Operation (SCORPION) uses tiny microjets known as synthetic jet actuators to make mid-course corrections for improving the projectile's accuracy.

Developing Next-generation Phased-array Radar Systems

Researchers from the Georgia Tech Research Institute (GTRI) and the Georgia Electronic Design Center (GEDC) at Georgia Tech are collaborating on a new breed of highly-integrated silicon-based microchips for ultra-sophisticated radar systems.

Their focus is on silicon-germanium (SiGe) integrated circuit technology, which can provide cost savings, compact size, and improved efficiency for the next generation of phased-array radar systems.

Phased-array radar systems under development by the Department of Defense, such as the Theater High-Altitude Area Defense Radar, are large, bulky, and consume huge amounts of energy to power the thousands of modules and thousands of gallium arsenide chips needed to electronically direct the radar beams.

"We're trying to put all the functionality of those complex modules onto a single chip, essentially reaching for the same level of functional integration in radar systems that has been going on in consumer electronics for the past decade," explained co-principal investigator Mark Mitchell, a GTRI senior research engineer.

Silicon-germanium chips have the capacity to hold an extraordinary number of very high-speed circuits on a single chip. In addition, silicon-germanium is less expensive than the compound semiconductors such as gallium arsenide that have long been used in radar systems.

"In SiGe, you take a conventional silicon integrated circuit and use nanotechnology techniques to introduce germanium inside the silicon on an atomic scale," explained John Cressler, Byers Professor in Georgia Tech's School of Electrical and Computer Engineering and a GEDC researcher.

Silicon-germanium technology could make possible a new generation of phased-array antennas. Above, GTRI's Mark Mitchell shows a concept model of a highly mobile antenna.

The nanoscale silicon-germanium layers can double or even triple chip performance, but the procedure is "completely compatible with conventional silicon chip manufacturing, so there's no cost penalty for the improved performance," he noted.

Silicon-germanium is not without drawbacks for radar systems, however.

"The biggest limitation for the radar application is the amount of power that you can generate,"said Mitchell. Silicon-germanium amplifiers can only produce about one watt of radio frequency power, versus ten watts from a typical gallium arsenide device. That would require more antenna elements to generate the same output, but because the silicon-germanium devices would be so much cheaper, the cost overall should be less.

Another design challenge is that SiGe-based radar's lower per-element power equates to a larger antenna for greater sensitivity—perhaps tens of meters in size, depending on the application.

In work supported by the U.S. Missile Defense Agency, GTRI researchers, including Senior Research Engineer Tracy Wallace, are exploring ways to make these larger systems "tactically transportable" for use in the field. "They can be much thinner, and they can be folded up onto themselves," he explained. "We have sketches, models, and drawings of how that can be done."

John Cressler of the Georgia Electronic Design Center holds a 200-gigahertz silicon-germanium integrated circuit wafer.

Helping Unmanned Aerial Vehicles Be More Independent

Camera-carrying unmanned aerial vehicles, or UAVs, are useful for military surveillance tasks, but a human operator must constantly monitor the visual information they radio back.

A program supported by the Georgia Tech Research Institute's (GTRI) independent research and development funds is seeking to make the unpiloted crafts more autonomous. The idea is to enable them to alert their operators when they find something of interest.

"What we're trying to do is put the intelligence on it," said GTRI engineer Mike Heiges. "That means mounting some advanced sensors on board the aircraft rather than just a video camera."

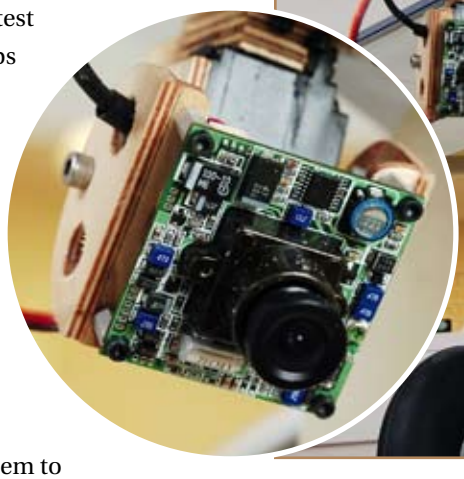
Typically, a UAV flies a preprogrammed route using global positioning system technology. As it goes, it sends back images—video during the day, infrared at night—to enable surveillance of a given route.

In a combat zone, this approach can mean problems for the UAV operating team, Heiges said. Their attention goes into monitoring the video feed rather than keeping track of their situation, which could include snipers and other dangers.

Doppler radar is an immediate candidate for adding smart-sensor capability. When this radar detects ground movement, it can trigger a high-resolution camera that relays back photos or a short video of the suspicious situation.

GTRI research scientist Gene Greneker has tested Doppler radar on UAVs. Using the Banshee, a GTRI-designed craft, he has demonstrated that off-the-shelf components can detect a moving ground object from more than 1,000 feet away and can successfully trigger an onboard camera. Greneker plans further test flights, perhaps with custom-built radar optimized for UAV use.

Infrared sensors could also help make UAVs more autonomous, by allowing them to detect warm or hot objects—human beings or vehicles—on the ground. Other potentially useful sensors could detect chemical or biological agents, or locate movement by simulating the human vision process.



A Banshee unmanned aerial vehicle (above) is shown with a Doppler radar and a video camera (center). The development team (below, left to right) includes researchers Steve Williams, Mike Heiges, Gene Greneker, and Andre Lovas.

GTRI is using a technology called fuzzy cognitive controllers (FCCs) to assist development of autonomous UAVs. Using fuzzy logic, FCCs help connect a UAV's control and guidance systems to its sensors to help the craft operate more independently. For example, FCCs could help a UAV know when and how to change course and follow a target picked up by its sensors, or they could enable the craft to watch its fuel and head back when levels get too low.

Using Imaging Radar to Land in Poor Visibility

Aircraft facing low-visibility conditions have traditionally been dependent on ground-based navigational aids to guide them to a safe landing. Even then, there were limits on the visibility conditions under which pilots were allowed to land.

Georgia Tech Research Institute (GTRI) research engineers are investigating the use of millimeter-wave imaging radars that would allow aircraft crews to generate a pilot-perspective image of a runway area even in zero-visibility conditions and without ground support.

"The Air Force wants to field an onboard system that allows aircraft to land in any type of weather condition, whether it be rain, fog, snow, a dust storm, day or night," said Byron Keel, a GTRI research scientist.

GTRI researchers are investigating the use of millimeter-wave imaging radars that would allow aircraft crews to generate a pilot-perspective image of a runway even in zero-visibility conditions.

Called the Autonomous Approach and Landing Capability Program, the project is directed by the Air Force Research Laboratory at Wright-Patterson Air Force Base for the Air Mobility Command, and is funded by the U.S. Transportation Command. GTRI is working collaboratively with BAE Systems, MMCOM, Goleta Engineering, and the Air Force Research Laboratory.

GTRI began about two years ago to look for radar systems with the potential for supporting low-visibility landings. They identified BAE Systems as having an experimental two-dimensional system developed in the 1990s. This two-dimensional system measured azimuth and range using millimeter-wave technology at ninety-four gigahertz, a frequency at which a radar can see effectively through fog and dust.

The two-dimensional system does not measure elevation, which is a potential shortcoming. Accurate elevation measurements are needed to represent elevated structures on or near the approach path, such as towers, buildings, or trees.

Researchers also face the problem that an aircraft has limited area in which to place an antenna that can measure elevation.

To support elevation measurements, BAE Systems developed a new approach that uses an interferometer to measure elevation. They modified their experimental two-dimensional radar system, which had one transmit channel and one receiver channel, and converted the single receiver channel into two receiver channels.

GTRI has supported the Autonomous Approach and Landing Capability Program with extensive pretest analysis and test planning of BAE Systems' new three-dimensional hardware. Keel took part in non-flight testing of the new hardware at Wright-Patterson in the winter and spring of 2005.

Initial test results were encouraging, Keel said, but researchers are enhancing the system with modifications to both the hardware and image-processing algorithms. Flight tests of the radar's effectiveness in low-visibility landings are planned for the latter part of 2006.

Creating IT Capability for Joint Task Force Deployments

Georgia Tech Research Institute (GTRI) engineers are leading the system integration and production design effort that will create a broad-based information technology capability for the command and control needs of future U.S. task forces.

Their work is part of an approach that includes not only full IT capabilities (networks, voice, video, telephone, etc.), but also shelters, environmental control units, and power for a stand-alone, fully deployable system.

The Deployable Joint Command and Control (DJC2) program is envisioned as a "system of systems." It will integrate new and existing applications into a shared-information environment that connects a joint task force (JTF) with the national military command structure, combat support, regional combatant commands, intelligence, and service and multinational components.

The DJC2 program is headed by the DJC2 Joint Program Office and is run through the Naval Surface Warfare Center in Panama City, Florida. GTRI support is funded under the C4I Munitions Test and Improvement Contract (CIMTIC II), for which GTRI is a prime contractor.

"DJC2 is the hardware and software solution to bring everything together that needs to be packaged and sent out for joint task force deployments," said Carlee Bishop, a GTRI researcher and DJC2 project director. "With this equipment, they can set up a command center in the middle of nowhere and run a full JTF."

GTRI engineers are designing the information technology portion of DJC2, with the aim of integrating custom military technology and off-the-shelf civilian technology into a seamless unit. This effort includes network, software, communications, and telephony/video subsystems. GTRI is also researching state-of-the-art concepts to enhance the DJC2 capabilities, plus designing and integrating the engineering solution.

The prototype DJC2 system was recently put to the test during the Hurricane Katrina relief effort. While the task force was being formed to support the victims of the hurricane, the DJC2 system was being packed up and shipped to Louisiana to support command and control of these efforts. Although still under development, the system provided essential communications capabilities needed to conduct the complex task of coordinating civilian, state, federal, and military personnel.

Engineers from GTRI are leading the system integration and production design effort on the Deployable Joint Command and Control (DJC2) program. The prototype system was put to the test during the Hurricane Katrina relief efforts.

Securing Our Homeland

Ensuring Public-safety Communication in Emergencies

When a crisis occurs, it is critical for public safety officials to coordinate their efforts. Yet in Georgia, law enforcement agencies and first responders have radio systems that operate on different frequencies and technologies, which makes it difficult for various agencies to communicate effectively.

In response, the Georgia Office of Homeland Security asked the Georgia Tech Research Institute (GTRI) to help implement a statewide communications system that enables interoperability among agencies. The $8 million project is funded through the federal Department of Homeland Security's Law Enforcement Terrorism Prevention Program.

"One of the advantages of this system is that it allows agencies to use their existing equipment," explained Douglas Cobb, a principal research engineer at GTRI and the project's technical lead. Instead of replacing legacy radio equipment—which would carry a price tag of $200-$300 million—interoperability will be achieved through a "gateway approach."

How it works: Internet networking components and a type of Voice over Internet protocol (VoIP) software will be installed in selected 911 dispatch centers throughout the state. This allows radio calls from law officials and first responders to be routed over the state's private Internet network, which uses multi-protocol label switching technology designed to carry voice, data, and video traffic.

The new system would help in a variety of scenarios, such as:

- transporting prisoners from one jurisdiction to another;
- manhunts like the one for Brian Nichols, Atlanta's courthouse shooter, where lookouts were posted in a number of counties;
- chemical spills or other accidents that might require re-routing of traffic; and
- hurricane or other disaster evacuations.

As the project's technical adviser, GTRI has been involved in a variety of ways, from conducting feasibility studies to helping the Georgia Technology Authority identify vendors to provide networking equipment and service.

Installation of the system has begun at four 911 centers in Cobb, Floyd, Glynn, and Muscogee counties, along with one mobile communications unit. After these pilot sites are up and running, the system will be rolled out to the rest of the state in collaboration with local governments.

By the end of 2006, more than three-quarters of Georgia's population will have access to the system through fixed assets in 911 centers, while the remaining 25 percent of the state will be served by mobile communications units.

GTRI is supporting an interoperable radio system that will help public safety agencies communicate. Shown left to right are GTRI's Douglas Cobb; Tony Wheeler, Cobb County's 911 director; and Mickey Lloyd, the county's public safety director.

Shown in Cobb County's 911 Center are Radio System Manager Tracy Roberts and GTRI's Jay Sexton, Doug Cohen, and Douglas Cobb.

Assisting U.S. Government Agencies with Information Sharing

The U.S. Department of Homeland Security (DHS) and U.S. Department of Justice (DOJ) are collaborating with related federal agencies on a technology that will facilitate sharing of vital public safety and criminal justice information. Known as the National Information Exchange Model (NIEM), the new effort will provide a foundation for sharing information using Extensible Markup Language (XML), an open standard that allows exchange of information regardless of computer system or platform.

With technical support from the Georgia Tech Research Institute (GTRI), the NIEM builds on the successful Global Justice XML Data Model developed earlier for the criminal justice community. The NIEM has released early drafts of the new system's components and programming tools, with the goal of having a completed system ready for use by November 2006.

"By establishing a single standard for XML applications, the National Information Exchange Model will build a foundation for exchanging information among the DHS, DOJ, and supporting organizations responsible for emergency management, intelligence, and other areas," explained John Wandelt, a GTRI principal research scientist. "Building on the success of the Global Justice XML Data Model, NIEM will extend the benefits of a common data model to other agencies at the federal, state, and local levels."

GTRI assisted with the Global Justice initiative, and now serves as the technical lead for the NIEM Project Management Office, which was established as a collaborative effort between the two lead organizations. Working with GTRI, the group is identifying the core data components, reusable XML exchange packages, and business-process models for information sharing that should be included in the NIEM. The Global Justice XML Data Model serves as a foundation for the expanded system.

"This project focuses on applying reusable components as the foundation and building blocks for our XML exchange packages," explained Michael Daconta, metadata program manager for the DHS. "This standardization of exchange packages is critical to allowing the kind of information sharing and interoperability needed among agencies with similar missions."

The National Information Exchange Model will help federal agencies share public safety and criminal justice information. Customs and Border Protection officers review shipping paperwork (above) while an officer monitors a scanner (below).

Key to success for the initiative will be developing partnerships among organizations.

"Improving our nation's ability to exchange mission-critical information cannot be solved by any one entity alone," noted Jim Feagans, NIEM project manager at the DOJ. "This will require a partnership among organizations, governments at all levels, and industry. The NIEM was created to assist in developing a unified strategy, partnerships, and technical implementations for national information sharing across all levels of government in support of justice, public safety, judicial intelligence, and homeland security interests."

The project has been supported by the Bureau of Justice Assistance within the DOJ's Office of Justice Programs.

Preparing for Emergencies in Schools

Because of its size and location in metropolitan Atlanta, the DeKalb County School System is vulnerable to natural and human-caused disasters. Recognizing the potential for crisis, the district has sought help from the Georgia Tech Research Institute (GTRI) in improving its emergency preparedness.

GTRI Research Associate Dara O'Neil and her colleagues are providing technology and policy assistance and emergency preparedness evaluation through DeKalb's Schools United Responding to Emergencies initiative. The U.S. Department of Education is funding the effort.

"The DeKalb County School System has become one of the more innovative school systems in implementing new technologies to help prepare for a crisis situation," O'Neil said.

In May 2005, O'Neil helped organize a tabletop emergency exercise involving a simulated petroleum tank farm explosion near DeKalb's Oakcliff Elementary School. About twenty school employees and top state and local emergency response officials participated in the event, which was sponsored by the Office of Homeland Security-Georgia Emergency Management Agency (OHS-GEMA).

"The tabletop drill is a very effective way to review plans, get feedback, and make improvements—all without the trauma of a real emergency," said DeKalb Administrative Coordinator Terry Segovis, the former principal at Oakcliff. "As we moved through the exercise, I was able to test our plans, hear from the responders about the quality of those plans, and make some important connections along the way."

In the exercise, officials planned an evacuation of Oakcliff, but the scenario was complicated by an estranged parent holding his child hostage.

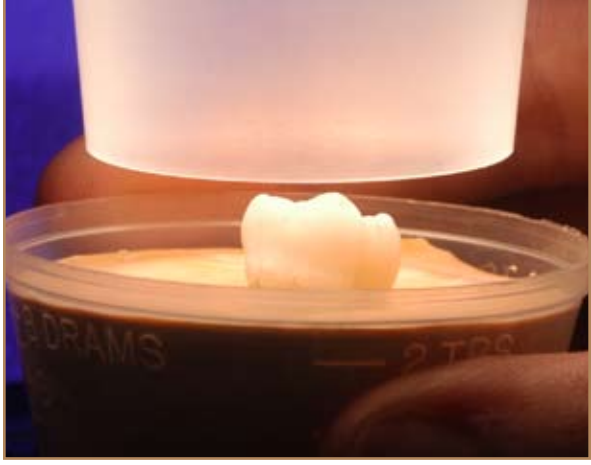
To help officials respond, GTRI researchers demonstrated the Geographic Tool for Visualization and Collaboration (GTVC), a high-tech collaborative mapping tool developed by GTRI for OHS-GEMA. It allowed participants to see the distance between the tank farm and the school and the best route to take for the evacuation. Also, GTVC was linked to panoramic images of every entrance, classroom, hallway, and closet of the school through a video database that GTRI is helping the school system build.

The exercise concluded with everyone safely evacuated to a nearby middle school and apprehension of the parent. Participants agreed that DeKalb responded satisfactorily during the exercise, but they made recommendations for improvement, O'Neil says.

"This exercise was a good opportunity to get first responders and school personnel to know each other face-to-face under fairly normal circumstances," she added. "That kind of contact helps them later when there's a crisis."

GTRI is helping the DeKalb County School System improve emergency preparedness. GTRI's Ray Doyle (top) describes an emergency scenario. GTRI's Kirk Pennywitt (center) explains program components and program participants examine a school floor plan (below).

Protecting Our Health



DenTeC researchers are applying engineering expertise to the field of dentistry. Here, a tooth is examined in a 3-D microscope.

Bringing Engineering Expertise to Dentistry

Attrition within the dental industry has resulted in fewer dentists at the same time there are more mouths to care for, due to a growing population, longer life spans, and greater awareness about oral healthcare.

To help dentists treat more patients and improve quality of care, the Georgia Tech Research Institute (GTRI) has launched a new research center, the Dental Technology Center (DenTeC).

"This is the only center of its kind in the country," observed Dr. Don Ranly, DenTeC's director. "Dental research traditionally has been carried out by corporations or dental schools and had a biological focus. In contrast, DenTeC will draw upon Georgia Tech's expertise in everything from nanotechnology to computer-aided manufacturing."

DenTeC has already signed partnership agreements with a number of companies, including DENTSPLY, one of the country's largest suppliers of dental equipment and products.

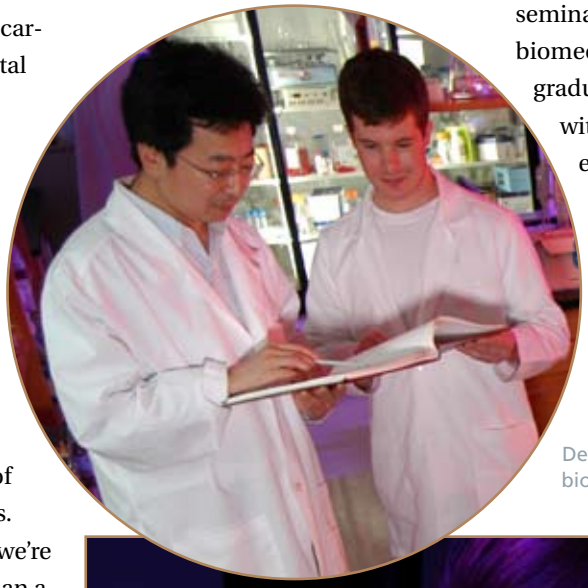
"Companies like the fact that we're an engineering school rather than a dental school, because it means we don't have a 'this-is-the-way-it's-always-been-done mentality,'" explained Jeff Sitterle, GTRI's chief scientist who helped spearhead the Center.

Among DenTeC's current research projects are:

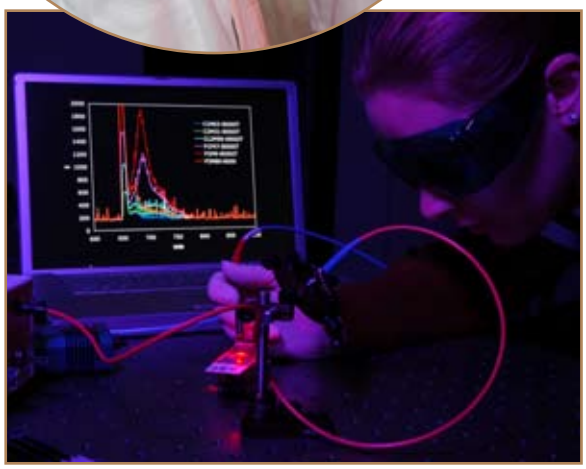
- an "all-in-one" tool that can remove decay, fill a tooth, and administer preventative fluoride treatment;
- transferring aerospace technology to improve air abrasion techniques for removing tooth decay without anesthesia;
- sprayable fillings that prevent shrinkage, which can cause additional decay or infection;
- improved diagnostic methods for detecting bacteria; and
- three-dimensional imaging that enables more precise restorations and prosthetics.

"Projects like these will mean significant advances for dentists, not just incremental improvements," said Jennifer McDonald, an industry consultant who is working with the Center.

In addition to its research and testing capabilities, DenTeC also has a strong educational focus. The Center conducts a technology seminar that exposes Georgia Tech's biomedical engineering undergraduates to career opportunities within dentistry. DenTeC is also establishing a joint program with the Medical College of Georgia that allows doctoral students in dental medicine to take technology courses at Georgia Tech.



DenTeC researchers examine biomedical data.



Multi-spectral imaging provides new data.

Reducing Interference for Implantable Medical Devices

As new wireless technologies advance security, commerce, and entertainment, they also produce interference that may cause problems for people with implanted medical devices.

For example, the electronic article surveillance (EAS) systems used by retailers, libraries, and post offices to prevent theft and track inventory may cause medical devices to do anything from shutting down to invoking therapy at the wrong time.

The EAS/Medical Device E3 Test Center at the Georgia Tech Research Institute (GTRI) works with manufacturers of EAS systems and medical devices to improve compatibility of the products by analyzing electromagnetic environmental effects (E3).

Typically, manufacturers can use filters to reduce electromagnetic interference, but medical devices can pose special challenges. "Simply filtering out the EAS signals is not an option because the very signals the device is designed to detect would also be filtered out," explained Ralph Herkert, manager of the Center. "Instead, medical device manufacturers must deal with the interfering signals in other ways, such as refining their firmware algorithms."

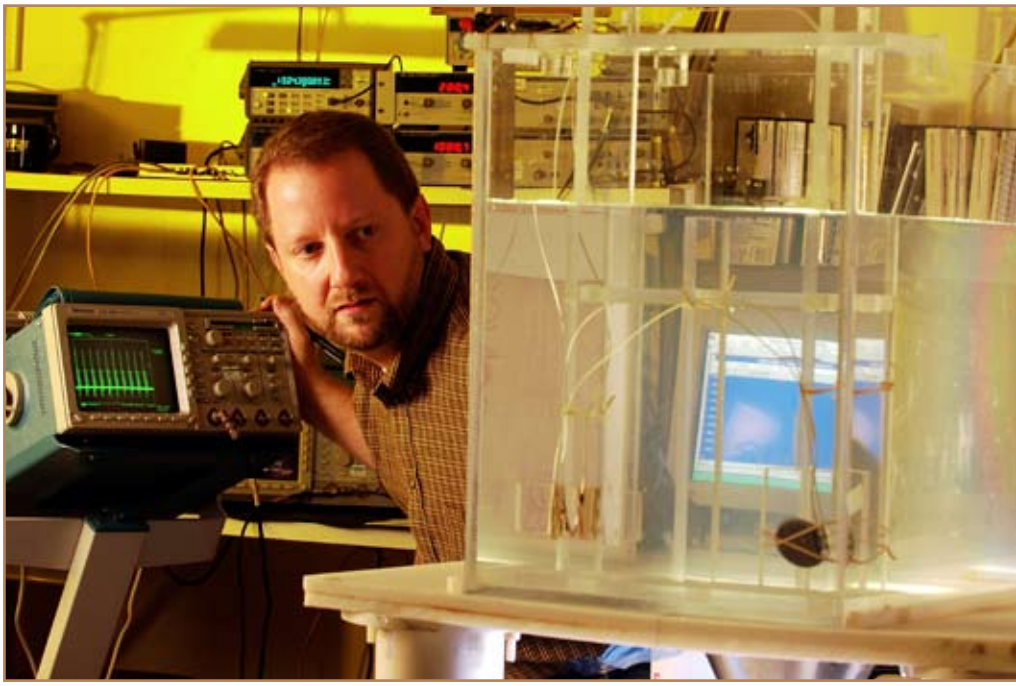
At the Center, researchers expose medical devices to EAS systems and tag deactivators in a manner that simulates real-world conditions. The resulting data are used by the manufacturers' design and quality assurance departments to improve products and make sure they meet Food and Drug Administration requirements.

"By enabling manufacturers of EAS systems and medical devices to work together, the Center reduces adversarial roles and minimizes problems before they occur," said Jimmy Woody, who spearheaded establishment of the EAS Test Center and served as its manager through 2001.

Since its inception in 1995, researchers in GTRI's EAS/Medical Device E3 Test Center have tested more than 600 medical devices. Initial testing focused on pacemakers and defibrillators, but now research is conducted on a variety of devices, including implantable hearing devices, drug-infusion pumps, neurostimulators, cardiac monitors, and glucose monitors.

The Center is expanding its testing capabilities for new types of emission sources. For example, interaction between different types of medical devices has become a new concern as more patients rely on multiple implanted devices. Radio frequency identification (RFID) systems, which are used for tracking and inventory control, are another growing concern.

"Preliminary research that we've conducted has shown that RFID systems may cause interference with medical devices similar to EAS systems," Herkert said. GTRI is acquiring RFID systems, which will be set up to be used with the Center's EAS test protocols.



GTRI researcher Ralph Herkert monitors the output of a pacemaker mounted in a torso simulator in the EAS/Medical Device E3 Test Center.

Enabling Faster, More Accurate Injections with 'Vein Finder'

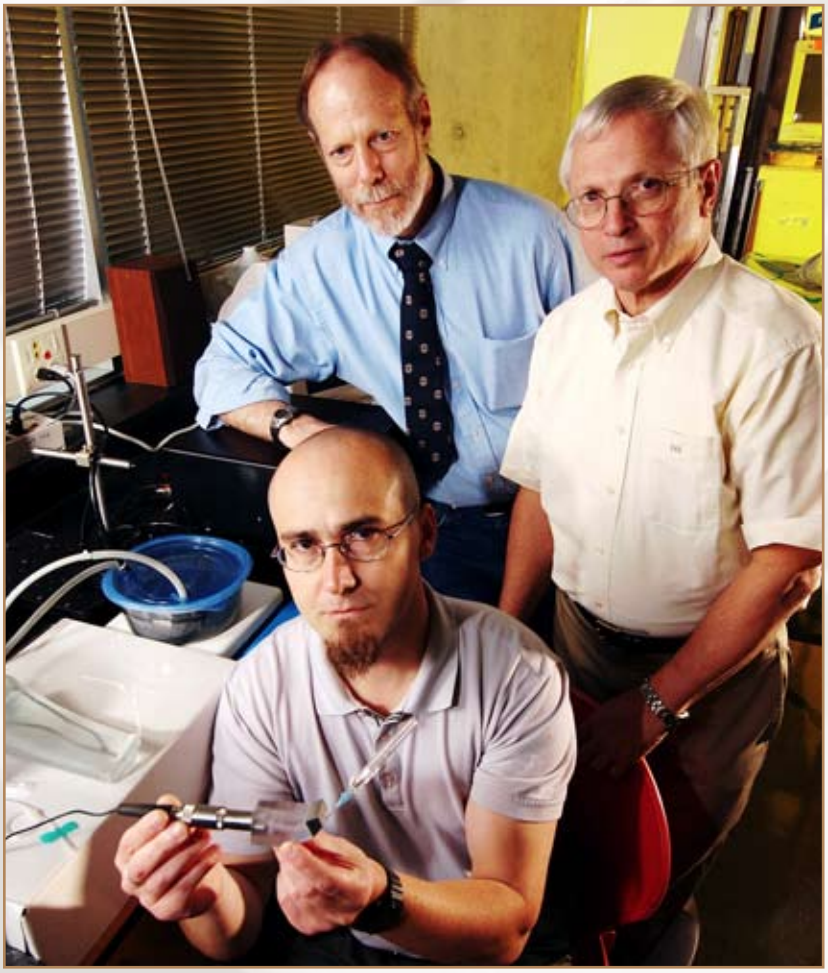
When medics are treating trauma patients, every second counts. Yet bruises, burns, dehydration, and other physical conditions often make it difficult to locate veins and administer lifesaving drugs or solutions.

In response, a multidisciplinary team of Georgia Tech researchers is developing an inexpensive, handheld device that uses Doppler ultrasound technology to find veins quickly.

"Depth and angle are the critical issues for vessel detection," said Michael Gray, a Georgia Tech Research Institute (GTRI) researcher. "Even if you locate a vein from the skin's surface, it's still easy to miss when you try to insert a needle into the tissue below."

Hospitals have sophisticated ultrasound systems to evaluate the heart, valves, and blood vessels in general blood-flow studies, but this equipment is impractical and too costly for field use.

"Although the use of Doppler technology isn't new, the novel aspect of our vein finder is the system's design, which makes it both portable and economical," explained Peter Rogers, a professor in Georgia Tech's Woodruff School of Mechanical Engineering.



The patent-pending vein finder is composed of two parts: A reusable unit houses the electronics and signal processing components, while a disposable coupler box holds a reflector and needle guide. The needle guide is positioned parallel to the sound beam being transmitted by a transducer within the reusable unit.

As medics move the device along a patient's arm or leg, the transducer emits a thin acoustical beam, about the size of pencil lead, into the reflector. Then the reflector directs the ultrasonic waves into the patient's skin at a slight angle. The device can determine the direction of blood flow to distinguish arteries (which carry blood away from the heart) from veins (which carry blood to the heart). Once the device detects a vein, an alarm is triggered, and medics insert the needle.

The vein finder has proved highly effective on phantom-tissue models, and researchers are transitioning the device to work on humans.

The project is sponsored by Reynolds Medical, a medical device company based in Fairburn, Georgia. Connell Reynolds, the company's founder, noted that a couple of existing devices on the market try to locate veins with lights and heat strips, but the GTRI-developed system will be faster and more reliable, making it invaluable for a variety of users, including ambulance services, hospital emergency rooms, clinics, the military, and nursing homes, Reynolds said.

Researchers Francois Guillot (seated), James Larsen (left), and Peter Rogers examine a laboratory prototype of the vein finder. The device uses Doppler ultrasound to locate veins quickly.

Providing a New Weapon against Avian Influenza

Georgia Tech Research Institute (GTRI) engineers are evaluating their optical waveguide sensor—which can detect a variety of environmental, food-borne, and terrorism-related agents—to determine whether it may provide a faster and more portable means of identifying avian influenza. Quicker identification of the virus could limit the spread of the disease, which continues to surface in the U.S. poultry industry from time to time.

Recently, a highly pathogenic and virulent strain of avian influenza, H5N1, has begun to threaten not only birds, but also humans in Asia. In response to the threats, the U.S. Department of Agriculture's Cooperative State Research Education and Extension Service awarded its largest grant ever to study a single animal disease or health threat. That $5 million, multi-institutional study, headquartered at the University of Maryland, is funding the GTRI biosensor research in collaboration with USDA's Southeast Poultry Research Lab. This research is also being supplemented with funding from the Georgia Research Alliance.

"This groundbreaking work promises to deliver a field-deployable detection device that will provide those collecting samples with results while the animal is still in their control, giving them a huge jump in controlling the spread of the disease," said J. Craig Wyvill, head of the GTRI Food Processing Technology Division.

The sensor consists of a laser light source, a planar waveguide (essentially a small piece of glass through which the light travels), and a detector for monitoring light output. Chemical reactions on the waveguide surface—in this case, the binding of an avian influenza antibody to the virus that causes the disease—alter the speed of light through the waveguide.

This change is monitored with an interferometer by comparing a reference beam with another beam traveling under the sensing chemistry. Signal processing software interprets the sensor's results and delivers information on the agent's identity and quantity.

With the new funding, GTRI researchers are testing various avian influenza antibodies to serve as the sensor's receptor for binding the virus to the sensor surface and optimizing the assay procedure, explained GTRI Senior Research Scientist David Gottfried.

In contrast to most antibody assays that contain multiple chemical binding steps, the GTRI sensor is a direct assay, meaning it directly detects the antibody binding to the target virus.

In preliminary work using low pathogenicity strains of the virus, the GTRI sensor was shown to be considerably more sensitive than a commercial influenza assay while providing discrimination of virus subtypes.

GTRI researcher David Gottfried shows components of GTRI's optical waveguide sensor, which is being evaluated as a potentially more rapid means of detecting avian influenza.

Educating Our People

Involving People Who Are Deaf or Hard of Hearing

GTRI researcher Leanne West displays equipment that is part of a wearable captioning system for providing text-based information to people who are deaf or hard-of-hearing.

For people who are deaf or hard of hearing, the voices of actors, teachers, sports announcers, and clergy are often silenced, limiting their involvement in community activities. A new wearable captioning system developed at the Georgia Tech Research Institute (GTRI) may change that reality for the twenty-eight million Americans who are deaf or hard-of-hearing.

The system, which relies on mobile wireless technology, will allow users to easily receive information that is being presented audibly to the general public in a variety of venues such as movie theaters, playhouses, government meetings, sports arenas, and places of worship. Because the system can transmit multiple text streams, it could also be used for language translation or for providing information such as statistics to hearing patrons at sporting events.

"The venue must generate the captions for patrons, but our system is an easy way to get captioning to patrons in a way they want, customized for each person," said GTRI project director Leanne West. "Right now, captioning is typically available only in movie theaters—and just a limited number of them—but this device gives us a way to deliver captioning at any venue."

In the system, captions are sent by a venue's transmitter via standard wireless technology—the 802.11b wireless protocol—to a receiver device, such as a personal digital assistant (PDA), which also displays captions. Users could borrow the receiver and display from the venue or bring their own.

Patrons would use a micro display that plugs into a PDA and attaches to their glasses or is worn on a headband. Although positioned close to the eye, the micro display uses optics that make its screen appear to float several feet away, giving users relaxed viewing of text seemingly overlaid on their visual field.

The project got funding from GTRI and a grant from the Wireless Rehabilitation Engineering Research Center at Georgia Tech, which is funded by the National Institute on Disability and Rehabilitation Research, a unit of the U.S. Department of Education.

Researchers tested the system with sixty-three volunteers who were deaf or hard-of-hearing and ranged in age from fifteen to seventy-five. "We wanted to make sure we were on the right track and including features they wanted and felt were necessary," West said. "We took their comments and included some of the features they wanted to see."

GTRI expects to license the system to a company that can commercialize it.

Helping Students Experience Scientific Research

It's tough to acquire a taste for oceanography when you're surrounded by urban asphalt, farm fields, or suburban malls. Yet with SeaMaven, middle-school students hundreds of miles from the nearest ocean can enter the world of marine biology and related sciences.

Developed by researchers at the Georgia Tech Research Institute (GTRI), SeaMaven is a unique Web portal (www.seamaven.org) that gives students access to continuous, near-real-time data collected from naval platforms sixty miles off the coast of Georgia.

Eight platforms, currently operated by the U.S. Navy for flight training, have been equipped with sophisticated sensors to monitor various ocean and meteorological conditions, such as barometric pressure and dissolved oxygen in water. Located both above and under the water, these sensors are part of an observational network used by researchers, weather forecasters, and environmental resource managers.

In cooperation with the Savannah-based Skidaway Institute of Oceanography, which manages the network, GTRI uploads data every hour to SeaMaven. This enables students to participate in a variety of learning activities, from mapping the ocean floor to understanding the moon's effect on ocean tides.

"SeaMaven gives students a better idea of how science is applied in the real world," said Jim Demmers, project director and a GTRI senior researcher. Demmers' inspiration for SeaMaven stemmed from his work with Foundations for the Future, a collaboration of Georgia Tech researchers that helps K-12 educators incorporate technology into classrooms. "Students can read about ocean management in a textbook, but that doesn't really give them a clear idea of what marine scientists do," Demmers explained.

"SeaMaven also helps students understand the connection between people's activities on the mainland and how that affects the ocean," he added. For example, middle-schoolers can analyze how onshore rainfall and runoff affect ocean salinity, a concern for the shrimping industry.

Funded by the National Science Foundation, SeaMaven began in 2003 when Demmers met with a group of middle-school teachers to seek recommendations for learning activities to be included in the Web portal.

SeaMaven makes learning "stickier," said Dawn Adams, internship coordinator at Wheeler High School's magnet program, who helped Demmers develop many of SeaMaven's online exercises.

SeaMaven is a Web portal that helps students understand the world of marine biology. Using data from naval platforms off the coast, the project provides real-time data on factors affecting sea life.

Extending Internet Learning to Rural Areas

In U.S. cities and suburbs, high-speed wireless Internet connections are becoming more commonplace, making "anytime, anywhere learning" possible for students, but that kind of access and the opportunities it provides are not yet available in many rural areas.

However, two recent demonstrations at educational technology conferences in Missoula, Montana, demonstrated a possible solution for educators and information specialists who want to use it to level the playing field. Atop a remote mountain near Missoula, engineers from the Georgia Tech Research Institute (GTRI) awed conference attendees with the video streaming, Web access, and e-mail capabilities of new wireless technology standards called 802.16 or Worldwide Interoperability for Microwave Access (WiMax).

WiMax is a set of standards for delivering point-to-point, as well as point-to-multi-point wireless broadband connectivity. Point-to-point transmission is a direct transmission from a tower to a central-office-type location up to thirty miles away. At the central office location, point-to-multi-point connectivity extends up to five miles from the central office.

"WiMax is important because it's potentially the most cost-effective approach for broadband data service in rural areas," said Jeff Evans, a GTRI senior research engineer who led the demonstration team.

In rural areas, the cost to lay fiber for wired broadband service can be prohibitive. "With WiMax, an Internet service provider that wants to reach a small community up to thirty miles away can set up a wireless link for thousands of dollars rather than hundreds of thousands," Evans notes. "You can quickly provide a long-haul link of seventy megabits per second and then deploy a local WiMax radio to provide up to several megabits per second to each home in the area, giving you DSL speeds at a reasonable cost."

Around the nation, wireless technology companies and researchers have been demonstrating the capabilities of WiMax. The Georgia Department of Education's Mike Hall, deputy superintendent of information technology, involved GTRI researchers in the Montana demonstration through GTRI's Foundations for the Future (F3) technology assistance program for K-12 Georgia schools. Intel sponsored the conferences and invited Evans and his colleagues to design and implement the network demonstrations.

Hall hailed the success of the demonstration in overcoming the speed, performance, distance, and security issues that hamper current wireless technology. Though WiMax won't necessarily be a solution inside the walls of Georgia schools—many of which are already hard-wired for broadband Internet access—the technology could make it possible for students to learn in all kinds of places.

GTRI researchers recently demonstrated the potential for WiMax technology for extending Internet connectivity to rural areas where traditional wired broadband service would be too costly to provide.

Improving Product Usability for People with Disabilities

When the designers of photocopiers, ATMs, cell phones, printers, and other equipment need help determining how well these devices can be used by people with disabilities, they can turn to the Georgia Tech Research Institute (GTRI).

GTRI's Accessibility Evaluation Facility assesses a variety of products based on the requirements outlined in Section 508 of the federal Rehabilitation Act. Beyond evaluation, however, the researchers can recommend improvements based on the concept of universal design.

"When we test products for accessibility, we conduct user testing and perform a checklist evaluation of the product based on technical standards for accessible design and sound human-factors design principles," explained GTRI Senior Research Scientist Brad Fain, who leads research in the Facility.

Research participants recruited from the local disability community perform a series of tasks with the products being tested. Researchers monitor participants' performance on these tasks. The results of this user testing and the checklist evaluation provide objective data about product accessibility.

"We can collect human performance data and provide it, along with our checklist evaluation results and design recommendations, to designers who can make changes in products to make them more accessible to people with disabilities, as well as everyone else," Fain said.

That concept is called universal design, and it makes a product accessible to as many different types of users as possible. One example of universal design is a cell phone created for the hard of hearing; it would also be useful to people talking on their phones in noisy environments.

Universal design concepts, as well as federal standards, guide Fain and his colleagues as they evaluate products. They have examined items for customers, including Ricoh, Pitney-Bowes, the National Council on Disability, the Arthritis Foundation, and the National Institute on Disability and Rehabilitation Research, a division of the U.S. Department of Education.

To assist designers and government officials with Section 508 compliance, researchers at GTRI and Georgia Tech's Center for Assistive Technology and Environmental Access (CATEA) created the Accessibility Assistant, an online evaluation tool available at accessibility.gtri.gatech.edu/assistant.

GTRI also conducts evaluations for the Arthritis Foundation to determine a product's ease of use for arthritis patients, who have upper and lower mobility issues, including difficulty grasping and lifting, as well as reduced sensation. GTRI is the sole independent laboratory authorized to test products for the Arthritis Foundation's Ease of Use program.

Volunteer James Johnson, who uses a wheelchair for mobility, helps GTRI researcher Brad Fain evaluate the accessibility of a photocopier in the Accessibility Evaluation Facility.

Facilitating Industry-university Collaboration

Researchers and industry leaders working to make food processing safer and more efficient got a boost recently with the opening of a new building designed for collaborative technology development at the Georgia Institute of Technology.

The 36,000-square-foot first phase of Georgia Tech's Food Processing Technology Building houses offices and research laboratories for automation, information, and environmental technology development. The building also includes a 4,300-square-foot high-bay prototyping area, a forty-eight-seat auditorium, and a large conference room for industrial and organizational meetings and events.

The new building serves as headquarters for the Food Processing Technology Division of the Georgia Tech Research Institute (GTRI). Through the division, GTRI conducts significant industrial research under two major programs: the Agricultural Technology Research Program (ATRP) and Georgia's Traditional Industries Program for Food Processing, which is managed through the Food Processing Advisory Council (FoodPAC).

Ranked as one of the top programs of its kind in the country, ATRP works closely with Georgia agribusiness, especially the poultry industry, to develop new technologies and adapt existing ones for specialized industrial needs.

Researchers focus on both immediate and long-term industrial needs, ranging from advanced robotic systems to improved wastewater treatment technologies to machine-vision grading and rapid microbial detection. FoodPAC is committed to enhancing the competitiveness of Georgia's food industry, and through the Traditional Industries Program, has helped GTRI commercialize some of its developments while also adapting them to the needs of such industries as bakeries and fruit processors.

"The completion of the Food Processing Technology Building marks the start of a new era for Georgia Tech's food processing research activities," said J. Craig Wyvill, division chief. "The facility, with its many state-of-the-art laboratories, small prototype fabrication shop, and high-bay test and construction area, provides an environment that will help facilitate collaborative food processing technology development."

Fundraising for the Phase I building was coordinated through FoodPAC and the Georgia Poultry Federation. State bond funds were supplemented by private sources that included pledges and donations from seventeen companies that manufacture food products or offer equipment and technological support to the industry.

Georgia Tech's Food Processing Technology Building hosts research of benefit to industry. Aklilu Giorges and John Pierson conduct flow visualization studies (above, left to right) while Erik Kline and Doug Britton (below, left to right) test an inspection system.

Improving Communication between Workers and Machines

Technology that transfers computer-generated information into the physical world is being tested for use in poultry plants to improve communication between computers and workers.

Using augmented reality (AR) technology, researchers have designed two systems that project graphical instructions from an automated inspection system onto birds on a processing line. These symbols tell workers how to trim or whether to discard defective products.

Right now, inspection is done visually by human screeners, who communicate instructions to trimmers using gestures. Automated inspection systems under development at the Georgia Tech Research Institute (GTRI) and at a limited number of commercial and governmental labs promise to change this situation in the near term.

"When that happens, the industry will need an efficient way to link communication from the imaging system to the trimmers," said J. Craig Wyvill, head of the GTRI Food Processing Technology Division.

So in a project funded by GTRI's state-supported Agricultural Technology Research Program, GTRI researchers are collaborating with experts in the Georgia Tech College of Computing to use AR technology in poultry plants. AR applications have been successfully demonstrated in industrial assembly and inspection, as well as the medical field.

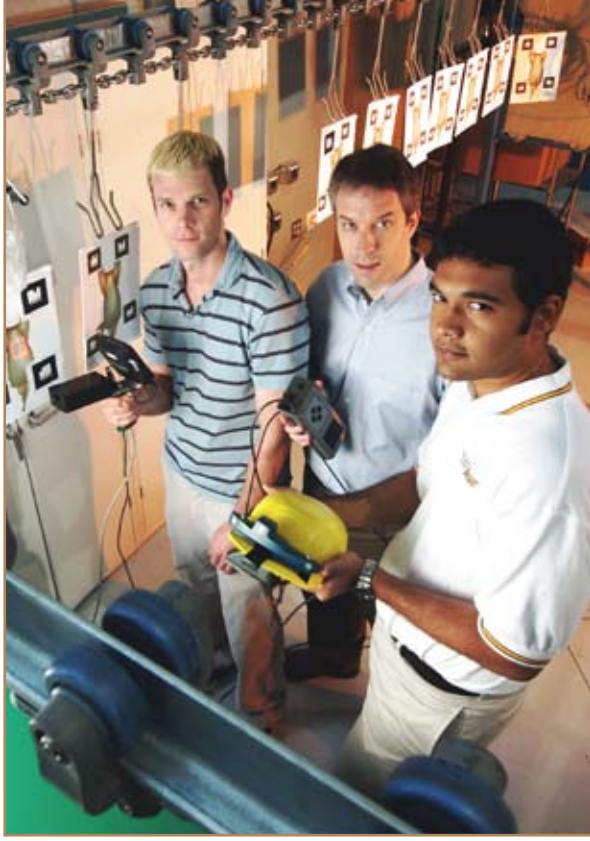
"It's easy to see this technology working in a poultry plant," said Blair MacIntyre, an assistant professor in the Georgia Tech College of Computing. "The question is, 'What is the best implementation of the technology to satisfy the environmental constraints?'"

Researchers have had to consider that poultry processing plants are typically wet and slippery and have to be thoroughly washed down with high-pressured water streams daily. Also, trimmers need simple, graphical instructions and must have their hands free of any object except a knife for cutting defective bird parts.

Two AR solutions developed by MacIntyre and colleagues Parth Bhawalkar, a College of Computing graduate student, and Simeon Harbert, a GTRI research engineer, address these requirements.

The first approach uses a location-tracked, see-through, head-mounted display worn by a trimmer that directly overlays graphical instructions on a trimmer's view of the birds. A second solution uses a laser scanner, mounted in a fixed location near the processing line, to project graphical instructions directly onto each bird that requires some action.

Researchers plan to conduct laboratory experiments to uncover the potential benefits or drawbacks of each AR application. Researchers will likely choose one of the two solutions to develop further based on economics and logistics.



Augmented reality technology could improve communication between workers and automated inspection systems. (Above) Simeon Harbert, Blair McIntyre, and Parth Bhawakar display the technology. (Below) A close-up of an augmented reality system.

GTRI across the Nation

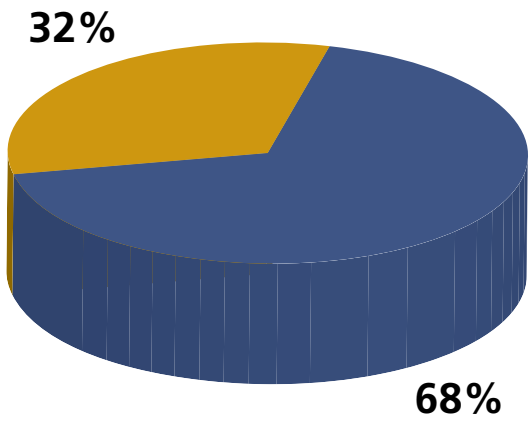
The Georgia Tech Research Institute (GTRI) is headquartered on the Georgia Tech campus in Midtown Atlanta, where five of its eight research laboratories are also located.

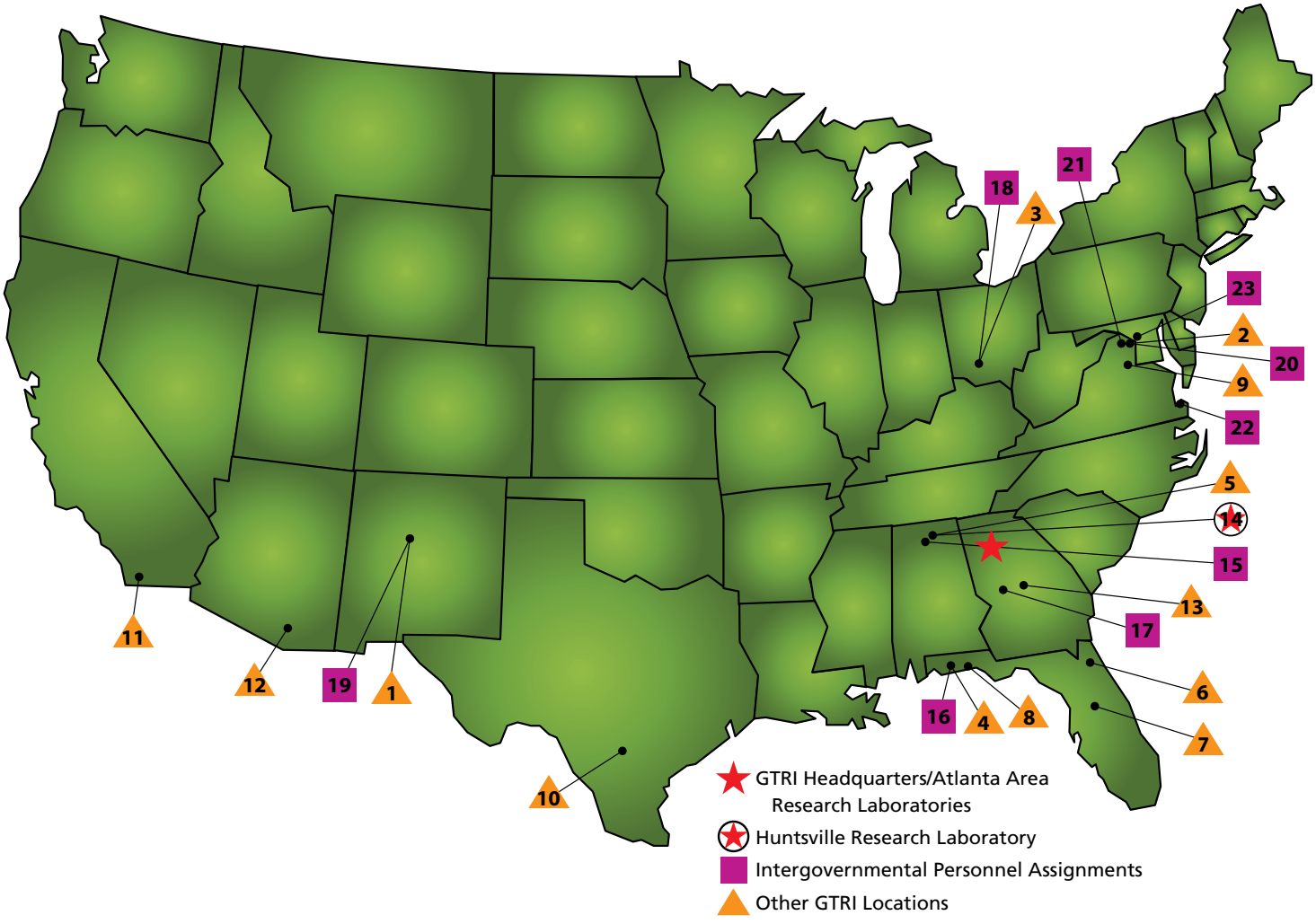
Two GTRI laboratories operate at a major off-campus research facility approximately fifteen miles north of Atlanta in Cobb County adjacent to the Dobbins Air Reserve Base. Additionally, GTRI operates a laboratory in Huntsville, Alabama.

On-site research and business services also take place at a number of GTRI offices around the nation with locations in Alabama, Arizona, California, Florida, Georgia, New Mexico, Virginia, Ohio, and Texas.

GTRI Research Facilities, Fiscal Year 2005

Facility	Square Footage
On-campus Research Space	302,624
Off-campus Research Space	141,080
Total	443,704





Other GTRI Locations

1 Albuquerque Field Office
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Albuquerque, NM 87106
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joe.accetta@gtri.gatech.edu

2 Arlington Field Office
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W. Ed Eagar, Manager
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ed.eagar@gtri.gatech.edu

3 Dayton Field Office
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David G. Erickson, Manager
937.427.0125
dave.erickson@gtri.gatech.edu

4 Eglin Field Office
Eglin Air Force Base, Florida
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A. Neil Christianson, Manager
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5 Huntsville Field Office
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13 Warner Robins Field Office
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Warner Robins, GA 31088
Lee Evans, Manager
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GTRI Intergovernmental Personnel Assignments

14 Huntsville, Alabama
- U.S. Army Lower Tier Project Office/ Program Executive Office Missiles and Space (PEO MS)
- U.S. Army Aviation and Missile Research, Development, and Engineering Center; Ground-Based Midcourse Defense Joint Program Office (ARMDEC GMD JPO)

15 Redstone Arsenal, Alabama
- U.S. Army Aviation and Missile Research, Development, and Engineering Center (ARMDEC) (2)
- U.S. Army Program Executive Office Missiles and Space (PEO MS)

16 Eglin Air Force Base, Florida
- Air Armament Center Armament Product Directorate (AAC APD)

17 Fort McPherson, Georgia
- Headquarters, U.S. Army Reserve Command (HQ USARC), Army Environmental Policy Institute (AEPI)

18 Wright Patterson Air Force Base, Ohio
- Air Force Research Laboratory Sensors Directorate (AFRL/SN)
- Advanced Strategic Command Center/Campaign, Simulation, & Missile Analysis Branch
- National Air & Space Intelligence Center (NASIC) Engineering Division

19 Kirtland AFB, New Mexico
- Air Force Research Laboratory, Space Vehicles Directorate (AFRL/VS)
- Air Force Research Laboratory/Phillips Research Site (AFRL-PRS)

20 Arlington, Virginia
- Washington Headquarters Services (WHS), Human Resources Directorate (HRD); Executive & Political Personnel Division
- Office of Naval Research (ONR)

21 Chantilly, Virginia
- National Security Space Office (NSSO)

22 Norfolk, Virginia
- U.S. Joint Forces Command, Joint Experimentation Directorate (USJFCOM/J9)
- U.S. Joint Forces Command, Command, Control, Communications, and Computer (C4) Systems Directorate (USJFCOM/J6)

23 Washington, D.C.
- National Defense University (NDU), Center for Technology and National Security Policy (CTNSP)

The Research Laboratories of GTRI

GTRI conducts its programs of research through eight laboratories that focus on specific areas of technical excellence. These laboratories include:

Aerospace, Transportation and Advanced Systems Laboratory (ATAS)

– James McMichael, laboratory director, 770.528.7826

ATAS develops advanced systems concepts and performs research related to aerospace systems, power and energy systems, threat systems, intelligent autonomous systems, and systems engineering methodologies. The lab also develops advanced technologies and performs research in a range of areas relevant to aerospace and ground transportation as well as to national defense. Current contracts include work in aerodynamics and flow control, aeroacoustics, computational aeroelasticity, wind tunnel testing, aircraft structural analysis, rotorcraft, intelligent systems, fuel cell and battery technologies, smart small-scale projectiles, embedded computing, unmanned aerial vehicles, and flight stability and control.

The lab also performs applied research and development of radar-related technologies in support of national defense preparedness. The lab's prototype development capabilities span the spectrum from mechanical and electronics design and fabrication to full system integration including embedded computing and control systems. ATAS has also achieved a national reputation for its expertise in threat systems, advanced transmitter technology, radar system development, and weapon systems interpretation.

Electronic Systems Laboratory (ELSYS)

– William Rogers, laboratory director, 404.407.7303

ELSYS focuses on systems engineering solutions in electronic defense; modeling, simulation, and analysis; countermeasures technique development; sensors performance analysis; electronic warfare systems integration; standardized test procedures; flight test support; laboratory support stations and test systems; missile warning system improvements; technology insertion and human factors. ELSYS researchers are nationally recognized for their contributions to national defense in countermeasures technique development, employing an end-to-end approach to countermeasures development.

ELSYS also specializes in areas of detailed mathematical modeling and analysis of dynamic systems, specialized instrumentation, and real-time simulation. Sensor performance analysis includes intercept receiver analysis, advanced radar concepts analysis, electronic countermeasures analysis, specialized instrumentation, and real-time simulation. In the past decade, ELSYS has supported flight tests covering all aspects of airborne testing.

Electro-Optical Systems Laboratory (EOSL)

– Gisele Bennett, laboratory director, 404.894.0155

EOSL has technology thrusts in the areas of electro-optical modeling and analysis, microelectronic and nanotechnology development, remote sensing, acoustics, and mechanical systems. EOSL has numerous technology areas of preeminence that include LIDAR systems development, hyperspectral and multi-spectral imaging, ultraviolet/infrared stimulator development, countermeasures technology, microelectronics, and electro-optical modeling and analysis.

The research activities extend to nanotechnology carbon tubes; RFID; advanced container security development; optical tagging and tracking technology; measurement data collection, analysis, and dissemination; atmospheric modeling; geospatial information systems and analysis; and human vision modeling. The laboratory has been heavily involved in the development of geographic information system databases and advanced rendering techniques to include modeling of various backgrounds in the ultraviolet to infrared portions of the spectrum.

Research centers within EOSL include the following:

- The Sensors and Sensing Systems Information and Analysis Center (SENSIAC) serves the military sensor community as a repository of information, provider of symposia and specific technical tasks related to sensing technology.
- The Logistics and Maintenance Applied Research Center (LandMARC) provides analysis, design, and integration of technology to support activities essential to sustaining complex military and commercial systems.

- The National Guard Technology Program Office provides unbiased and quick solutions to support domestic operational missions for the National Guard.
- The Phosphor Technology Center of Excellence is involved in the research and development of light-emitting materials, devices, and displays.

Health and Environmental Systems Laboratory (HESL)

– Jeff Sitterle, interim laboratory director, 404.894.3369

HESL is a leader in the development and application of innovative technologies, information, and engineering solutions focused on enhancing human health and its relationship with the environment. Researchers in HESL work in biomedical diagnostics and therapeutics, in environmental assessment and remediation, and in the intersection between health and the built environment: green buildings, smart and sustainable urban neighborhoods, and healthy environments.

The Health Systems Division conducts research and development in the areas of diagnostic sensors, biomarkers, vision enhancement, materials characterization and delivery, and advanced prosthetics. The Environmental Systems Division conducts research and development in the areas of air and water quality, hazardous materials, sustainable facilities, and environmental sensors. It is also involved in energy-related issues as they impact the environment.

The Food Processing Technology Division conducts significant research in improving the production and quality of food while minimizing the environmental impacts of the industry. This program is designed to enhance the productivity of Georgia's agribusiness and the competitiveness of Georgia's food processing, applying computer vision, robotics, plant ergonomics, biosensors, and wearable computer technology.

The Occupational Safety and Health Division offers programs of technical assistance on-site at private and public facilities, along with research and development of cost-effective solutions.

Huntsville Research Laboratory (HRL)

– Barry Bullard, laboratory director, 205.876.1301

This laboratory, located in Huntsville, Alabama, primarily supports the U.S. Army Aviation and Missile Research, Development and Engineering Center (USA AMRDEC) in its aviation and missile R&D efforts. The laboratory's multidisciplinary research skills include battlefield command and control simulation and analysis, analysis and modeling of complete air and missile defense systems, sensor and fuze simulation and analysis, and aviation mission planning software engineering. Other research involves field and hardware-in-the-loop testing of air defense weapons equipment, war gaming and force-on-force simulations, guidance and control simulations, and tactical software development.

Information Technology & Telecommunications Laboratory (ITTL)

– Randolph Case, laboratory director, 404.407.6456

ITTL conducts a broad range of research in areas of computer science and information technology, communications and networking, and the development of commercial products from university research.

ITTL's Computer Science and Information Technology Division conducts research that solves complex problems involving information processing, storage, representation, and exchange; Internet and database technologies and applications; information security and assurance; along with privacy, knowledge management, data visualization, mapping/geographical information, distributed simulation, and enterprise information systems.

Communications and Networking Division researchers work in broadband telecommunications, wireless access systems, network security, multimedia information systems, tactical communications, communications surveillance and disruption, information warfare and assurance, communications networks and network management, technology assessment, application integration, and software radio systems.

The Commercial Product Realization Office leads multidisciplinary research teams drawn from across GTRI and Georgia Tech in applied product research and development toward product commercialization. The Office of Policy Analysis and Research provides policy monitoring and assessment to facilitate responsiveness to changes in the technological research environment. ITTL also provides C4I capabilities and functional requirements analysis to various service components across the Department of Defense in northern and eastern Virginia.

Sensors and Electromagnetic Applications Laboratory (SEAL)

– Robert Trebits, laboratory director, 770.528.7915

SEAL researchers investigate radar systems, electromagnetic environmental effects, radar system performance modeling and simulations, and antenna technology. Radar programs focus on the development, analysis, and performance evaluation of radar systems; reflectivity and propagation measurement characterization; electronic attack and protection techniques; avionics integration; non-cooperative target identification; vulnerability analysis; signal processing techniques; ground and airborne moving target indication; synthetic aperture radar; and system sustainment tool development.

Antenna-related research programs characterize antenna gain characteristics, develop phased array antenna concepts, and develop various kinds of reflector-type and lens antennas. In the field of electromagnetic environmental effects, SEAL researchers analyze, measure, and control the electromagnetic interactions among elements of an electronic system and between the system and its environment. Additional research areas include sensor development for ballistic missile defense, physical security, meteorology, space-based surveillance and detection, transportation applications, engineering data analysis and modeling for sustainment of complex electronic systems. SEAL also provides customer-tailored short courses in electronic defense.

Signature Technology Laboratory (STL)

– John Meadors, laboratory director, 404.894.2539

STL conducts research and development in four technical areas: electromagnetic materials and structures, electromagnetic apertures and scattering, optical and infrared physics and phenomenology, and secure information systems. The lab's main focus is the development of technologies for the management and control of multi-spectral signatures of objects under observation by sophisticated sensor systems.

The laboratory maintains an extensive numerical modeling and measurement capability for the design and development of thin, broadband antennas with tailored performance and controlled impedance surfaces for management/control of signature characteristics of systems and components. Numerical modeling has recently been extended to nano- and micro-magnetics phenomena with emphasis placed on modeling of nanoparticle nonlinear magnetics (NPNM). Novel techniques for correlating optical and infrared scattering properties with material composition have been developed and modeled for application to paint and photographic film characterization, optical signature control, and the evaluation of sensors and image-based tracking algorithms.

STL maintains and operates extensive facilities for optical measurements specializing in laser and white light scatterometry, electromagnetic materials characterization, radar cross section measurements, antenna characterization, and computational electromagnetics. The secure information systems work is nationally recognized for the design, development, and deployment of enterprise information systems requiring state-of-the-art database, platform, and Internet security.

Interdisciplinary Centers Reporting through GTRI

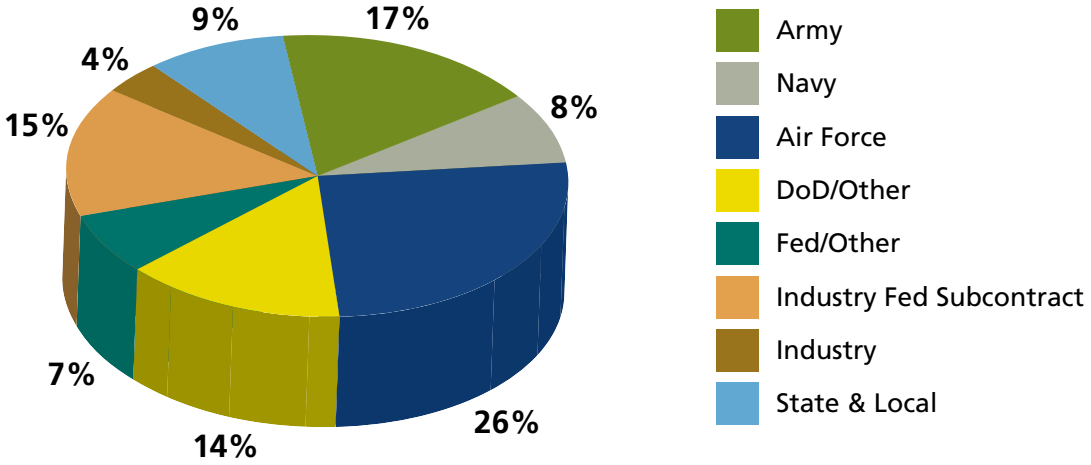
Several interdisciplinary research centers report through the Georgia Tech Research Institute (GTRI). They include:

Center	GTRI Lab
Center for International Development and Cooperation **www.gtri.gatech.edu/seal/cidc.html**	SEAL
Commercial Product Realization Office **www.gtri.gatech.edu/cpro/**	ITTL
Criminal Justice Science and Technology Center **www.gtri.gatech.edu/ittl/csit/facil_cjstc.html**	ITTL
Dental Technology Center (DenTeC) **www.dentec.gatech.edu/**	HESL
Center for Innovative Fuel Cell and Battery Technologies **www.fcbt.gatech.edu/**	ATAS
Logistics and Maintenance Applied Research Center (LandMARC) **landmarc.gtri.gatech.edu/**	EOSL
Military Sensing Information Analysis Center (SENSIAC) **www.sensiac.gatech.edu/sensiac/**	EOSL
Phosphor Technology Center of Excellence (PTCOE) **www.gtri.gatech.edu/eoeml/oemcs/proj_phosphorcenter.html**	EOSL
Severe Storms Research Center **www.gtri.gatech.edu/seal/radar/facil_ssrc.html**	SEAL
Space Technology Advanced Research Center (STAR) **www.star.gatech.edu**	ELSYS
Test and Evaluation Research and Education Center (TEREC) **www.terec.gatech.edu/**	ELSYS

GTRI Finances by the Numbers

The Georgia Tech Research Institute (GTRI) ended the 2005 fiscal year with total sponsored research approximately $3.5 million higher than for the 2004 fiscal year. GTRI budgetary reserves also increased by $350,000, an increase made possible through fiscal discipline. Additionally, cost overruns on research programs decreased by more than 50 percent over fiscal year 2004.

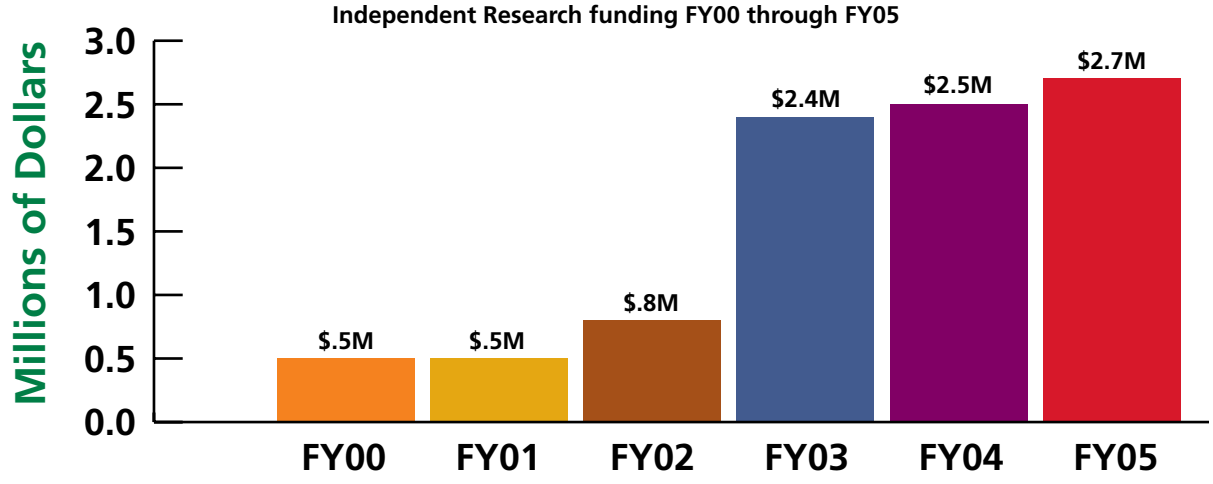
During fiscal year 2005, GTRI reported $135.4 million in contract awards and grants. Major customers for GTRI research include U.S. Department of Defense agencies, the state of Georgia, non-defense federal agencies, and private industry. Overall, contracts and grants from Department of Defense agencies account for approximately 72 percent of GTRI's total expenditures.



Independent Research and Development

The Georgia Tech Research Institute independent research and development program supports the GTRI Strategic Plan through investment in programs with anticipated long-term return. Independent research investment is intended to expand capability and sustain a competitive position in critical research areas. It also fosters exploration and accelerates entry into new areas that may have a high payoff for GTRI's stakeholders and potential customers.

The GTRI Fellows Council assesses and recommends future technological directions for GTRI's research program. Composed of the organization's most senior and distinguished research faculty, the Council also evaluates proposals for funding through GTRI's internal research programs.

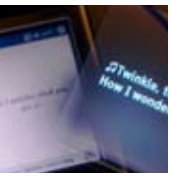


GTRI in the News

The Georgia Tech Research Institute attracts state, national, and international news coverage in media ranging from ***USA Today*** and ***Rolling Stone*** to ***National Defense*** and ***Computerworld***. Below are a few examples of coverage received by GTRI's cutting-edge research.

USA Today, ***Fortune***, the ***Atlanta Journal-Constitution***, **WXIA-TV**, ***National Defense***, ***Machine Design***, **MSNBC.com**, and ***Rolling Stone*** magazine covered development of a concept vehicle designed to illustrate technology options for improving survivability and mobility in future military combat vehicles. Known as ULTRA AP, the vehicle demonstrates better protection for crew members, a more powerful engine, and advanced systems such as stability control. Gary Caille of GTRI is leading the project. See the story on page 3.

A new wireless technology known as WiMax promises to extend Internet connectivity to rural areas that would be economically impractical to serve with conventional broadband technology. GTRI telecommunication researchers Jeff Evans and Jay Sexton led a demonstration of WiMax educational capabilities that attracted coverage in ***Computerworld***, ***Mechanical Engineering***, and the German technology newspaper ***Computer Zeitung***. See the story on page 24.



R&D magazine, ***Electronic Design***, ***Government Product News***, and national television science service ***Discoveries and Breakthroughs Inside Science*** featured GTRI work on a wireless captioning system for the deaf and hearing impaired. The system allows persons with hearing limitations to receive text-based announcements on PDAs and other devices at events such as public meetings, sporting competitions, worship services, and theaters. Leanne West is leading the project. See the story on page 22.

Government Technology and ***Washington Technology*** mentioned GTRI's role in developing the Global Justice XML Data Model. Based on Extensible Markup Language (XML), the model helps justice agencies share information, and lowers the cost of developing new systems. John Wandelt is leading GTRI's part of the effort, which provides the foundation for the broader programs of the National Information Exchange Model. See page 16.

Protecting workers involved in Gulf Coast recovery efforts is a high priority for the U.S. Occupational Safety and Health Administration, which awarded GTRI a grant to train workers on safety-related issues. Media outlets covering this work included ***Professional Safety***, the ***Augusta Chronicle***, the ***Columbus Ledger-Enquirer***, the ***Americus Times-Recorder***, **WSB-TV**, and several smaller Georgia newspapers. See story at: gtresearchnews.gatech.edu/newsrelease/hurricane-worker.htm

Machine Design, ***Photonics Spectra***, ***Computerworld***, ***Industrial Engineer***, ***Automation World***, ***Sensors***, and the German newspaper ***Computer Zeitung*** reported on a pair of GTRI projects designed to address issues facing the food processing industry. One project, headed by John Stewart, Doug Britton, and others, is developing a vision system to catch potential plastic contamination on production lines used for food. The second project uses augmented reality techniques to improve communication between new generations of automated inspection systems and workers on food processing lines. See story on page 27.

A new GTRI training initiative designed to help public safety and first-responder personnel protect themselves from the hazards of clandestine methamphetamine laboratories has received wide coverage. ***Occupational Health and Safety***, ***POLICE*** magazine, the ***Covington News***, the ***Athens Banner-Herald***, the ***Augusta Chronicle***, and **WSB-TV** all covered the initiative, which is led by Kevin Caravati and Ray Doyle. See story at: gtresearchnews.gatech.edu/newsrelease/meth-training.htm

Machine Design, ***LiveScience***, ***In Tech***, ***Transport Topics***, and ***Fleet Management*** reported on GTRI's work aimed at improving the fuel efficiency of heavy trucks. The work, led by Bob Englar, involves aerodynamic improvements and pneumatic flow controls to reduce drag and improve airflow over the vehicles. The improvements could boost fuel efficiency of the trucks by up to 12 percent. See story at: gtresearchnews.gatech.edu/newsrelease/truckfuel.htm

Collaboration with Georgia Tech Academic Units

The Georgia Tech Research Institute (GTRI) enriches the Georgia Tech research environment for faculty and students by conducting externally sponsored, applications-oriented research programs that benefit the state, region, and nation. These programs, led by GTRI research faculty, have resulted in major technological advances for national defense, civilian needs, and industrial competitiveness, and have provided students with valuable career experiences.

GTRI plays a vital role in the Georgia Tech community. These contributions include collaborative research with academic faculty, courses originated by GTRI faculty, and joint service efforts. Collaboration is strong between the faculties of GTRI and the academic schools and departments. Many GTRI researchers hold appointments as adjunct faculty members in Georgia Tech academic departments, serve on thesis advisory committees, and teach both academic and continuing education courses.

GTRI reaches out to academic researchers at the Georgia Institute of Technology for collaboration on many research activities, building interdisciplinary research teams that take advantage of the broad experience and expertise of Georgia Tech's top-ranked research and academic departments. Among Georgia Tech's superlatives are the following:

- National Science Foundation statistics place Georgia Tech third among all U.S. universities for the volume of engineering research and development conducted. Georgia Tech's total research program topped $400 million for fiscal year 2004.

- Georgia Tech ranks first among all U.S. universities in the number of women receiving engineering degrees, and is a top producer of African-American engineering graduates.

- For the seventh consecutive year, *U.S. News & World Report* included Georgia Tech among the top ten public universities for undergraduate students.

- Georgia Tech's academic program in industrial engineering has consistently been ranked as the best in the United States by *U.S. News & World Report*.

- Fundraising is underway for the new Nanotechnology Research Center, which will help focus Georgia Tech's broad-based program in this important new research area.

- More than one hundred interdisciplinary research centers at Georgia Tech bring together scientists and engineers to work on cross-cutting efforts.

The People of GTRI



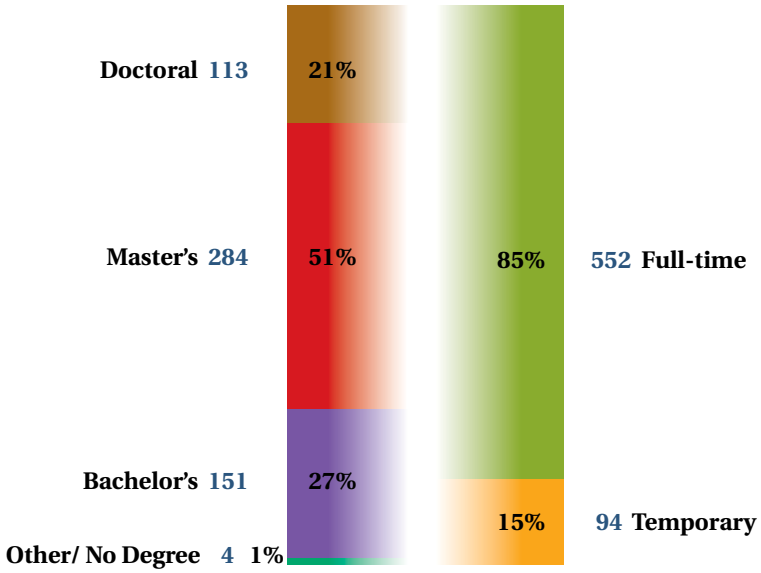
GTRI hires, equips, and supports the best research faculty and support personnel in the business. As of September 2005, the GTRI team was 1,276 people strong. This includes researchers, students, and technical support and administrative staff.

Researchers

The integral role of GTRI in the university community also includes collaborative research with academic faculty and joint service efforts. More than 70 percent of GTRI's researchers hold advanced degrees.

Research Professionals (by highest degree)

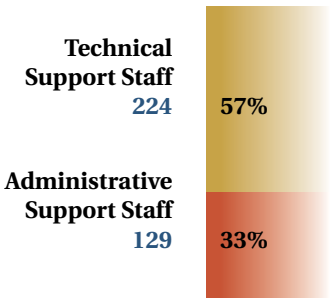
Total Research Professionals 646



Support Staff

GTRI's support staff includes skilled technical specialists and others working in the areas of business services, budgeting, information technology, security, communications, personnel, maintenance and construction, property control, and administration. Staff in these areas work across the organization, operating with a single goal in mind: supporting GTRI researchers and customers.

Total Support Staff 393



Students

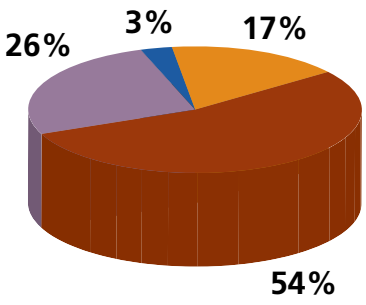
GTRI is the largest employer of Georgia Tech students. Bright graduate and undergraduate students work alongside full-time researchers, making unique contributions to real projects for real sponsors.

Many of the highly skilled researchers now employed by GTRI are homegrown. Each year as many as a quarter newly hired full-time researchers are former Georgia Tech students. GTRI also has relationships with other prominent universities, providing opportunities for their students to work with Georgia Tech researchers to gain practical engineering experience.

Student Employees

- Graduate Research Assistants and Graduate Students in Georgia Tech's Cooperative Education (Co-op) Program ... 40
- Undergraduate Co-op Students. 128
- Student Assistants 61
- Non-Georgia Tech Students 8

Total Students 237






People Profiles

GTRI's outstanding research faculty and support staff includes people with a broad range of interests who contribute to society in many ways beyond their official duties. Among them are musicians, athletes, wood-carvers, and community volunteers. Here are a few of their stories.

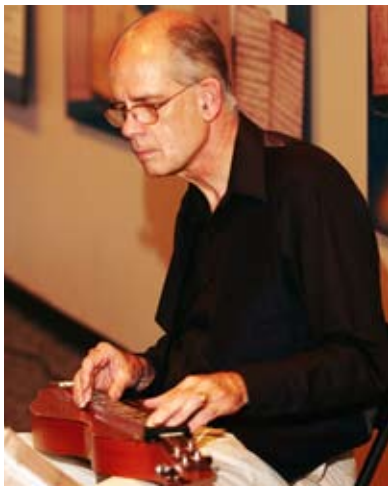
Carving out a Niche

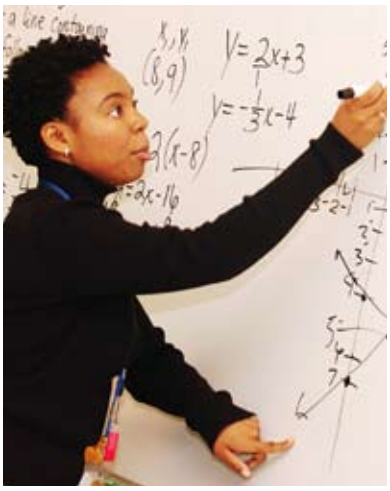
When GTRI Principal Research Engineer John Estes was a child, he'd intently watch his father make amazing creations out of wood. The talent truly runs in his family. Since building his first wooden ship at five years old, he has designed guitars, custom walking sticks, and a number of collectable mementos for high-ranking U.S. and foreign military officers, including the late Vice Admiral James Stockdale, who was the nation's most senior ranking Vietnam P.O.W. Now manager of GTRI's San Antonio, Texas office, John is best known for his custom pens, which are always given as gifts, and made from special materials, such as the floorboard of an old Georgia Tech gymnasium or a deer antler.

David Aalfs
Freeland Abbott
Linda Abercrombie
Joseph Accetta
James Acree
Joseph Adams
Ethan Adler
Vito Adragna
Diane Aenchbacher
Sean Ahonen
Krishan Ahuja
Vicki Ainslie
Marlene Aldridge
Brian Alexander
Neal Alexander
John Alford
Richard Allen
Sarah Allen
Stephanie Allen
A. Allison
Madina Anderson
Patricia Anderson
Dinal Andreasen
Harry Andrews
Katherine Andrews
Diana Antoni
Chadwick Arnold
Odell Arrington
Oscar Asbell
William Asher
Billy Atcheson
Jennifer Atkinson
Thomas Autrey
Todd Bacon
John Baden
Shakeela Bader
James Baer
Robert Baggerman
Christopher Bailey
Gary Bailey
Mary Bailey
Bradford Baker
Gayathri Balasubramanian
Sara Ballard
William Ballard
Jeanne Balsam
Justin Balsam
Scott Banks
Tanah Barchichat
Theodore Barna
Brett Barnett
Eric Barnhart
Ellen Barrett
Oliver Barrett
Robert Barrett
Marsha Barton
Steve Barton
Jonathan Baskette
Ann Batchelor
Christina Baxter
Charlene Bayer
Danielle Bayer
Roderick Beard
Robert Beardsworth
Carl Beasley
Larry Beasley
Robert Beasley
Andrew Beck
James Beisner
Anthony Bell
William Bell
Kristen Bellamy
Harold Belyeu
Stephen Benda
Ehren Bendler
Beau Bennett
Gisele Bennett
Malachi Bennett
Sky Bennett
Scott Berger
Alex Berkobin
Mark Berkobin
Charles Berkowitz
Juwan Bernard
James Bertoglio
Thomas Bevan
Rajib Bhattacharjea
Anita Bhavinani
Linda Bigham
Carlee Bishop
Tammy Blair
William Blair
Stephen Blalock
Melissa Blanchard
Julie Blankenship
Samuel Blankenship
Austin Blochberger
Carl Blunt
Robert Bock
Catherine Bodurow
William Bohaboy
Ronald Bohlander
William Borland
Richard Boyd
Kenneth Boyle
Benjamin Brackett
Matthew Bradley
Thomas Bradley
Philip Brady
Michael Brainin
Evon Braselman
Lisa Brezee
Terry Bridges
Michael Brinkmann
Douglas Britton
Jennifer Brookover
Joseph Brooks
Joseph Brooks
Ralph Brooks
Robert Brooks
Mark Brothers
Abbie Brown
C. Brown
Charles Brown
David Brown
David Brown
George Brown
Ida Brown
James Brown
Katherine Brown
Marguerite Brown
Paul Brown
Terrell Brown
Joseph Bruder
Christopher Bruhn
Tamika Bryant
William Bryant
Xavier Bryant
Jerry Bryson
Denis Bueno
Pamela Buggs
Barry Bullard
William Bullard
Ramon Burke
Laura Burkhart
Paul Burns
Chris Burton
William Butler
John Cabaniss
Rodney Cagle
Gary Caille
Gina Calcaterra
Frank Caldwell
Thomas Callis
Rodolfo Camacho-Aguilera
Stephen Camp
Daniel Campbell
Daniel Campbell
Demetrius Campbell
Derek Campbell
Norma Campbell
Jason Candler
James Cannady
Keviin Caravati
Rebecca Caravati
Gerald Carey
Clarence Carney
Ann Carpenter
Clayton Carpenter
Steven Carr
Linda Carroll
Charles Carstensen
Jessica Cartensen
Randolph Case
Jayme Caspall
James Cathcart
Justin Cathcart
James Chaloupka
Glenn Champion
Rajeswari Chandrasekaran
Kenneth Chaney
Cynthia Channell
Walter Chastain
Brenda Cheeks
Balaji Chellamiyengar
Albert Chen
Garry Cheshire
Mati Chessin
Brian Childress
Chunkit Chiu
Myung Choi
Albert Christianson
Phyllis Christopher
Adam Churney
Brian Cieszynski
Louis Circeo
Mark Claffee
William Claggett

Technical Folk

When nineteen-year GTRI veteran Randy Case isn't leading cutting-edge research programs as director of the Information Technology and Telecommunications Laboratory (ITTL), he is making music with the Mountain Laurels. Having played the dulcimer for more than twenty years, Case puts his talent to the test playing traditional Celtic, Appalachian, and folk music at coffee houses, music festivals, and charity benefits across the Southeast. Case has directed ITTL since 1992.





Knowledge Transfer

After joining GTRI in 1999, former Research Scientist Valerie Lafond Favieres quickly built a solid reputation for technical excellence as a part of GTRI's Electro-Optical Systems Laboratory. Her work included the development of dynamic Web-based applications supporting military logistics and maintenance efforts. Six years later, she decided to put her love of learning to use motivating young people. She moved from the world of high-tech research to the classroom, becoming a ninth grade math teacher. Not only does she have a long list of technical contributions, but now she's doing her part to better equip young people for the future.

Donald Clark
Geraldine Clark
William Clark
Charles Claxton
Jenny Clayton
David Cleveland
Duston Cline
Douglas Cobb
Janet Cobb-Sullivan
Homer Cochran
Chandler Coe
James Cofer
Douglas Cohen
Marvin Cohen
Murray Cohen
Ashley Coker
Byron Coker
Angela Colar
Mitchell Cole
Douglas Coleman
Graham Coleman
James Coleman
Sheree Colestock
Alexander Coletti
Jeanette Collins
Matthew Collins
Thomas Collins
Ryan Colton
Robrt Combier
Russell Compton
Albert Concord

Kathie Coogler-Prado
Amy Cook
Brian Cook
Jim Cook
Kevin Cook
James Corbett
Larry Corey
Brian Corner
Henry Corriher
John Cortese
Joshua Cothran
Julian Cothran
Henry Cotten
Rickey Cotton
Thomas Cotton
Carl Cox
Harold Crain
Charles Crawford
Demetria Crawford
Kyle Crawford
Christina Creyts
Don Creyts
John Cribbs
Stephen Cross
David Crowe
Michael Crowe
Scott Crowgey
Carol Croy
Nicholas Currie
William Cutts
John Daher

Wayne Daley
Gwyneth Dalton
Jimmie Dalton
Donald Daniel
Carlos Davila
James Davis
Joshua Davis
Kyle Davis
Nancy Davis
Rodger Davis
Walter Davis
Martha Dawsey
Alyssa Daya
Thomas Dean
Bartholomew Debacker
Sami Deen
Victor Dejesus
Lee Dellenbaugh
James Demmers
Jonathan Denalsky
Douglas Denison
Dennis Denney
Hugh Denny
Lisa Detter-Hoskin
Phillip Detweiler
Douglas Devine
Mamadou Diao
Roger Dickerson
Benedict Difrancesco
Misty Dirksen
John Doane

Matthew Donohue
Ry Doolittle
William Dorris
Jennifer Doss
John Doss
Sean Doublestein
Patrick Dowdy
William Doyle
Jennifer Drake
Angela Dubose
Jennifer Dubose
Susan Dugas
Daniel Duke
Shaun Duncan
Ann Dunehew
Michelle Dunham
Andrew Dykes
William Eagar
Jerry Eaves
Clifford Eckert
Sandra Edge
Brian Edgerton
Lisa Ehrman
Jared Eisner
Candy Ekangaki
Johanna Eliot
Norman Ellingson
Mark Elliot
James Ellis
Russell Embry
John England

Robert Englar
Kirk Englehardt
Billy English
Mark Entrekin
Christine Erdy
David Erickson
Kenya Ervin
Bernardo Espinosa-Santos
John Estes
John Etherton
Jeffrey Evans
Lee Evans
Karen Everson
George Ewell
Traci Ewers
Walter Fain
Kathleen Falconer
Michael Fanuele
Martha Farley
Shannon Fatehi
Nickolas Faust
Donna Favors
Lee Feagin
David Fentem
Paula Ferguson
Jeffrey Fetta
Suzanne Fike
Corey Fischer
William Fishbein
Michael Fisher
Judith Fitzpatrick

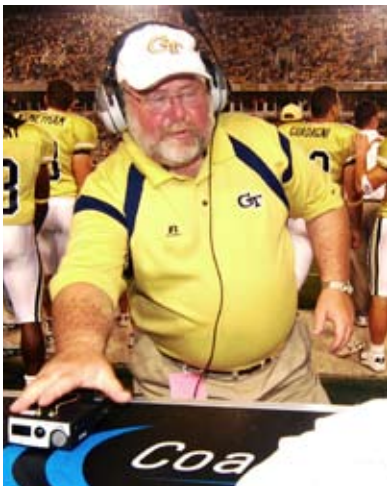
Jason Fleming
Kathryn Fletcher
Brian Fleuridor
Ashley Flick
Mario Flores
D. Flowers
Julianne Flowers
Timothy Floyd
Fatmata Fofanah
Mikhail Fogelson
Dennis Folds
Renita Folds
Shaohui Foong
Brian Foster
Tina Fountain
Christopher Fowler
David Fowler
Justin Fox
James Fraley
Jerry Freeland
Kyle French
Laura Friederich
Paul Friederich
James Froelich
Mark Frost
Richard Fuller
Thomas Fuller
Omar Fung
Robert Funk
Annette Gaddis
Philip Gadomski

Richard Gaeta
James Gaines
Enoch Gamble
Raymond Garcia
Dayne Gardner
Lisa Gardner
Daniel Garmedia
Jeff Garmon
Jeffrey Garnett
Melanie Garrick
Allen Garrison
Sean Garrison
Stephen Gaw
Gregory Geaman
Johnathan Geisheimer
Jennifer Geist
Mark Georges
Geoving Gerard
Jeffrey Gerth
Eric Geter
Azita Ghaneei
Vincent Gibson
David Gifford
Kathryn Gilbreath
Edward Gilmore
Gary Gimmestad
Aklilu Giorges
Bruce Glasgow
Terrence Gleaton
Samuel Glidewell
Roy Glover

Kelly Goad
Joni Gober
Robert Golden
Alan Golivesky
Robert Goodman
Christopher Gooley
Steven Gordon
Jill Gostin
L. Gostin
David Gottfried
Anthony Grantham
Cleo Graves
Gary Gray
Michael Gray
Molly Gray
Janice Green
William Greene
Sarah Greenwood
Jonathan Greer
William Gregory
Eugene Greneker
Ayana Gresham
Brian Greve
Tamar Grimes
Greta Guentcheva
Thomas Guinn
Michael Gurley
Wallace Gustad
Joseph Guster
Kevin Guthrie
Andrew Guyton

For the Birds

Bird enthusiast Steve Thomas spends much of his spare time collecting supplies and donations to help care for more than 200 parrots rescued in the New Orleans area following Hurricanes Katrina and Rita. A graphics specialist with GTRI's Food Processing Technology Division, he also put his technical skills to work creating a unique Web site (www.for-the-birds.org) with links to bird rescue resources and a journal chronicling his rescue activities. The plight of avian hurricane victims hits close to home for Thomas and his wife, Jinx, who are proud parents of fourteen-year-old Clarence, an abandoned parrot they adopted in 1997.



Making the Right Call

Maintenance and Construction Manager Rusty Embry has been part of the GTRI team for twenty-one years, but this die-hard Georgia Tech fan also plays an important role with the Tech football team. While he spends his days building GTRI's infrastructure, he spends his nights helping the football team build a winning record. For twenty-eight years, Embry has handled sideline communication for the Georgia Tech Yellow Jackets. At both home and away games you will find Embry hard at work making sure the coaches can communicate with one another.

William Guzak
Matthew Habib
Hal Hagemeier
Stephen Hague
Walter Haines
Johnny Hall
Keesah Hall
Louis Haller
Jeffrey Hallman
Stanton Halpern
James Hampton
Herschel Haneline
John Hankinson
Gregory Hanlon
David Hanson
Terence Haran
Johncie Harbert
Simeon Harbert
Jeffrey Harding
Hisham Harik
Scott Harlan
Kyle Harrigan
Adrienne Harrington
Anika Harris
Brian Harris
David Harris
Herbert Harris
George Harrison
Judy Harrison
Margaret Harrison
Edward Hart

Jack Hart
Alexa Harter
Lynn Hartley
Paul Hawley
John Hay
Comas Haynes
Marlit Hayslett
Gregory Heagerty
Ted Heath
Daniel Hegeman
Michael Heiges
Benjamin Heiskell
Anne Helton
Annelouise Hemingway
Christopher Hemphill
Robert Hemphill
Christopher Henderson
Mary Henderson
Robert Hendry
Andrew Henshaw
Ralph Herkert
Ryan Hersey
Morris Hetzler
Richard Hicks
Charles Higgins
James Higgins
Melinda Higgins
Alice Hightower
Terry Hilderbrand
Alex Hill
Brenda Hill

Kendal Hinton
Phyllis Hinton
Robert Hochman
Mark Hodges
Wiley Holcombe
Ernest Holder
Jill Holder
Simon Holley
William Holm
Ryan Holman
Johnathan Holmes
Mark Honeycutt
Edward Hopkins
Glenn Hopkins
Walter Horne
Margaret Horst
Tom Horton
Andrew Howard
Robert Howard
Richard Howland
James Howry
Brian Hudson
Kenneth Hudson
Claudia Huff
J. Huggins
Clarence Hughes
Stanley Hughes
Walter Hughey
Gary Hulsey
Wayman Humphrey
Kellie Hunter

Nathaniel Hunter
Helen Hunton
Joseph Hurst
Steven Hurst
Beverly Hutchinson
Leslie Hutchinson
Clayton Hutton
Richard Ingle
Charlotte Irvine
Shelia Isbell
Ricky Ivey
Lucja Iwanska
Aaron Jackson
Timothy Jackson
Vineet Jain
Elisa James
Jonathan James
Calvin Jameson
Ann Jaudon
Aaron Jaynes
Gregory Jenkins
Jeffery Jenkins
Burt Jennings
Mahmudul Jilani
Jeffrey Jo
Allan Johnson
David Johnson
Erma Johnson
Kenneth Johnson
Lucy Johnson
Valerie Johnson

Bobby Jones
Corissa Jones
Michael Jones
Roger Jones
William Jones
Sujay Joshi
Jared Julian
Bernd Kahn
Jesse Kallman
Kevin Kamperman
Heewon Kang
Zhitao Kang
Raymond Kangas
Daniel Karnik
Jason Kau
Joshua Kayse
Robert Kearney
Byron Keel
Rashard Kelly
Olga Kemenova
Jeff Kemp
Paul Kemper
Karen Kendall
Brian Kent
William Kenyon
James Kerce
Andrew Kerr
Robert Kerr
Morris Kesler
Gregory Kiesel
Manion Kilpatrick

Alvan Kimbrough
Kimberly Kimmel
Mark Kindl
James King
Sandra Kirchoffer
Kathleen Kirk
Michelle Kitaoka
Donald Kitchen
Randy Knight
Diane Knobloch
Michael Knotts
Kathryn Knox
Sharon Koberg
James Koch
Stan Komsky
Shayne Kondor
Michael Kopp
Michael Kraus
John Krish
Jeffrey Krug
Victor Kumsomboone
Matthew Kurjanowicz
Eric Kuster
Valerie Lafond-Favieres
Cynthia Lagesse
Jeffrey Lahr
David Lai
Sandra Laib
Quimin Lam
Darrell Lamm
David Landgren

John Landgren
Donald Landry
Teddy Lane
Michael Langford
Garrett Langley
Neil Lareau
James Larsen
Peter Lawrence
Victor Lawson
Daniel Leatherwood
Matthew Leblanc
James Ledbetter
James Lee
Sherwin Lee
Steven Lee
Warren Lee
Morris Leesang
Sanford Leffingwell
Matthew Lenarz
James Lentini
Stephen Leonard
Jerry Lett
Jacob Leverett
Richard Levin
Zdzislaw Lewantowicz
Christopher Lewis
James Lewis
Sheena Lewis
Jun Li
Qiang Li
Andrew Licausi

Susan Liebeskind
Deborah Light
Douglas Lilley
Cheryl Lilly
Amy Lin
Jennie Lincoln
Kathryn Lindsey
Laurence Lindsey
Malik Little
Marie Little
Robert Loebach
William Lohsen
Brian Long
Maurice Long
Terry Long
Daniel Longhurst
Kim Longshore
Cyrus Loper
Margaret Loper
Steve Loraine
Andre Lovas
Rafael Love
Benjamin Lowers
John Lowrey
Chen-Chang Lu
Kristin Lum-Young
Sharon Lyons
Stephen Macke
Paul Mackie
Reid Mactavish
John Maguire

The Iron Man

As if finding new formulations of dental materials, designing prosthetics and durable medical devices, and studying aerodynamics haven't kept him busy enough, GTRI Senior Research Engineer Shayne Kondor recently completed Ironman Wisconsin. Swimming 2.4 miles, cycling 112 miles, and then running a full marathon, Kondor tackled the ultimate test of athletic endurance. He finished in just under 13 hours, placing him in the top 25 percent of the more than 2,000 athletes who began the race. His next monumental task: wrapping up his Ph.D. in Aerospace Engineering.

Cleaning up for Kids

During the week adjunct professor and GTRI Research Engineer Jud Ready works with tiny nanostructures, but can just as easily tackle a fifteen-foot-high mountain of mulch. Ready is always involved in activities that improve the community and recently led the cleanup of a neighborhood park. Coordinating nearly fifty volunteers and getting local businesses to donate materials and supplies, he helped give the kids in his community a shiny new place to play.

Richard Maier
Keith Main
Shawn Malone
James Maloney
Frederick Mann
Matthew Manning
Raymond Marceau
Miroslav Marek
James Marks
James Maroney
Matthew Marshall
William Marshall
Douglas Martin
Jonathan Martin
Linda Martin
Michael Martin
Robert Martin
Robert Martin
James Martino
Joshua Mason
Armand Masse
Dawn Massey
Derek Massey
Douglas Massey
Kevin Massey
James Matthews
John Matthews
Sharon Mattson
Scott Maurer
Brett Mauro
Doresa May
David Maybury
Brian Mayhew
Bettie McAddoo
Kyle McCaffrey
George McCall
Mark McCans
Tara McCart
Tim McClune
Leigh McCook
Adam McCorkle
Julie McCoy
Russell McCrory
Charles McCullough
Adam McDaniel
Thomas McDermott
Jennifer McDonald
Lisa McDonald
Marqus McDuffie
Maria McGaha
Robert McGahee
Jason McGarr
Akilah McIntyre
Paul McKellar
Mary McKenna
Patrick McKeon
Angus McLean
Morgan McLean
Brandon McMahan
James McMichael
Gary McMurray
Shawn McNutt
Patrick McPherson
Kevin McRae
Starlyss McSlade
John Meadors
Phyllis Means
Benjamin Medlin
Christina Medlin
Nanette Meeks
Antonette Melvin
William Melvin
H Menhorn

Hicham Menkara
Jason Merkel
Paul Miceli
Robert Michelson
Robert Michelson
David Millard
Sarah Millard
Martin Miller
Matthew Miller
Thomas Miller
William Miller
Sarah Milway
Brent Minter
Barry Mitchell
Mark Mitchell
Natalie Mitchell
Robert Mobley
Gregory Mohler
Dan Molino
Larry Moore
Ricky Moore
Thomas Moore
Todd Moore
Adam Morber
Mark Moreno
Andrew Morris
John Morris
Robert Morris
Richard Morrison
David Morton
Richard Moser
Richard Moss
Shantia Moss
Shantrell Moss
Matthew Moyer
Benjamin Mullenix
Albert Mullikin
Samuel Mullinax
Jomkwun Munnae
Suwana Murchison
Tam Muto
Brent Myers
Robert Myers
Virginia Myers
James Mykytyn
Jason Nadler
Richard Nakasato
Donald Nance
Kim Nara
Arun Nayyar
Valyncia Neal
Patrick Neely
E. Nelson
Jennifer Nelson
Michael Nelson-Palmer
Josh Nessmith
Robert Newsom
Zi Ng
Binh Nguyen
Veit Nguyen
Charles Nickey
William Nipper
Damon Nix
Donald Noble
Delores Nogradi
Michael Norris
Matthew Noury
Maurice Novembre
Kelly Oconnor
David Odom
Joel Odom
Michael Odom
Richard Odom

Terrence Ogle
Didem Okutmantas
John Oleynik
Dara O'Neil
Gary O'Neill
Michael O'Neill
Michael Orr
Daniel Ortiz
Daniel Osiecki
Christopher Owens
Michael Owens
Arkadas Ozakin
Eddie Paige
Timothy Palmer
Vasilios Pantazopoulos
Chrysanthos Papanicolo-poulos
David Parekh
Brian Parise
Deborah Park
June Park
Glenn Parker
Joe Parks
Jonathan Parks
Judy Parks
Chris Parnin
Jason Parrish
Aram Partizian
Chirag Patel
Gautam Patel
Pratiq Patel
Duane Patterson
Edward Patterson
Julie Patterson
Anita Pavadore
Nicholas Payne
Stephanie Payton
Kristen Pealer
Paul Pearlman
James Pearson
Mark Pellegrini
Kirk Pennywitt
Martha Perdue
Ulrich Perleberg
Benjamin Perry
Brandon Perry
Raymond Perry
Thomas Perry
Samuel Peters
Andrew Petry
Kathy Pham
Gordon Phillips
Michael Phillips
Leslie Pickering
Michael Pieper
Miriam Pierce
John Pierson
Lawrence Pihera
Lauren Pinson
Samuel Piper
Charles Pippin
Jeffrey Pitcher
Megan Pittman
Nicholas Pomponio
Benjamin Poole
Bryan Popka
David Poskevich
S. Powell
Ronald Prado
Thomas Pratt
Daryll Prescott
Richard Presley
David Price

Julian Price
Lon Pringle
Paul Pritchett
Richard Protus
Erin Prowett
Kenneth Pullen
Kerry Pullen
David Pyne
Margaret Quiggle
Eric Rader
Gerald Radovich
Mindy Rakestraw
Peter Ralston
Bobby Ramey
Susan Ramos
Don Ranly
Kimberly Ransom
Justin Ratner
Mohammed Rauf
Ekkehart Rausch
Jerry Ray
Richard Ray
William Ready
Gabriel Rebeiz
Erin Reddick
Edward Reedy
Deeann Reese
Jason Reeves
William Reeves
Andrew Register
George Reinhardt
Bryce Remesch
Larry Respress
Rebecca Reynolds
Richard Reynolds
Jacob Rhodes
Robert Rhodes
Robert Rice
Grover Richardson
Colleen Richmond
Douglas Rigdon
Georgie Riggs
Ashley Riley
Jon Riling
David Rimmer
Gerald Rivard
Cynthia Roberts
David Roberts
David Roberts
Russell Roberts
Webb Roberts
Steven Robertson
William Robinson
Michael Rodgers
Kevin Rodkey
Don Rogers
Janice Rogers
William Rogers
Gregory Rohling
Patricia Rose
David Roselius
Kady Rosier
James Ross
Robert Rosson
Stefan Roth
Francis Rotoloni
Michael Rowan
Kevin Ruffin
Alan Russell
Barbara Russell
James Saffold
Philip Safir
Adam Sakautzky

Darryl Sale
Alexander Samoylov
Robert Sandford
Jean Sands
Betty Sanford
Juan Santamaria
Robert Santiago
Spiro Sarris
Joseph Saur
Stephanie Savelle
Sandra Saxon
Larry Schaefer
Cecilia Scheer
James Scheer
Katharine Schlag
Paul Schlumper
Melissa Schmidt
David Schmieder
Robert Schmitter
Michael Schork
Hilarie Schubert
John Schultz
Robert Schultz
Stephen Schulze
Gaynell Scott
John Scott
Randy Scott
Shawn Scott
Melanie Scoville
Shemerra Searcy
William Sears
Michael Seelhorst
D. Senn
Antonio Serna
Jerry Sexton
Deepa Shah
Timothy Shands
Christine Shapiro
Christopher Shappert
Barry Sharp
Steven Sharpe
Craig Shaw
Daniel Shaw
Charles Sheets
Albert Sheffer
Luther Sheffield
Leland Sheiner
Wilburn Shell
Christopher Shepherd
Duane Sheppard
Gregory Sheridan
Rex Sheridan
Donald Sherman
James Sherrill
Frances Shiflett
Brian Shirley
Beth Showman
Gregory Showman
Yevgeniy Shrom
David Shumaker
Jagjeet Sidhu
Breck Sieglinger
Scott Silence
Lisa Sills
Erwin Simmons
Jack Simmons
Louis Simonetta
Christopher Simpkins
Robert Simpson
Thomas Singleton
Dean Singley
Jason Sirichoke
Jeffrey Sitterle

Valerie Sitterle
Eric Sjoberg
Paige Skidmore
Glenda Skinner
Gregory Slagle
Christopher Slater
Matthew Slater
Lauren Slavich
Brenda Smart
Jeffrey Smart
Leslie Smee
Brian Smith
Bryan Smith
Christopher Smith
Gerald Smith
James Smith
Mark Smith
Megan Smith
Michael Smith
Michael Smith
Orville Smith
Ronnie Smith
Steven Smith
Thomas Smith
Robert Smock
Lawrence Snead
Scott Snyder
Stephanie Sodipo
Eric Soto
Thomas Spangler
Norman Speakman
Lillian Spearman
Jonathan Spencer
Scott Spencer
Melissa Spiers
Chris Spivey
Kristi Spivey
Mark Sponsler
Carl Springer
James Stalvey
Jeffrey Stamper
Charles Stancil
Richard Stanley
Russell Stanton
William Stark
David Starling
Stancil Starnes
Monti Staton
Lisa Steele
Roger Steines
Brian Stevens
Donald Stevens
Kelly Stevens
John Stewart
Wilbert Stewart
Dana Stocks-Douglas
Herbert Stokes
Mark Strickland
Timothy Strike
Weilian Su
Michael Suckow
Jon Suggs
Joseph Sugrue
Susheel Sukhtankar
Sandra Sullivan
Vikki Sutton
Donald Swank
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Large-scale Systems Engineering

When the U.S. military needed a concept vehicle to demonstrate new science and technology options for improving future combat vehicles, GTRI responded by bringing together a team of engineers to create the ULTRA Armored Patrol (AP). Taking a systems approach to the task, the research team included experienced automotive design specialists, materials scientists working on new armor materials, engineers with NASCAR expertise and researchers experienced in bringing together entire systems. The project, described on page 3 of this annual report, is but one example of GTRI's capabilities in large-scale systems engineering.

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