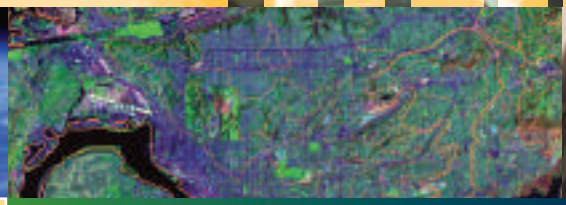
ANNUAL REPORT 2004

70 Years

of Creating Solutions through Innovation








GTRI

Integrity **Innovation** Excellence

Georgia Tech Research Institute

www.gtri.gatech.edu

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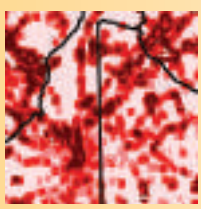
Table of Contents



As GTRI celebrates its 70th birthday, we look forward to the challenges that lie ahead. We also remember the accomplishments that provide the strong foundations for what we do today.

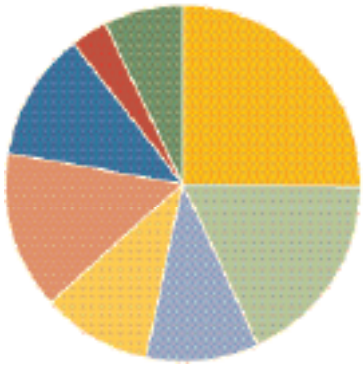
Creating Solutions through Innovation

Letter from the Director

This has truly been an exciting and productive year at the Georgia Tech Research Institute (GTRI).

On behalf of our many stakeholders in industry and government—and in collaboration with the other major research, education, and service programs at the Georgia Institute of Technology—we have created and are executing an exciting and far-reaching strategy for the twenty-first century. This strategy strengthens our long-standing commitment to technical excellence in core areas, while expanding our impact on new areas where our strong foundation of experience, expertise, and creativity can find useful application.

As we move into these new areas, our mission remains unchanged—to rapidly mature and transition new technologies into the marketplace, and to provide innovative engineering solutions for the technically challenging problems of the state, the nation, and the world.



GTRI FY 2004 Major Customers

(% of Research Expenditures)

U.S. Air Force	25.3%
U.S. Army	18.0%
State of Georgia	10.3%
Other Department of Defense (DoD)	10.0%
Industry - Federal Subcontracts	14.4%
U.S. Navy	11.6%
Industry - Commercial	3.4%
Federal Non-DoD	7.0%

Hundreds of important projects are underway throughout GTRI as I write this letter. Following are highlights of some outstanding projects that illustrate our strategic directions:

In the world…

Protecting Our Military Personnel
GTRI has been on the forefront of military research since the 1950s, working with our Department of Defense customers to mature new technologies that help our soldiers, sailors, and airmen do their jobs more effectively—while keeping them safe. In this annual report, for example, we describe FalconView™, a flight-mapping system developed and refined over many years with collaborators such as the Air National Guard, U.S. Air Force Reserve, U.S. Navy, and the U.S. Special Operations Command. With more than 20,000 users today, FalconView is utilized by all branches of the U.S. military—and our allies—to help pilots plan safe routes through dangerous skies.

Restoring Angola's Environment
GTRI researchers are part of a broader Georgia Tech team that is helping the government of Angola restore thousands of acres of mangrove trees that are essential to feeding the people of an oil-rich state known as Cabinda.

Advancing Alternative Energy
Operated in collaboration with Georgia Tech's academic colleges, the Center for Innovative Fuel Cell and Battery Technologies is helping advance alternative energy and storage technologies in a variety of applications. This year, the Center attracted a new director with broad experience in private industry fuel cell applications.

In the nation…

Finding Abducted Children
Working with the law enforcement community and industry, GTRI facilitated the adoption of new Internet standards that allow the efficient sharing of information among local, state, and federal agencies. Beyond improving homeland security, one direct benefit, as noted by U.S. Assistant Attorney General Deborah Daniels, is a more capable and responsive national Amber Alert system.

Ensuring Our Safety
GTRI information technology experts worked closely with state and federal officials to ensure security during the G8 Summit held in Georgia during June 2004. GTRI fielded new technology that facilitated the interoperability of diverse communication and information systems used by federal, state, and local public safety organizations responsible for protecting Summit participants.

Responding to Bioterror
Should terrorists ever use biological weapons in the United States, sensing technologies being developed at GTRI could help first responders diagnose the threat and chart an appropriate response. GTRI's optical sensors, under development for more than a decade, can detect a broad range of potential biological and chemical agents.

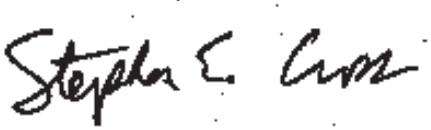
Boosting Fuel Efficiency
Using flow control technology originally developed to increase lift and decrease drag in military aircraft, GTRI engineers have developed a new system that could improve the fuel efficiency of the nation's fleet of heavy trucks. Recent Department of Transportation studies show the technology can cut fuel consumption by as much as 12 percent, producing real, bottom-line savings.

In the state…

Preparing for Careers
GTRI educational technology experts worked with five southeast Georgia school districts and a local technical college to better align high school curriculums with the real-world needs of industry. Changing what is taught in high school eases student transition to technical education and helps set graduates on a positive career path.

Promoting a Healthy Environment
Mold hidden behind the walls of homes and businesses can cause serious health problems and do significant damage before it is detected. GTRI experts in radar and environmental technology are working together to develop a handheld device able to detect hidden mold without removing wallboard for inspection.

Accomplishments like these result from the hard work and collaboration of GTRI's talented and experienced staff of more than 1,200 scientists, engineers, technologists, students, and support personnel. This fine staff shares a passion for solving the technologically challenging issues facing society today. It is an honor to work with these great people every day and to provide this report of their activities to you.



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

In the World...

Current Research

Growing the Audience for Flight-mapping Software's Diverse Capabilities

When engineers developed FalconView™ in the early 1990s, their goal was to make flight planning easier for pilots by moving mapping software from big Unix systems onto desktop and laptop computers. Yet, GTRI researchers and their Air National Guard, U.S. Air Force Reserve, U.S. Navy, and U.S. Special Operations Command collaborators never envisioned how pervasive FalconView would become—both in users and uses.

The multimedia software displays aeronautical charts, satellite images, and elevation maps along with overlay tools that, for example, mark no-fly zones and ground obstructions. Originally designed for the U.S. Air Force's F-16 (known as the Fighting Falcon), FalconView has been adopted by a wide variety of aircraft and spread throughout other branches of the U.S. military. Most recently, it was enhanced for the U.S. Army's use.

An integral part of the military's Portable Flight Planning Software, FalconView counts more than 20,000 users today. The software has won several awards, and Microsoft chairman Bill Gates even devoted a chapter to it in his book, *Business @ the Speed of Thought*.

"Convenience and time savings have been two key reasons for FalconView's success," said Terry Hilderbrand, a GTRI division chief. In fact, one FalconView user estimated that the software sliced his mission planning time from four and a half hours to twenty minutes.

Ease of use is another big benefit. Case in point: Hilderbrand loaded FalconView on his son's laptop computer two days before the young man, a member of the Third Infantry Division at Fort Benning, was deployed to Iraq.

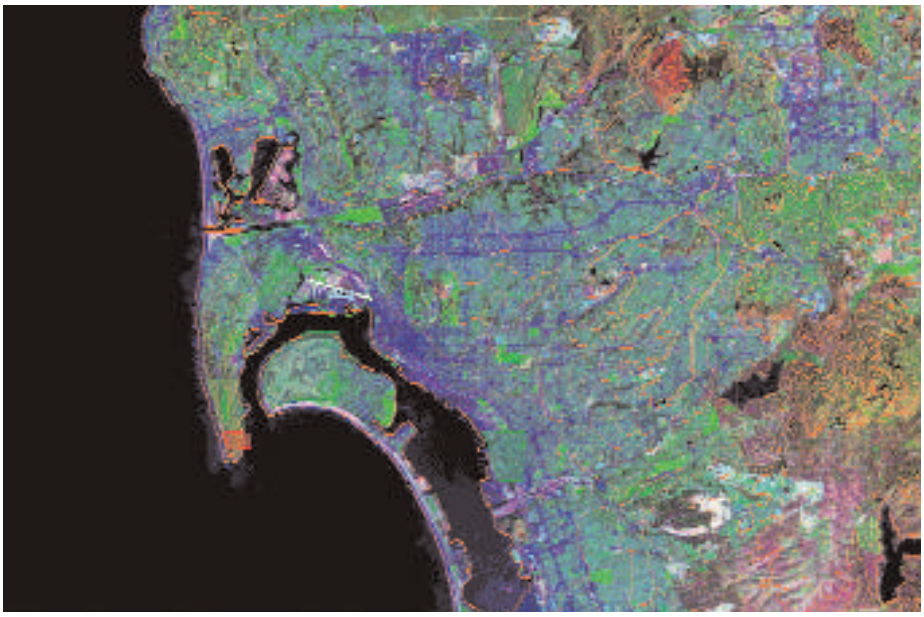
"There was no time to give him training on the software," Hilderbrand said, "yet he was able to figure out the program on his own and generate maps for leaders in his platoon and battalion in Iraq, which was important to rapid movement in the desert."

U.S. Geological Survey satellite imagery is overlaid with U.S. Department of Transportation street data in Manhattan in this FalconView-generated map.

FalconView's open architecture and interoperability also have contributed to its popularity. It is currently used throughout the United States services, and several European nations use a special version of the software for their air forces.

Through the years, GTRI researchers have continued to expand FalconView's capabilities and make it more robust, particularly in the area of situational awareness.

By reading and parsing messages from tactical radios, FalconView creates a visual representation that shows users the position, in near real time, of friendly and enemy forces. Researchers also have added



Landsat false color imagery of the San Diego area is overlaid with contour lines generated by FalconView software developed at Georgia Tech.

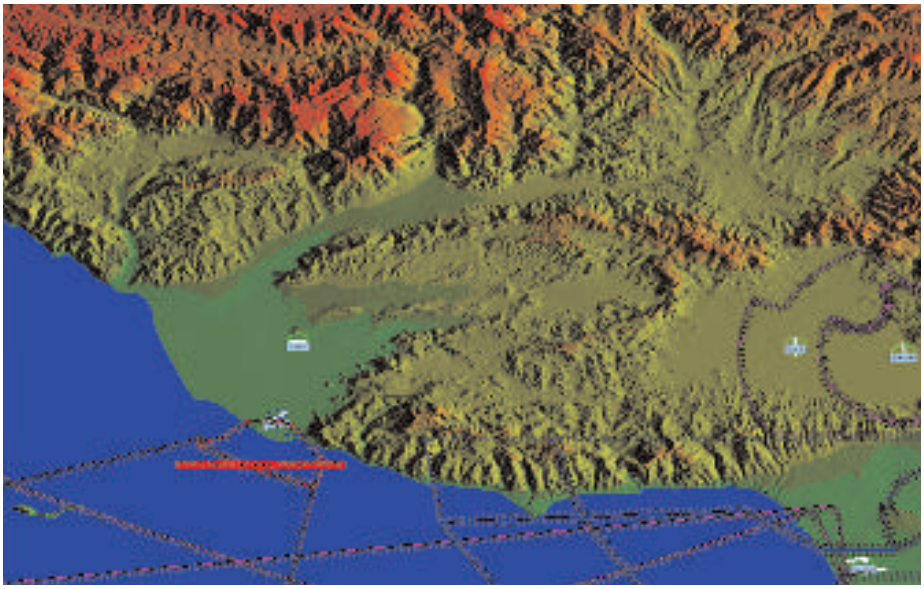
illumination-planning features to FalconView, which enable Special Forces to plan flight paths that keep their aircraft in the shadows.

Another recent component is SkyView, a tool that combines elevation data with maps and imagery to create a three-dimensional perspective. Aviators use SkyView primarily for mission rehearsal.

FalconView is used for a wide range of other mapping activities, including dropping fire retardant, communicating with ground workers about where and how fast forest fires are spreading, sighting whales, tracking drug-runners, and recreating geographic conditions for investigating aircraft crashes.

Components of FalconView are now being adapted to the new Joint Mission Planning System, the military's next-generation mission planner.

www.gtresearchnews.gatech.edu/newsrelease/falconview.htm



Elevation data from the Los Angeles area is overlaid with shadows and colored by FalconView software.

Helping Angola's Government Restore the Country's Environment

GTRI researchers are part of a broad-based Georgia Tech team that is helping the government of Angola with efforts to restore thousands of acres of mangrove forests that once provided food for the people of Cabinda, an oil-rich jungle region near the Congo River.

Cabinda's once-thriving mangrove forests were largely wiped out by the mid-1980s.

Ravaged by decades of foreign control and civil war, Angola has been relatively peaceful for only the past several years. Its government wants to develop a healthy economy, improve Angolans' quality of life, and maintain a united nation. The nation's challenges include natural resource and waste management, environmental restoration, and an independence movement in its oil-rich state of Cabinda.

Faced with these formidable challenges, the Angolan government sought the expertise of environmental engineer Joe Hughes several years ago when he was a professor at Rice University in Houston. Now chair of Georgia Tech's School of Civil and Environmental Engineering, Hughes has involved researchers in his

Continued on next page

Proper handling of hazardous wastes is one of the environmental challenges facing Angola.

Though their destruction has been widespread, some of Angola's mangroves continue to thrive.

Continued from previous page

department, as well as GTRI and the College of Architecture.

Their top priority now is to restore thousands of acres of mangrove forest that once provided a safe haven for fish, crabs, shrimp, and other foods for Cabinda's people. To unravel the mystery of Cabinda's mangrove destruction, GTRI conducted an aerial imagery survey led by senior research scientist Kevin Caravati. Archived U.S. intelligence images show thriving mangrove forests in 1953 that were wiped out by 1984. During this period, U.S. oil exploration began, and roads were built into Cabinda from the Congo Republic to the north.

"When the habitat destruction began is a critical question in trying to understand the cause-effect relationship," Hughes said. "It is well known that oil spills can kill mangroves, and there have been significant oil spills in this area…. So a lot of people are pointing fingers at the oil companies, and the oil companies are saying they didn't cause it."

From the aerial imagery study, Caravati found that a wide beach of several hundred feet, as well as the direction of ocean currents, hinder spilled oil from migrating inland to the mangroves. Also, he noted that spilled oil would have had to move through still-healthy mangroves to get to the destroyed habitat that is further inland.

Researchers are now working from the hypothesis that Cabinda's destroyed mangrove forests were cut off from the circulating water—both from the ocean and from inland drainage—that they need to survive. The researchers attribute that cutoff to road building without culverts on the East side and sediment buildup from the Congo River on the West side.

Joe Hughes, chair of Georgia Tech's School of Civil and Environmental Engineering, takes a water sample during a 2003 trip to Angola.

Hughes has proposed to Angola's government that it fund researchers to travel to Cabinda in the spring of 2005 to set up a mobile laboratory and collect environmental samples. They are hopeful that mangrove restoration efforts will soon follow.

www.gtresearchnews.gatech.edu/reshor/rh-f04/angola.html

1953 Aerial Panchromatic Photo

2002 Aster CIR Satellite Image

Aerial photographs nearly a half-century apart show how Cabinda's mangrove forests have changed. The 1953 photo (left), appears to show an estuarine environment with a river feeding the mangroves. A photo taken in 2002 appears to show a change in the circulation of water.

Advancing Alternative Energy through Fuel Cell and Battery Technologies

This transmission electron microscope image shows the copper branches of a 3-D foam structure that is part of an improved electrode developed by Georgia Tech researchers.

Conservative estimates indicate that ten additional terawatts of power, roughly equal to the total power consumed today, will be needed in the next few decades to meet growing global demands for energy. Beyond determining where that power will come from, scientists and public policy experts will have to address the complex environmental and security issues associated with meeting these growing power demands.

In addition to the need for clean and efficient power production, the storage of energy will continue to grow in importance. With many renewable sources of energy, including photovoltaics, the rate of production and end-user demand for energy are different. That mandates a system for storing energy, a need that is met most often today by chemical storage in batteries or stored hydrogen.

Department of Defense agencies have additional requirements. For instance, the energy needs of the dismounted soldier continue to increase as new electronics are developed—and current battery technology is inadequate to meet these needs. Advanced lithium batteries, regenerative fuel cells, and hybrid systems are some of the technologies being developed to meet these military requirements.

The Center for Innovative Fuel Cell and Battery Technologies, a collaboration between the Georgia Tech Research Institute (GTRI) and Georgia Tech's academic colleges, is helping address all of these challenges through innovative research and the development of prototype systems designed to demonstrate new ideas.

Developing transient models of solid oxide fuel cells—work supported separately by the U.S. Department of Energy and NASA—is one example in which scientists and engineers, who are part of the Center, are advancing tools for fuel cell development. Another example is the careful integration of fuel cells and gas turbine engines, which is critical to achieving high efficiency and long life for both stationary and auxiliary power generation systems.

Center researchers in Georgia Tech's School of Materials Science and Engineering have been addressing basic needs of fuel cells and batteries with such developments as more efficient electrode technology. By taking advantage of an electrochemical phenomenon—the generation of gas bubbles—that had been considered a nuisance, the researchers have developed a new class of three-dimensional nanoporous electrodes that could boost the performance of fuel cells, batteries, and sensors.

GTRI scientists are also studying the fundamental mechanisms of degradation in proton exchange membrane (PEM) fuel cells and conducting a variety of sophisticated performance tests—from precise measurement of chemical constituents to evaluating electrical power under dynamic loads.

"Fuel cells convert chemical energy directly into electrical energy, which makes them more environmentally friendly than many existing energy technologies," noted Tom Fuller, director of the Center. "But fuel cells face durability and cost issues that must be resolved before they can be a major factor in the mainstream energy market."

Fuller recently joined the Center from United Technologies Corporation (UTC), where he was director of engineering at UTC Fuel Cells, a unit of UTC Power. At the company, he led development of technology for fuel cell stacks and directed the design, construction, and delivery of fuel cell power sections. During his ten-year career at UTC, he built a team of scientists and engineers who regularly integrated newly developed lab results into products for manufacturers.

www.fcbt.gatech.edu

In the Nation...

Providing a Foundation for a New Justice Information Sharing Initiative

The Global Justice XML Data Model helps public safety agencies share information. Here, a hazardous materials team practices at the Georgia Institute of Technology.

GTRI researchers have played a key role in developing the software foundations for a new U.S. Department of Justice initiative that will make it easier for local, tribal, state, national, and international agencies to share criminal justice information among themselves. The project has already made possible an improved Amber Alert program to quickly locate abducted children.

Based on the popular extensible markup language (XML), the Global Justice XML Data Model (GJXDM) was recently released in Version 3.0 for use by software developers—and won an Intergovernmental Solutions Award from the American Council for Technology.

"Incompatible databases and computer systems for many years have limited the ability of federal, state, tribal, and local agencies to rapidly and efficiently share justice information," said John Wandelt, a GTRI senior research scientist. "The Global Justice XML Data Model initiative is designed to provide a way to translate information between different systems, allowing a more efficient flow of data among agencies that need to share information about potential criminal and terrorist activity."

Wandelt and his colleagues provided engineering support and technical guidance for the new system as part of a broad-based collaboration involving dozens of agencies and industry partners. GJXDM is already being used in more than fifty information-sharing efforts.

The GJXDM initiative involves three major components: an object-oriented data model, a data dictionary, and XML schema specification. The data model and dictionary are part of a common "vocabulary" used by different computer systems to describe data objects to be shared. Using these standardized definitions, software scripts automatically translate information as it passes from one system to another.

"By providing a common language and vocabulary, the XML initiative allows agencies to efficiently share data while continuing to maintain their own data and operate their own computer systems," Wandelt noted. "This avoids the cost and compatibility issues that would be involved in trying to develop a single unified national network. It also provides a foundation that individual agencies can use to develop compatible systems without having to reinvent key elements."

The standardized data objects were chosen by representatives from the agencies and industry partners who have been working together since March 2001. The group, known as the Global Justice Information Sharing Initiative, identified approximately 2,500 common data objects after reviewing more than 20,000 candidate objects, many of which were redundant.

"Emerging technologies like XML are a core component of our strategy to give state and local governments new tactics and methods to help them respond to the security challenges of a post-September-11 era," noted Deborah Daniels, assistant attorney general in the Office of Justice Programs. "We recognize the ability of XML to bring about paradigm shifts in information processing, and in our responses to an increasingly complex and technology-driven world."

www.gtresearchnews.gatech.edu/newsrelease/globalxml.htm

Aerodynamic Improvements Boost Fuel Efficiency in Heavy Trucks

Flow control techniques and aerodynamic improvements developed at GTRI could save the U.S. trucking industry several hundred million gallons of fuel per year. Tests done using a full-size tractor-trailer truck show the techniques—based on systems originally developed for jet aircraft—could increase fuel economy by as much as 11 to 12 percent, while also potentially improving safety.

The aerodynamic improvements, which generate fuel savings of as much as 6 to 7 percent, involve rounding aft trailer corners, installing fairings, and making other changes that smooth airflow over the boxy trailers. Fuel savings of an additional 5 percent come from pneumatic controls that blow air from slots at the rear of the trailer to further improve airflow.

"Aerodynamically, we have found a lot of the answers, and the next step is to get this into a fleet of trucks for more extensive testing," said Robert Englar, a GTRI principal research engineer. "We have shown that this works, and we expect that the industry will find a 12 percent fuel economy improvement worth pursuing. At highway speeds, each 1 percent improvement in fuel economy results in savings of about 200 million gallons of fuel for the U.S. heavy truck fleet."

Supported by the U.S. Department of Energy, the project began in the late 1990s with tests of simple scale model tractor-trailers in GTRI's low-speed wind tunnel. Those studies suggested the possibility of dramatic fuel savings.

Working with Volvo Trucks and Great Dane—manufacturers of the basic tractor and trailer, respectively—Englar's research team and Smyrna prototype shop Novatek installed aerodynamic features and blowing outlets at the rear of the trailer. A series of high-speed test runs at a seven-and-a-half-mile Ohio track recently demonstrated the fuel savings that had been expected from the wind tunnel studies.

Before the pneumatic control system can be widely used in trucks, researchers will have to choose the best source of compressed air for the blowing system, Englar noted. Options include a diesel-powered motor installed in the trailer like current refrigeration units, bleeding pressurized air from the truck's supercharger, or a simple chain drive to turn air blowers from the trailer's wheels.

Aerodynamic improvements such as rounded corners, coupled with pneumatic controls for blowing air from slots, help reduce drag at the rear of heavy trucks.

To fully assess the energy savings, the researchers will have to accurately account for the power needed by the blowing system, which will cut into the fuel savings. Other practical issues—such as protecting the pneumatic surfaces from damage during docking—still must be resolved.

Beyond boosting fuel efficiency, the pneumatic system can also provide a form of aerodynamic braking to assist the mechanical brakes, Englar said. Differential blowing could also improve control of trailers in crosswinds.

www.gtresearchnews.gatech.edu/newsrelease/truckfuel.htm

Researcher Robert Englar (right) and Co-op student Daniel Hegeman adjust blowing slots on a model truck inverted in GTRI's low-speed wind tunnel. The testing helped assess the value of fuel-saving improvements.

Developing New Sensing Technologies for Biological and Chemical Agents

Should terrorists ever use chemical or biological weapons against the United States, new sensing technologies being developed at GTRI could help public safety officials respond more rapidly and effectively.

For example, chemical sensors in building ventilation systems could detect a release of gas and then shut down the ventilation system, said Dan Campbell, a GTRI senior research scientist. Chemical sensors could also be mounted on an unmanned aerial vehicle (UAV) to track a chemical plume, giving emergency managers insight on evacuation plans. Rapid biological sensors could be incorporated into handheld devices for first responders investigating a suspicious package.

Researcher Dan Campbell and his colleagues are testing the operation of GTRI's chemical sensor in the nose cone of the U.S. Department of Defense's Dragon Eye mini-UAV (unmanned aerial vehicle).

"Many sensor technologies under development are becoming reliable, versatile, inexpensive, and presumptive—they can help first responders make a reasonable assessment," Campbell noted.

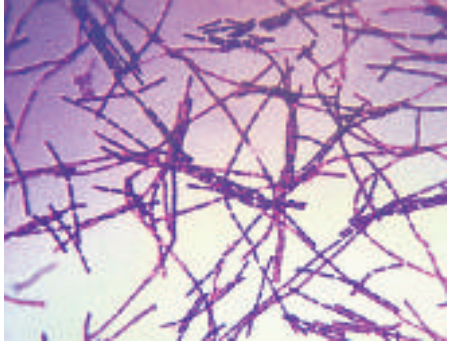
Campbell and his GTRI colleagues have been developing an integrated-optics sensor that can detect the presence of biological agents in minutes and chemical agents in seconds. They are tuning the sensor for detection of industrial pollutants, food-borne pathogens and, most recently, agents associated with terrorist attacks. The U.S. Marine Corps Warfighting Laboratory and Marine Corps Systems Command supported the latter research.

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.

Reactions on the waveguide surface 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 agents' identity and quantity. The small waveguide chip can accommodate several sensing channels designed to detect a wide variety of chemical and biological agents.

"We've built one platform for all possible uses, both in the air and in the water," Campbell explained. "You don't change out the laser or detector. You just plug in the chip you need and you're ready to go."

Researchers have successfully and rapidly detected numerous agents—including *Salmonella* and *Campylobacter* bacteria, anthrax, ricin, and ammonia—in laboratory tests, as well as groundwater contaminants such as chlorinated hydrocarbons in field tests.



In laboratory tests, GTRI researchers have successfully detected numerous agents with their sensor. Shown above is anthrax.

Recently, they have improved the sensor's reliability and sought new applications for the technology. To sense biological agents, the device takes rapid, direct measurements of the binding of an antigen to a chemical receptor on the waveguide surface. Researchers previously used antibodies as receptors, but they are more expensive and less reliable than aptamers—the synthetic, nucleic-acid-based receptors used in the sensor now, Campbell said. GTRI research scientist Jie Xu has been assisting Campbell with the aptamer work.

GTRI is exploring several opportunities for its sensor. The U.S. Naval Research Laboratory and the Marine Corps Warfighting Laboratory are seeking applications for their Dragon Eye mini-UAV. The reconnaissance device can fly one-hour missions within a six-mile radius of the launch site. So GTRI researchers are testing the operation of the chemical sensor mounted in the UAV's nose.

Meanwhile, Campbell's GTRI colleague David Gottfried is collaborating with the University of Georgia's Center for Food Safety to develop the sensing chemistry to detect infectious disease agents, including potential bioweapons, in water, fruit juice, milk, food, and the environment.

www.gtresearchnews.gatech.edu/reshor/rh-f04/danger.html

Improving Safety and Efficiency in a New Generation of Military Vehicles

Military police roll their Humvees through a course to test their ability to react to ambushes and shoot on the move at a training range in the Kuwait desert in February 2004.

Those who recall the old Jeep, of World War II fame, may view today's imposing Humvee as a cutting-edge vehicle. Yet, the 1970s-designed Humvee has been the military's all-around workhorse almost as long as the Jeep—and commanders today are calling for a vehicle more suited to twenty-first century tasks and perils.

Engineers at GTRI recently took on the substantial challenge of developing revolutionary, "leap-ahead" designs for not one, but two new Marine Corps vehicles. The researchers have been joined by an outside team that includes professional vehicle designers. The aim is to unite academic expertise with real-world, advanced engineering and production-level experience.

"What's different about this for Georgia Tech is we're actually bringing in very senior people from the auto industry," said GTRI researcher Mike Dudzik. "These are people who are well known for building unique vehicles—the hands-on guys who were basically the innovators of the automotive organizations they led."

The Office of Naval Research (ONR), which is funding the project, is eager for an improved vehicle to aid Marines in the near term. So, by March 2005, GTRI expects to have produced a technology demonstrator vehicle called the ULTRA AP (Armored Patrol). The ULTRA AP will emphasize high-output diesel power combined with revolutionary armor and a fully modern chassis.

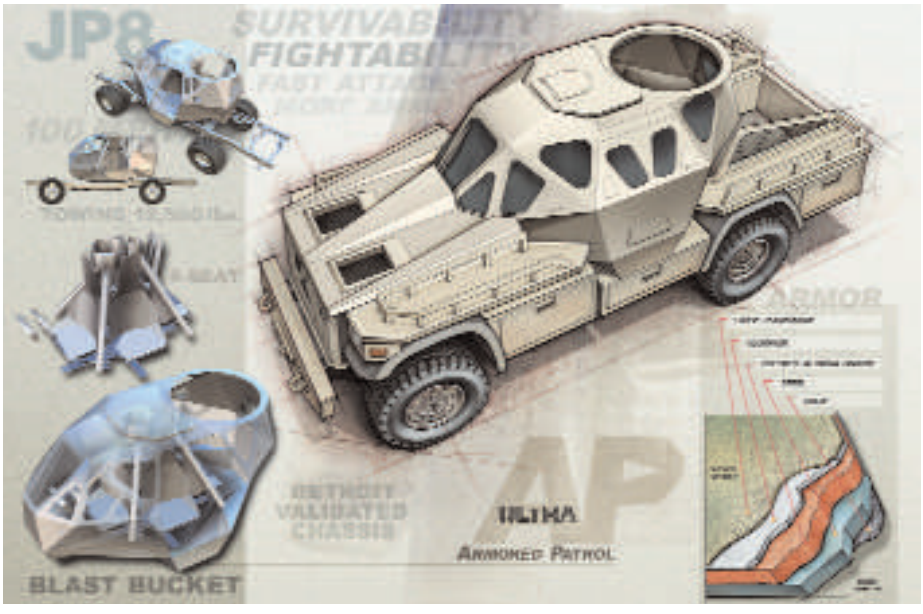
A more long-range project, the ULTRA 3T, will involve GTRI in a ground-up rethinking of military vehicles to reshape the battlefield. The 3-ton ULTRA 3T will unite an array of advanced technologies in a single automotive package. Some of these technologies, such as antilock brakes and airbags, are commonly available on production automobiles. Others, such as computerized stability control systems and advanced power-generating capabilities, are truly cutting-edge, said Scott Badenoch, GTRI principal scientist and project manager.

The project will make improvements in three key areas:

- safety with performance, using onboard computers to integrate steering, suspension, and brakes;
- survivability to shield occupants against new threats, while maintaining performance adequate for the mission; and
- improved power generation able to provide up to one megawatt of power for new battlefield concepts such as electrostatic armor or bunker-busting rail guns.

ULTRA 3T plans call for a hybrid engine that combines diesel and electric power plants. That setup would not only aid power generation, but offer a silent electric mode when stealth is needed. Moreover, the new engine will give the ULTRA 3T the critical ability to move more swiftly out of harm's way. Pound for pound, today's diesels develop about twice the horsepower of the Humvee's 1970s engine. Plans call for an unloaded ULTRA 3T to go from zero to sixty miles an hour in 4.8 seconds.

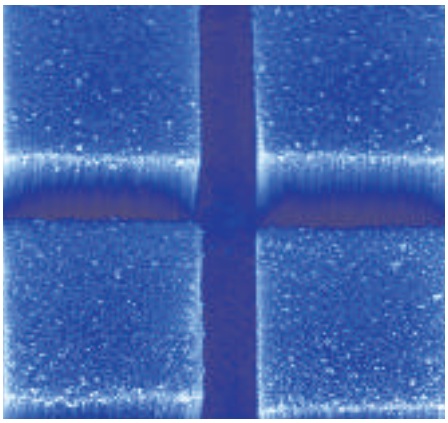
www.gtresearchnews.gatech.edu/newsrelease/ultra.htm



GTRI researchers are producing a technology demonstrator vehicle called the ULTRA AP (Armored Patrol). The ULTRA AP will emphasize high-output diesel power combined with revolutionary armor and a fully modern chassis.

Carbon Nanotubes Provide More Efficient Solar Power for Soldiers

When residents of New York's Manhattan Island ran out of real estate for new construction, they expanded vertically—



GTRI researchers have demonstrated an ability to precisely grow "towers" composed of carbon nanotubes atop silicon wafers.

using multi-story buildings to get more living space on their compact island. GTRI researchers hope to follow their example, but on a nanometer scale—building carbon nanotube "towers" atop photovoltaic (PV) cells to extract more power from the sun.

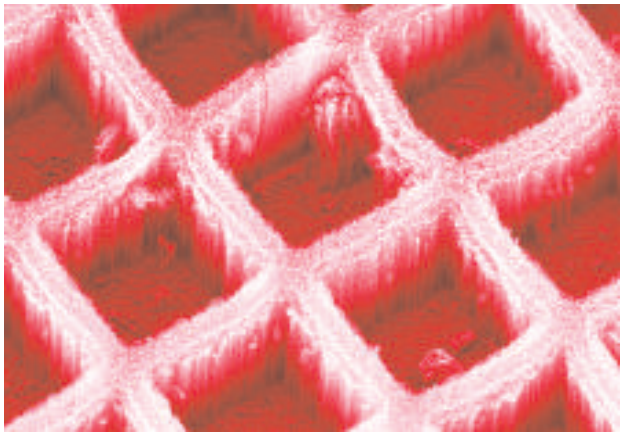
The nanometer-scale towers, which would be coated by special p-type and n-type semiconductor (p/n) junction materials used to generate electrical current, would increase the surface area available to produce electricity. Reflections off of the Gothamesque towers would provide more opportunity for each photon of sunlight to interact with the p/n junction of the cell. That would increase the power output from PV cells of a given size, or allow cells to be made smaller while producing the same amount of power.

For soldiers operating in the field, especially in desert areas that receive lots of sunlight, the new "solar tube" cells could provide an alternate power source for the growing number of electronic devices they use. Without the need for trucking in fuel, compact PV cells could directly power certain applications or be used to recharge batteries in soldiers' equipment.

"You will typically get low voltages from the sun, but it generates a steady state energy supply—like a fuel cell—but without the need for a consumable fuel," explained Jud Ready, a GTRI research engineer who is the project's principal investigator. "It would certainly be viable for recharging and for supplying power to a base where people are stationed long-term. This could have significant benefits from a supply logistics standpoint."

The three-dimensional cells could also be useful in space applications where power is in constant demand and launch weight is critical. Ultimately, they also could be used in developing nations where low-cost electrical power is vital to expanding economies.

The researchers have already developed techniques for precisely growing carbon nanotube bundles atop silicon wafers that have been treated with catalysts to produce geometries that resemble three-dimensional nano-models of Manhattan.



Using proven techniques, GTRI researchers are growing carbon nanotube bundles in their lab for testing.

The next step will be to work with collaborators at GTRI and the Georgia Tech Schools of Materials Science and Engineering and Electrical and Computer Engineering to apply the n-type and p-type coatings whose junction produces current. Because their cells will be more efficient, Ready believes they can use older and more mature p/n-type material technologies and less costly silicon wafers to hold down costs and rapidly advance the project into products that can be used in the field.

Challenges ahead include materials compatibility and long-term durability issues. Ultimately, the carbon nanotubes—which are themselves semiconducting at times—could be integrated to replace one or more of the p/n-type layers.

Reducing Cost and Cutting Power Consumption in Phased Array Radars

Phased array radars offer tremendous advantages over dish-based systems and so have become widely used by military and space agencies. But the complexity of these antennas—which use thousands or hundreds of thousands of elements to electronically steer radar beams—threatens to price phased arrays out of their existing markets and keep them out of new potential applications.

Phased array radars are essential components of U.S. defense systems, but their complexity threatens to price them out of existing markets and keep them out of new potential applications.

GTRI engineers are working with faculty in the Georgia Electronic Design Center (GEDC) to develop single-chip, transmit-receive modules that could replace complex multi-chip modules that are part of each element in today's phased array antennas. If the researchers are successful at integrating these functions into a single chip, they would do for phased arrays what earlier single-chip modules did for consumer electronics such as cellular telephones. That would not only lower the cost of the antennas and open up new applications, but also reduce power demands and the need for supplemental cooling—important considerations for mobile military systems.

To reach their goals, the researchers are exploring the use of chips built on silicon-germanium, a relatively new semiconductor material that costs much less than compound semiconductors such as gallium arsenide that have long been used in radars. Use of silicon-germanium could also allow other logic circuitry to be integrated into the same chips used for transmit-receive operations.

The researchers face some compromises in their efforts to replace existing multi-chip modules. The most important is that the silicon-germanium can handle less power than older materials, so more antenna elements will be needed to generate the same radar output. "But if our elements are three orders of magnitude cheaper and we only need twice as many, we'll come out way ahead," noted GTRI senior research engineer Mark Mitchell, who is the principal investigator for the project.

Preliminary design work with the GEDC researchers—who are internationally recognized for their work with silicon-germanium and hybrid digital-analog systems—has been encouraging. No "show-stoppers" have appeared so far, and the first chips could be fabricated within a year for initial applications in missile defense radar. But Mitchell is also thinking about other uses.

The Ballistic Missile Early Warning System's phased array uses thousands of multi-chip modules—one behind each antenna element. GTRI researchers hope to integrate the functions of the different chips of the modules onto a single silicon-germanium chip.

"Because of the expense, phased arrays have so far been mostly used for military radars," he said. "If we can get the cost down, a whole range of applications will open up, such as vehicle collision-avoidance radars, communications arrays, and aircraft weather radars."

Standardizing Information Systems on the Factory Floor

Andrew Dugenske (left) and Jeff Gerth pose with a Universal GSM placement machine used to manufacture electronic assemblies. Georgia Tech led an effort that resulted in an international standard for communication among such machines on the factory floor.

Electronics manufacturers use equipment and software from a variety of vendors, and this mix-and-match scenario causes a problem: Information systems must be modified whenever there's a change in assembly lines, which increases costs and delays production.

To address this issue, researchers at the Georgia Institute of Technology's Manufacturing Research Center (MARC) and the Georgia Tech Research Institute (GTRI) are working with the electronics-assembly industry to develop a family of international standards for interoperability. Known as Computer Aided Manufacturing using XML (CAMX), these specifications enable different machines and software on the factory floor to talk to each other in real time.

The newest addition to the CAMX family is the IPC-2501, recently approved by the IPC, a trade association for the electronics interconnect industry. The IPC-2501 features a centralized message broker, which uses an HTTP interface to pass XML (a universal format for Web-based documents and data) messages. "The message broker acts like a Web server and each piece of equipment or software application functions like a Web client," explained Andrew Dugenske, manager of research services at MARC.

In contrast to previous proprietary methods for message exchange, the IPC-2501 defines an open standard for routing information. "Now manufacturers can build their own systems and exchange messages seamlessly between different equipment and applications," Dugenske said.

Decreasing the complexity of communication yields significant benefits, including lower programming costs, faster production, and greater flexibility.

"Improving factory automation is critical because downsizing, consolidation, and outsourcing of factories require that fewer workers manage more and sometimes unfamiliar manufacturing processes," said Jeffrey Gerth, a senior research scientist at GTRI. "CAMX provides the conduit to distribute manufacturing messages, so rapid intervention can be made with a minimum of human effort."

A specialist in human factors, Gerth helped design a portal for the message broker, which graphically displays information from machines so manufacturers can see what's happening on their factory floors. "A standard isn't just about exchanging information, it's also about making decisions," he explained. "In the past, processes driven completely by technology often haven't provided the information individual decision makers need."

Georgia Tech is working with NACOM Corp., a manufacturer of automotive electronics, based in Griffin, Georgia, and several of NACOM's suppliers, to develop a CAMX application program interface. This software will make CAMX standards easier to implement and reduce costs for manufacturers.

www.gtresearchnews.gatech.edu/newsrelease/camx.htm

Saving Energy for U.S. Marine Corps Bases in California and Arizona

An energy conservation analysis by a team of Georgia Tech researchers is expected to save the U.S. Marine Corps about $1.85 million annually at seven bases in California and Arizona.

Cpl. Jason R. Slemmer works inside a Camp Pendleton warehouse lit by energy-efficient T-5 high-output fluorescent lamps.

Researchers recommended seventy-five energy conservation opportunities that will allow the Marines to recover an estimated $4.9 million investment in about 2.7 years, said Bob Martin, a GTRI engineer who led the twelve-member team of GTRI and Georgia Tech Economic Development Institute (EDI) researchers on the project.

The effort was part of the Western Power Grid Peak Demand and Energy Reduction Program led by prime contractor Intuitive Research and Technology Corporation of Huntsville, Alabama.

"California's recent power crisis provided the impetus for this project, but it was one of many programs aimed at cutting energy costs," said Bill Meffert, manager of energy and environmental management services at EDI.

Some facilities, including Twenty-Nine Palms and Camp Pendleton, resemble commercial facilities with an emphasis on conserving energy in building systems such as lighting and air conditioning. They had already implemented numerous conservation projects.

"The easy projects had already been done," Martin added. "We had to dig into systems performance to find opportunities."

Other places, such as the Logistics Base in Barstow, California, worked more like an industrial plant. "This is where we shine," said Meffert, noting that the team found more than $833,000 in annual savings, or some 20 percent of the base's yearly energy expenditures.

Audits, surveys, and data logging resulted in recommendations as simple as decommissioning old paint booths and as complex as recovering heat from the exhaust of a thermal regenerative oxidizer.

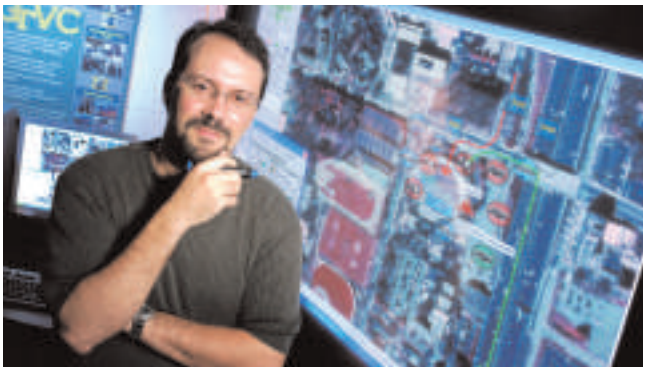
With this work complete, Georgia Tech hopes to apply the lessons learned to Georgia's Warner Robins Air Logistics Center and the Albany Marine Corps Logistics Base. Researchers also have submitted a proposal to the Federal Energy Management Program.

www.gtresearchnews.gatech.edu/newsrelease/savingenergy.htm

Georgia Tech researchers check an air conditioning unit at the Marine Corps Air Station Miramar in California.

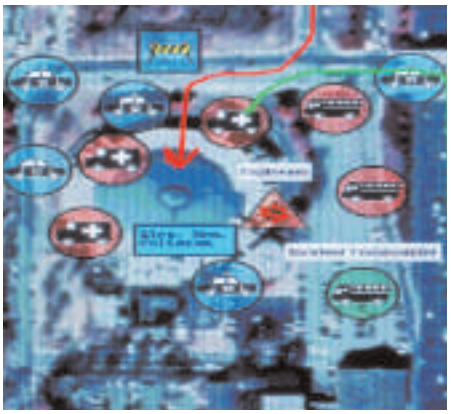
Improving Incident Planning and Response for Emergency Management Officials

An enhanced, high-tech, collaborative mapping tool is helping law enforcement and emergency management officials better coordinate event and incident planning, and real-time response.



Georgia Tech Research Institute engineer Rick Presley is one of the lead developers of the Geographic Tool for Visualization and Collaboration.

In its most significant deployment to date, the Geographic Tool for Visualization and Collaboration (GTVC) developed by the GTRI proved its usefulness during the G8 Summit of world leaders at Sea Island, Georgia, in June 2004. The Georgia Emergency Management Agency (GEMA), which is funding GTVC development and deployment, made the tool available to state and federal law enforcement agencies during the event to coordinate their combined resources and responses in real time.



The Geographic Tool for Visualization and Collaboration includes high-resolution imagery available at 1-meter resolution for all of Georgia, and even higher resolution for certain areas. The maps scale with each view and maintain all the markings made on them electronically.

While extensive state planning and tight security prevented any significant law enforcement problems during the Summit, GTVC's developers and users were pleased with the enhanced system, which was originally developed for military use, said Kirk Pennywitt, a GTRI senior research engineer. After nine months of work by Pennywitt's ten-member research team, GTVC provided many new features for its Summit use—including maps with six-inch resolution for Summit areas of interest. Researchers also boosted GTVC's reliability and robustness, and added secure encryption for communications.

"GTVC proved to be an extremely useful tool," said Ralph Reichert, director of GEMA's Terrorism Emergency Preparedness and Response Division. "Using GTVC, law enforcement teams were able to monitor and track activities. Consequence-management staff also used the system to make sure key resources were available at the right place and at the right time. Furthermore, and probably most importantly, command staff could immediately get a snapshot of what was going on without relying solely on traditional voice communications."

Besides GEMA, other agencies using GTVC during the Summit were the Georgia Bureau of Investigation, Georgia State Patrol, the Federal Bureau of Investigation, the National Guard, and the U.S. Secret Service. Users were able to share information simultaneously, keeping officials informed and coordinated, Pennywitt noted.

Georgia Tech Research Institute engineer Rick Presley demonstrates GTVC's easy-to-use planning features.

GTRI is also working with the Georgia Forestry Commission to adapt GTVC to track smoke during planned burns of forested land. Other potential applications for GTVC include tracking of chemical plumes and planning evacuation routes, as well as tracking of human and animal diseases, Pennywitt said. GEMA also uses GTVC for hurricane and flooding evacuation planning and for public event activity planning.

www.gtresearchnews.gatech.edu/newsrelease/gtvc.htm

Providing Information on Sustainability Issues for Building Professionals

Sustainable building isn't a technical problem—it's a people problem, said Annie R. Pearce, director of the Sustainable Facilities and Infrastructure (SFI) Program at GTRI.

"Everyone agrees that sustainability is a good thing," she explained. "But not everyone agrees on what it is, how to achieve it, or when it's been achieved."

Launched in 1997, SFI provides tools, training, and technical assistance to help building professionals use and apply sustainable materials and methods. Whether they're designing a new facility or renovating an existing one, the goal is to create structures with enduring environmental, economic, and social benefits.

One of the biggest challenges to sustainability adoption is overcoming the lack of communication among various groups involved in the building process.

"There is a huge disconnect, especially between design and operations," Pearce explained. "Architects conceive designs that may incorporate sustainable technology, but they don't always consider the facilities staff. This often results in sustainable buildings being built, but not used as intended."

Technology Square's Management building was one of the first buildings in Georgia to be certified as a Leadership in Energy and Environmental Design (LEED®) building, fulfilling several requirements for sustainable design, construction, and operation.

The Sustainable Facilities and Infrastructure Program at the Georgia Tech Research Institute recently hosted a "green" building seminar to help participants learn to apply sustainable materials and methods to construction and renovation projects. Shown facilitating a discussion is Annie R. Pearce, director of GTRI's Sustainable Facilities and Infrastructure Program.

To combat such problems, SFI takes an integrated approach to its curriculum. SFI classes target a broad audience—planners, project managers, architects, engineers, and maintenance personnel—with interactive exercises that teach people how to work together to identify strategies for implementing sustainability.

Because the building process is so complex, early collaboration is critical to understand how different components work together and result in higher-quality buildings that cost less to operate and maintain.

To promote greater synergy among building participants, SFI offers customized training on organizational change and how to implement sustainability. To date, clients include the U.S. Army, U.S. Air Force, state Department of Defense partnerships, the Centers for Disease Control and Prevention, and the U.S.D.A. Forest Service.

SFI is striving to combat information overload. "There's no lack of information out there on sustainability," Pearce observed. "The problem is trying to find what you need for your particular project."

In response, SFI has created the Sustainability Knowledge Base (**www.sustainablefacilities.org**), a project that began in 2002 with Defense Department funding. This online tool targets military installation personnel in the Southeast, but can benefit anyone trying to practice sustainable building.

The database captures real-world knowledge in an easy-to-digest form, enabling users to skim more than 200 different technologies—from aerated, autoclaved concrete to waterless urinals—and drill deeper when they want more details. "The idea is to deliver the right information to the right person at the right time," Pearce explained.

www.gtresearchnews.gatech.edu/newsrelease/sustainable.htm

Monitoring Costly Industrial Equipment in Harsh Environments

Maintaining large rotating equipment isn't easy or cheap. Take gas turbines used in power plants: inspecting one of these behemoths for possible wear-and-tear costs about $500,000 in parts and labor. If companies skip periodic checkups, they risk breakdowns averaging $4 million per incident.

Radatec's microwave-based vibration and displacement probe contains no active elements, enabling long-term operation in the harshest of industrial environments.

Atlanta-based Radatec Inc. is transforming condition monitoring with a new breed of non-contact displacement sensors that resulted in part from commercialization of GTRI research. Radatec's sensors provide real-time information about critical mechanical components in areas that were previously off limits.

"We take the guesswork out of maintenance," said Scott Billington, Radatec's president and co-founder. "Instead of having to shut down heavy equipment, Radatec's sensors allow operators to virtually see inside complex machinery and predict when repairs are needed."

Based on microwave technology, Radatec's innovative sensors measure motion by sending a continuous microwave signal toward a vibrating or rotating object. This signal is reflected back to a radio receiver in the sensor. A patented algorithm then compares the transmitted signal with the received one, calculating a measure of displacement.

These unique characteristics allow Radatec's sensors to operate in harsh environments. "Existing sensors work well in certain applications, but can't be used in areas where it's very hot, dirty, or contaminated," said former GTRI researcher Jonathan Geisheimer, Radatec's co-founder and vice president. "Because these regions are often the most stressed areas of machinery, it's where major problems develop first."

Billington and Geisheimer launched Radatec in fall 2001, licensing technology they helped develop as researchers at Georgia Tech's Manufacturing Research Center and GTRI. Since then, the company has filed several patents of its own and in 2002, Radatec was admitted to the Advanced Technology Development Center (ATDC), Georgia Tech's incubator for fast-growing technology companies.

Because initial sensors were built for high-end military aircraft, Radatec used expensive components in the 24.1 GHz band. Recently the company set out to build a more affordable system for commercial users.

Winning a $100,000 Small Business Innovation Research grant from the National Science Foundation, Radatec began working with 5.8 GHz components—parts found in consumer wireless networking applications. Completed in December 2003, Radatec's new 5.8 GHz platform has exceeded expectations, reducing both size and cost of sensors more than 100 times.

www.gtresearchnews.gatech.edu/newsrelease/radatec.htm

Shown with the displacement probe is Radatec's director of business development, Dave Burgess.

Detecting Hidden Mold Behind Wallboard Improves Indoor Environments

GTRI researchers are testing the feasibility of using radar technology to detect mold behind gypsum wallboard. A common problem, hidden mold can cause serious structural damage and health problems before it is discovered.

Hoping to develop a non-destructive and less expensive method than is now available to detect mold behind walls, GTRI scientists are collaborating with humidity control expert Lew Harriman of Mason-Grant Consulting in a two-year feasibility study primarily funded by the U.S. Department of Housing and Urban Development through its Healthy Homes Initiative. The Air-Conditioning and Refrigeration Technology Institute in Washington, D.C., and Munters Corporation in Norcross, Georgia, are also providing funds for the study.

"Mold is a common problem, especially in humid, southern climates, but people are often not aware of it because it's occurring behind a painted or wallpapered wall," said GTRI research scientist Victor DeJesus. "Then it's too late when they realize it. The wallboard must be replaced."

In addition to degrading structures, mold can emit smelly and potentially harmful compounds into the air, DeJesus added.

Researchers are conducting experiments on damp, mold-infested wallboard panels. Initially, they are using a signal processing algorithm and a high-sensitivity, laboratory-sized radar system recently developed by GTRI principal research scientist Gene Greneker and senior research scientist Otto Rausch.

They will determine the feasibility of using millimeter-wave, extremely high-resolution radar to detect mold in these panels based on the unique characteristics of the mold backscatter signature, extracted by unique signal processing techniques. Later, the researchers will examine the effectiveness of these techniques in detecting mold in other indoor building materials, including ceiling tiles typically used in commercial structures.

Ultimately, the researchers hope to produce a small, handheld prototype unit—something akin to a stud finder—to lay the technical foundation for a commercial product that contractors could purchase for about $1,000 to $2,000 and easily learn to use. They would then test that prototype in actual houses.

www.gtresearchnews.gatech.edu/newsrelease/moldradar.htm

Researchers Victor DeJesus (left) and Gene Greneker are testing the feasibility of using radar technology to detect mold behind gypsum wallboard. They are using a signal processing algorithm and a high-sensitivity, laboratory-sized radar system recently developed by GTRI.

Catching Bad Sandwich Buns via Digital Imaging on the Production Line

The perfect bun: That's one goal of an automated product-inspection prototype under development by Georgia Tech researchers working with Flowers Bakery in Villa Rica, Georgia.

The first phase of the work is introducing continuous imaging technology to the large-scale production of sandwich buns for fast-food restaurants, which hold to exacting product specifications.

The fresh-baked buns are scanned by a digital camera as they move along Flowers' production line. Items not measuring up in terms of color, shape, seed distribution, size, or other criteria are identified by the computerized eye's imaging software and eventually removed automatically from the conveyor.

The system concept is under development by GTRI engineers in association with researchers from Georgia Tech's School of Electrical and Computer Engineering (ECE) and BakeTech, a baking equipment manufacturer in Tucker, Georgia.

The project was made possible, in part, by funding from Georgia's Traditional Industries Program for Food Processing, a ten-year-old research and development program designed to improve the market competitiveness of Georgia's food processing industry—the state's second-largest employer. The Food Processing Advisory Council oversees such state-funded research grants.

The computerized imaging system in development will automate the inspection process at Flowers. Ultimately, the new approach will save money and time by increasing yield and reducing waste, said Doug Britton, a GTRI research engineer.

An automated product-inspection prototype is under development by Georgia Tech researchers working with Flowers Bakery in Villa Rica, Georgia. Researchers are introducing continuous imaging technology to the large-scale production of sandwich buns.

"It should reduce the time between noticing a problem and fixing it," Britton explained. "Also, the system will automatically record data, such as product count and the number of out-of-spec buns, to generate production reports. Flowers will have all this data immediately for doing statistical process control so they can implement changes that reduce the number of poor-quality buns."

The second phase of the project will extend automation by providing in-line mechanisms to correct the vagaries leading to poor-quality products. Proofers—the heat and humidity-controlled chambers where dough is sent to rise and bake—are subject to normal disturbances that can affect product quality. Automatically compensating for those disturbances reduces the amount of time spent correcting problems.

Researchers in ECE, working with the GTRI team, are using data from the screening and image-processing phase and from additional sensor inputs to build a supervisory control system. It will be able to make changes in the proofer and oven settings to fix problems as they are detected.

"Baking is both a science and an art," said Professor Bonnie Heck, Britton's colleague from ECE. "Good bakers know both and are able to react based on experience and feedback from the process. We're trying to enhance the ability of expert and novice bakers alike to make better quality-control adjustments, while also adding automation that can mimic some of those adjustments dynamically."

www.gtresearchnews.gatech.edu/newsrelease/bakery.htm

Connecting High School Curriculums to Real-World Needs

Foundations for the Future (F3), a collaboration of GTRI researchers, helps accelerate technology access and use in K-12 classrooms throughout Georgia. One of the group's many outreach projects has been a school-to-work consortium that supports economic development efforts in southeastern Georgia.

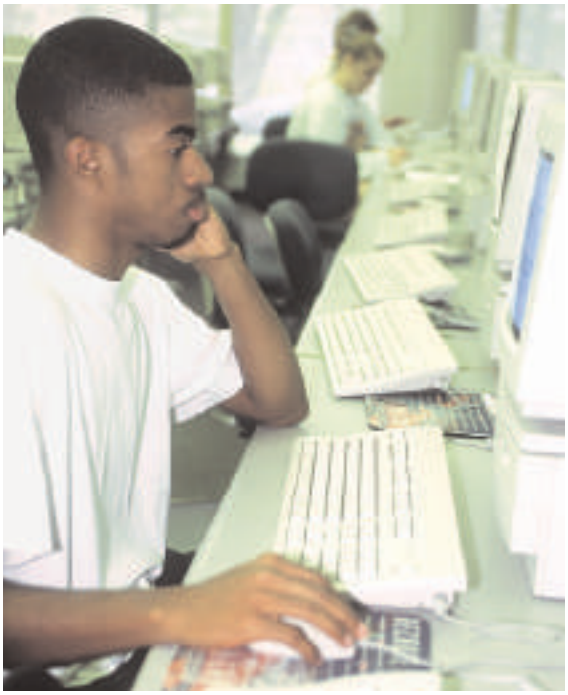
A new technology park in Fitzgerald, Georgia, is expected to attract companies that can bring high-paying technical jobs to the rural community. To support the new park, which is located adjacent to its campus, East Central Technical College (ECTC) is building a new telecommunications learning facility and developing a new curriculum to provide employers with a steady supply of well-trained graduates. Yet another important aspect in achieving this objective is to ensure the success of incoming students, and ECTC asked GTRI to help align its curriculum with the five high school systems feeding the college.

In addition to providing technical expertise, F3 developed the necessary infrastructure for the project. Faculty participants were recruited from ECTC and high schools in Ben Hill, Irwin, Atkinson, Coffee, and Wilcox counties.

"The idea was to bring teachers and curriculum specialists together to discuss their experiences with students and address disconnects that occur between high school, college, and the work world," said Claudia Huff, F3's director. "If educators don't understand what employers are looking for in terms of skills and academic background, students may be unaware of emerging career opportunities—or unprepared to take advantage of them."

During the past two years, the group analyzed 76 ECTC courses and thirty high school courses spanning mathematics, science, social science, English, and technology. The consortium recommended numerous modifications geared to increase student achievement and knowledge of technology careers, including:

- requiring more technical writing, such as asking students to create a "Read Me" file that describes how to use a particular software program;
- requiring students to learn binary numbers to become more familiar with how computers process information; and
- learning more computer terminology and maintenance basics, such as installation, troubleshooting, and repair.



GTRI educational outreach experts worked with five Georgia school districts and a local technical college to align high school curriculums to meet the real-world needs of high-tech industry.

In addition, a new high school course, Telecom Technology Overview, has been proposed to prepare students for new broadband and telecommunications offerings at ECTC. The consortium also recommended co-teaching efforts, such as having high school students visit the college to see how telecom technicians use equipment and materials or having ECTC faculty visit the high schools to conduct learning-centered demonstrations.

Demonstrations of technical equipment are especially effective in engaging students, said Jeff Evans, F3's associate director. "Students learn best when they understand why they're learning what they're learning," he explained. "For example, showing students what happens when a telecom cable is damaged or measuring signal reception on cellular systems illustrates why they need to know logarithmic concepts that are used in signal-testing equipment. If you tie concepts into a unique technology that captures their attention, it can motivate students to embrace a particular career path."

www.gtresearchnews.gatech.edu/reshor/rh-w05/f3.html

Demonstrating How Community Design Affects Air Quality and Health

Need to shed a few pounds? Besides counting calories and exercising, consider your home turf.

A comprehensive Georgia Tech study shows the built environment may relate to a person's prospects for being overweight. Every additional thirty minutes a person spends in a car translates into a 3 percent greater chance of being obese, according to the study.

Also, the study shows that people who live in neighborhoods with a mix of shops and businesses within easy walking distance are 7 percent less likely to be obese, lowering their relative risk of obesity by 35 percent.

The $4 million, seven-year study, Strategies for Metropolitan Atlanta's Regional Transportation and Air Quality (SMARTRAQ), also reveals that higher levels of land-use mix, residential density, employer density, and street connectivity are associated with fewer vehicle miles traveled, reduced emissions contributing to air pollution, greater use of public transit, and increased physical activity.

The SMARTRAQ study revealed that higher levels of land-use mix, residential and/or employer density, and street connectivity—such as are found in Midtown Atlanta pictured here—are associated with fewer vehicle miles traveled, reduced emissions contributing to air pollution, greater use of public transit, increased physical activity, and reduced obesity.

"The effect of urban form on travel behavior and health is one of the unique aspects of the project," observed James Chapman, SMARTRAQ co-director and GTRI researcher. "How we plan and build our communities not only affects air pollution and how much we drive, but also people's likelihood of being physically inactive and obese."

SMARTRAQ, which is unusual in both size and scope, takes a holistic approach to land use, transportation, and health issues.

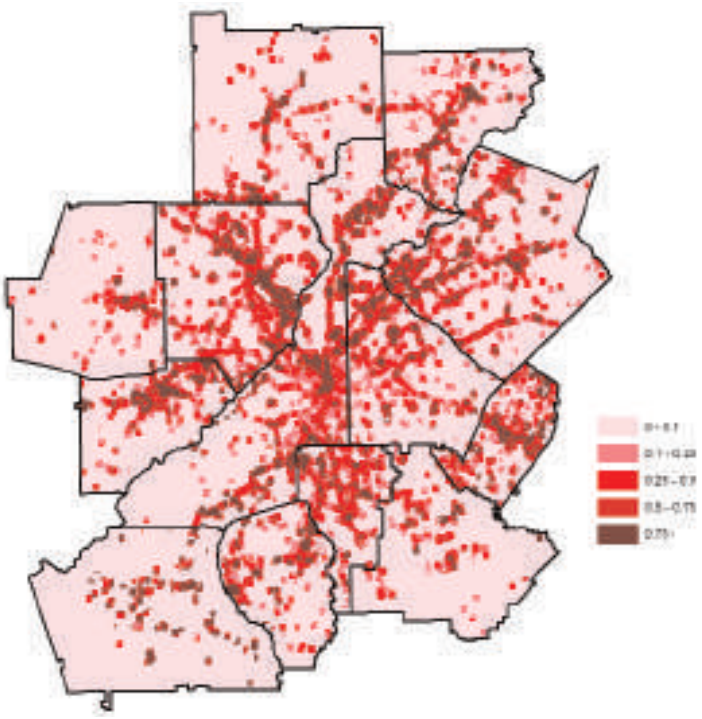
It is the first study to demonstrate that the built environment immediately around people's homes is a good predictor of how much they weigh, said principal investigator and lead author Lawrence Frank. Now a professor at the University of British Columbia, Frank spearheaded SMARTRAQ in 1997 when he was an assistant professor of city planning at Georgia Tech.

"Density and street connectivity also matter, but mixed use is the most important factor relating to physical activity and obesity," Frank said. "People need destinations to walk to." But Frank also noted that density is required to create the demand for local retailers and for other commercial activities to survive.

The SMARTRAQ study will help a variety of organizations improve their decisions and policies on transportation, environmental, and land-development issues, the researchers predict.

Underscoring its broad applications, SMARTRAQ's sponsors and partners include: the Georgia Department of Transportation, Federal Highway Administration, Georgia Regional Transportation Authority, Atlanta Regional Commission, U.S. Environmental Protection Agency, Turner Foundation, U.S. Centers for Disease Control and Prevention, Metro Atlanta Chamber of Commerce, and the Urban Land Institute.

www.gtresearchnews.gatech.edu/newsrelease/smartgrowth.htm



This map of metropolitan Atlanta shows the variation in land-use mix based on a ratio of residential, commercial, and office-floor areas (building size) within a given land area. The index ranges from 0 (no mix, single land use) to 1 (each use evenly present). The study shows that people living in mixed-use neighborhoods are 7 percent less likely to be obese.

Important Research Contributions

GTRI's Beginnings:

During the fall of 1999, the editors of the Georgia Institute of Technology's Research Horizons *magazine solicited nominations from faculty and administrators on the most important research performed at Georgia Tech during the twentieth century.*

Ten of the twenty-six projects featured in the Summer-Fall 1999 issue of the magazine germinated at the Georgia Tech Research Institute or its predecessor, the Engineering Experiment Station (EES). Of those ten, two—molecular and electron scattering, and OH radical measurement—were basic research projects. The remaining eight projects were technological innovations. Of those eight, two projects remain active and are featured elsewhere in this annual report. They are:

1. ***FalconView**, a mapping system originally developed to help F-16 pilots with flight planning. Now used by more than 20,000 air crews worldwide, the system has found broad applications well beyond those envisioned by FalconView's original developers.*
2. *The **integrated optic interferometric sensor**, developed to detect small amounts of contaminants in the air, soil, groundwater, and food. The device is finding homeland security applications as the basis for a sensing system that could detect potential biological and chemical weapons.*

We invite you to learn more about GTRI's research milestones.

"…When I came back to Georgia Tech I switched over to physics and had some wonderful professors there. One in particular…was …Dr. Jim Boyd. He was a physics professor and also a researcher at the Engineering Experiment Station, which is now the Georgia Tech Research Institute. When I was a student, he asked me if I would be willing to work part-time in the radar branch and I couldn't turn it down. So I got a physics degree and I stayed on [to pursue] a master's degree and [work]."

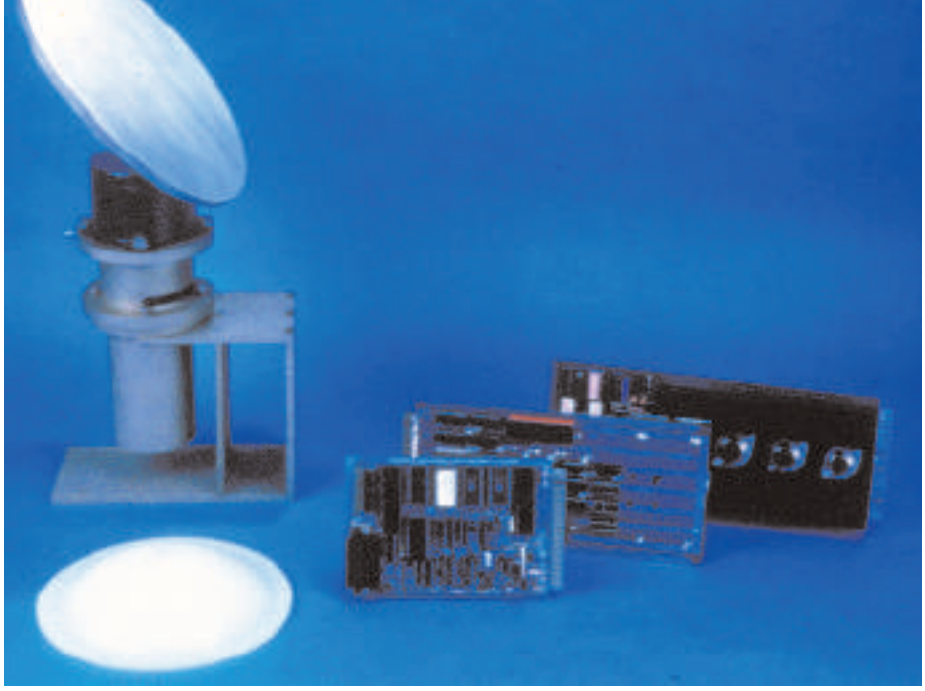
Glen P. Robinson Jr. — excerpted from the Georgia Institute of Technology "Living History" videotapes
Former EES/GTRI employee — funded GTRI's first chair, the Glen Robinson Chair in Electro-Optics; CEO of LaserCraft Inc.; retired chairman of the board at Scientific-Atlanta; founder of E-Tech energy technology company; holds at least thirty patents. Georgia Institute of Technology alumnus.

Millimeter Wave Radar

In the 1950s, scientists at the Engineering Experiment Station (now GTRI) began investigating use of the millimeter portion of the electromagnetic spectrum. That work represents significant contributions to the national technology base and established Georgia Tech's international reputation in radar research and development.

The advantages of millimeter waves include their ability to provide accurate, excellent image identification and resolution. They also provide remote measurements, while operating through smoke, dust, fog, or rain. At the same time, millimeter waves can be vulnerable to absorption by certain atmospheric and meteorological activity. GTRI scientists learned which frequencies work best for particular tasks and better identified and refined windows of attenuation—the frequencies that mitigate atmospheric interference with the signals.

Millimeter wave research at GTRI has been an ongoing process of discovering the appearance of objects—from tanks to raindrops—when viewed by high-frequency waves. Researchers have also determined the types of data, specifically the absorption and reflection characteristics they can derive from the interaction of those objects with the waves. In the process, they have pioneered the fundamental science of the millimeter wave environment, while inventing the hardware—antennas, receivers, and transmitters—to use that end of the spectrum.



GTRI scientists have used a millimeter wave radar direction finding system (shown here) to discover the appearance of objects—from tanks to raindrops—when viewed by high-frequency waves.

GTRI built the first military-designation millimeter wave radar in the late 1950s, followed by a succession of increasingly advanced models. By the 1980s, ongoing research to build a radar with a wavelength as near to 1 millimeter as possible culminated in the the development of the world's highest-frequency microwave radar, operating at 225 GHz. The device can provide useful imaging with an antenna less than 30 centimeters in diameter and is coherent, meaning it can detect Doppler returns from moving targets.

Research in millimeter spectroscopy paved the way for exploiting millimeter waves for measurements in radio astronomy; satellite-based studies of the upper atmosphere, climate, rainfall, and vegetation patterns; and a host of other environmental concerns.

Georgia Tech scientists have also achieved a number of firsts in millimeter characterization of clutter and targets—essential data for reliable millimeter radar systems. Since the 1960s, more than a dozen projects have provided millimeter measurements of the ocean, rain, snow-covered ground, desert, foliage, and foreign military vehicles. In the 1980s, GTRI researchers conducted a comprehensive study of the image-quality effects of atmospheric turbulence and precipitation on millimeter wave propagation.

www.gtresearchnews.gatech.edu/reshor/rh-sf99/t-wave.html

"To a large extent, faculty were shared between the academic departments and the [Engineering] Experiment Station. In the '60s, there was a lot of research money around. $10,000 went a long way…. We had a Nuclear Engineering Department, which was initially housed in the Hinman Building and in the Emerson Building, which at that time…we were sharing with the biology portion of the Engineering Experiment Station."

Geoffrey G. Eichholz — excerpted from the Georgia Institute of Technology "Living History" videotapes
Regents' professor emeritus of nuclear engineering and health physics—first Georgia Institute of Technology School of Nuclear Engineering faculty member.

Near-field Antenna Measurements

An antenna's placement has a substantial bearing on its performance, which can vary across different frequencies and depends upon the shape of the object on which it is mounted.

To determine the best antenna location for a particular situation, the late Richard C. Johnson of the Engineering Experiment Station (now GTRI) invented the compact radar range in the late 1960s. The technique simulates a plane wave over the entire antenna under testing and involves two main elements: a parabolic reflector and a mechanical device that lifts and rotates the target antenna.

Although the compact range operates in a relatively small space—most are indoors—it can measure the radiation patterns of antennas as they would occur over long distances. Advantages of indoor compact ranges are security and the ability to operate regardless of weather conditions.

Without the compact range, such studies would require a far-field range test site, which consists of two towers whose separation depends on the target size and frequencies studied. One tower holds the antenna under test while the other receives the signals. Given the size of vehicles and the high frequencies involved, far-field towers would have to be stationed several miles apart.

At Fort Huachuca, Arizona, the U.S. Army constructed an outdoor compact radar range thought to be the world's largest. GTRI scientist Dr. Richard C. Johnson invented the compact range in the late 1960s.

At Fort Huachuca, Arizona, GTRI designed an outdoor compact radar range, thought to be the world's largest, for the U.S. Army. The facility, which includes a 75-foot parabolic reflector and a lift capable of positioning objects up to 50 feet long and weighing as much as 70 tons, was built to measure antenna performance from 6 to 40 GHz on full-size vehicles and helicopters. (See page 28 to read Johnson's memories of GTRI.)

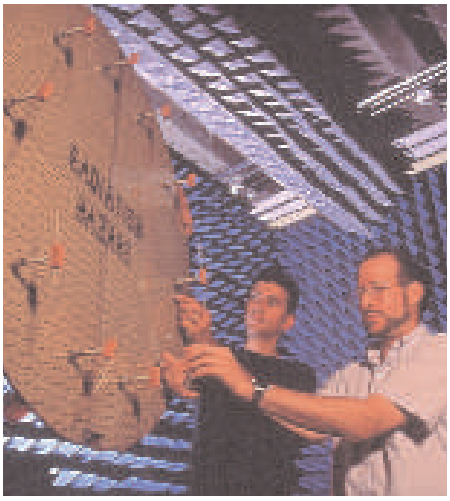
www.gtresearchnews.gatech.edu/reshor/rh-sf99/t-nearant.html

"We [had] field offices all over the state of Georgia, and we [had] engineers there. They would run into problems they could not solve from their own knowledge, or they would need some information about something. They would ship that question up to us [at EES/GTRI]. It was interesting, because everything was a different problem—textiles, to food, to manufacturing problems. It was fascinating…..[and] we taught an awful lot of people how to do industrial development. People all over the state took our training courses."

The late Richard C. Johnson — excerpted from the Georgia Institute of Technology "Living History" videotapes
Former EES employee—world-renowned antenna expert and mentor; invented and patented the Compact Antenna Range; authored widely known books on antenna engineering and designing microwave antennas; first "emeritus" research faculty member at Georgia Tech. Georgia Institute of Technology alumnus.

Near-field Sampling

In the early 1970s, the extensive antenna-testing research performed at Georgia Tech included development of techniques to measure antenna radiation patterns without the need for building a large far-field test range. One such technique was near-field sampling. Researchers measured the near field of an antenna, then calculated the far-field pattern from the measurements, while simultaneously correcting for the directional effects of the measuring probe.



In the 1980s, Georgia Tech researchers used near-field sampling to measure antenna radiation patterns, such as this one for the F-15, without needing to build a large far-field test range.

Researchers investigated plane and cylinder sampling surfaces. For the plane, the near field was measured in front of the test stationary antenna by moving the measuring probe both vertically and horizontally in front of the antenna. For the cylinder, the antenna was mounted on a rotating turntable in front of a probe that could be moved on a vertical line.

Near-field measurements can also be used to calculate other aspects of antenna performance, including gain and polarization ratio.

www.gtresearchnews.gatech.edu/reshor/rh-sf99/t-nearsamp.html

OH Radical Measurement

GTRI scientist Fred Eisele added to the understanding of atmospheric chemistry when he developed a sensitive new technique for measuring the hydroxyl (OH) radical. Considered the single most important cleansing agent in the atmosphere, the OH radical acts as an oxidizing agent and removes several greenhouse gases and other pollutants from the atmosphere. Continuously replenished during the daytime but highly reactive, the OH radical defied in situ measurement for twenty years until Eisele developed his technique.

In 1989, Eisele modified his ion-sampling apparatus to support the physical chemistry needed to detect the OH radical. His measurement technique combines the highly reactive nature of the OH radical with the extreme sensitivity offered by a mass spectrometer.

Working at a field experiment site, GTRI scientist Fred Eisele uses a sensitive atmospheric ion-measurement technique he adapted to measure the elusive hydroxyl (OH) radical. The OH radical is considered the single most important cleansing agent in the atmosphere.

Air drawn through a sampling tube is subjected to a rapid succession of chemical reactions initiated by the addition of isotopically labeled sulfur dioxide, which converts all of the naturally occurring OH into isotopically labeled sulfuric acid. The acid is ionized to form an isotopically labeled bisulfate ion, which is then measured with a selected ion chemical ionization mass spectrometer. Because the OH was converted into the acid in a one-to-one ratio, the amount of sulfuric acid reveals the ambient OH concentration.

www.gtresearchnews.gatech.edu/reshor/rh-sf99/b-ohrad.html

"In the late '60s… many of the universities doing Department of Defense research, because of student protests, really had to stop a lot of that research. Georgia Tech was able to pick up a lot of that research in radar, communications, and electronic countermeasures for the Department of Defense, and was growing quite rapidly."

H. Allen Ecker — excerpted from the Georgia Institute of Technology "Living History" videotapes
Former EES/GTRI employee—executive vice president, Scientific Atlanta; inducted into the Georgia Technology Hall of Fame. Georgia Institute of Technology alumnus.

Three-dimensional Vision

In the late 1970s and early 1980s, then-Engineering Experiment Station research engineer Richard Steenblik developed a three-dimensional vision technique that provided the basis for a successful and popular commercial optical film product used in certain 3-D glasses.

The Chromatek Inc. product, called ChromaDepth 3-D, uses pieces of microptic film to selectively shift the points at which different colors of light are focused. Known as chromostereoscopy, the technique makes objects of different colors appear to be at varying distances from the viewer.

The technique was developed after Steenblik noticed slight 3-D effects produced by a video game. The effect was caused by an imperfection called chromatic aberration in the lenses of the eye. Also, Steenblik knew the brain expects that red color often comes from objects close to the viewer, while blue tends to come from objects far away.

A three-dimensional vision technique patented in 1983 by a former GTRI researcher is used today in the production of a commercial optical film product used in 3-D glasses. Inventor Richard Steenblik (above) founded Chromatek Inc. to manufacture and market the product.

Steenblik worked to enhance the effect and concluded that passing light through two different liquids would provide the necessary shifting, known as refraction. In his first prototype model, he used two liquids of Chinese cinnamon oil and glycerin, which provided the opposing refraction needed to produce right-eye and left-eye views from the same two-dimensional image.

He patented the technique in 1983 and soon thereafter founded Atlanta-based Chromatek Inc. with New York businessman Frederick Lauter. The company then developed 3-D glasses based on double prisms, rather than liquids, but they did not work as well as Steenblik had hoped.

Collaboration with binary optics scientists at the Massachusetts Institute of Technology allowed for the inexpensive manufacture of the complex prism patterns needed to produce the 3-D effect. The new product debuted in 1992. Since then, more than 100 million pairs of ChromaDepth 3-D glasses have been purchased for marketing and promotional uses.

www.gtresearchnews.gatech.edu/reshor/rh-sf99/t-3d.html

Fused Silica Radomes

Radomes—the structures that shield a missile's sensors—must withstand rapid high heating and harsh weather while allowing radio signals to pass through them. That was part of the challenge for a research project first presented to the Engineering Experiment Station (now GTRI) in the late 1950s.

Highly regarded for their work in high-temperature ceramic materials, Georgia Tech researchers developed a slip-cast fused silica technique for forming refractories of massive size and complex shapes—structures such as radomes and missile nose cones, and rocket engine components.

Researchers developed several improvements to the fused-silica process over the years. In 1970, researchers discovered that manipulating the rate of heating, temperature, and the time of temperature affects the development of the ceramic's mechanical strength, in a phenomenon called sintering. The resulting material was 50 percent stronger than previous efforts, yet maintained the requisite electromagnetic properties.

By the end of the 1980s, Tech researchers learned that adding aluminoborosilicate fibers to the mix strengthened the material. A further refinement was made when they found that short fibers—meaning lengths twenty or thirty times their diameter versus fibers

Continued on next page

"[After graduating from Georgia Tech] I got a fellowship at the Engineering Experiment Station…. I did research on the X-ray structure of viscose rayon for two years with Jerry [Rosselot]…and why it gets weak when it gets wet was the question…."

Alfred Barnard — excerpted from the Georgia Institute of Technology "Living History" videotapes
Former EES employee. Georgia Institute of Technology alumnus.

Continued from previous page

measuring 100 times their diameter—doubled radome strength with only a minimal loss of density.

www.gtresearchnews.gatech.edu/reshor/rh-sf99/t-radome.html

Solar Energy

In the mid-1970s, the Engineering Experiment Station (now GTRI) operated a solar energy research program with interests in high-temperature, solar thermal energy conversion, electric power generation, and liquidification and gasification of biomass using solar thermal energy.

At the U.S. Department of Energy-funded Solar Thermal Test Facility on the main campus, GTRI researchers developed a method for creating high-grade synthetic fuels with solar thermal energy. In 1980, researchers from GTRI and Princeton University announced a breakthrough in pyrolysis in which highly concentrated solar energy, rather than burning of biomass, provided the heat necessary for pyrolysis reactions. Subsequently, GTRI researchers were instrumental in developing standards for several different types of biomass fuels through the American Society for Testing and Materials (ASTM).

GTRI engineers at the Solar Thermal Test Facility directly produced power-grid quality electricity with a Georgia Tech/Swedish-built Stirling external combustion engine whose pistons were driven by helium, heated by intense sunlight.

GTRI's Solar Thermal Test Facility evaluated the use of concentrated solar energy for biomass conversion and production of electricity.

By the mid-1980s, interest shifted to photovoltaics (PV), as the efficiency of PV devices increased and the cost of making solar cells decreased. A research program in the School of Electrical and Computer Engineering studied new semiconductor materials and designed innovative devices.

In 1992, that work garnered Georgia Tech a Department of Energy contract to operate the University Center of Excellence for Photovoltaics Research and Education (UCEP). Today, the Center operates a working PV system installed in the Georgia Tech Aquatic Center, and continues its work in developing improved materials and processes for PV manufacture.

www.gtresearchnews.gatech.edu/reshor/rh-sf99/t-solar.html

Molecular and Electron Scattering

During the 1960s, Georgia Tech was widely known for the development of innovative experimental systems in atomic collisions, initiated by the late Earl W. McDaniel of the Engineering Experiment Station (now GTRI). McDaniel later became a professor in electrical engineering and physics.

Among the notable projects was the first development of the drift tube mass spectrometer, used to study low-energy chemical reaction with defined species. Another highlight was the first series of U.S.-based experiments to study collisions between beams of electrons and ions. In the late 1960s, the program added a theoretical component to provide for the prediction and a fundamental understanding of atomic collisions.

Much of the early work was to provide data for support of the Controlled Thermonuclear Reactor at Oak Ridge, Tennessee. High-energy beam studies fostered development of neutral beam injectors to heat and fuel such reactors. Electron-ion collision experiments and theoretical predictions helped provide an understanding of the cooling processes in such devices.

www.gtresearchnews.gatech.edu/reshor/rh-sf99/b-scatter.html

"….We were doing microwave propagation work from the top of the physics building…propagation experiments between there and the top of Mt. Oglethorpe, which used to be the foot of the Appalachian Trail. There is a statue up there of Jim Oglethorpe at the top of the mountain, and that's where our end-of-sight was. So we operated between the two places and studied the effects of the weather on propagation."

Maurice W. Long — excerpted from the Georgia Institute of Technology "Living History" videotapes
Former director of GTRI, 1968-1975—wrote three seminal books, one on airborne early warning systems and two on radar reflectivity.

GTRI Employee Honored with Georgia Commendation Medal

The state of Georgia went all out to ensure that the June 2004 G8 Summit at Sea Island, Georgia, was a secure and seamless event. GTRI's Christina Baxter was part of that effort and was recognized this year by the Georgia Department of Defense-Military Division for her contributions.

Baxter was presented the Georgia Commendation Medal in honor of the support she provided to the Georgia State Patrol and the National Guard during the G8 Summit. Baxter, whose specialties include emergency management, fire fighting, and hazardous materials, helped provide training and preparation that ensured mobile field forces and command and control staffers were ready for any emergency situations at the Summit, as well as routine daily duty at the Summit. Additionally, Baxter also serves as a volunteer with the Douglas County Fire Department.

Golfing for Good

Golf is always good fun for those who play it. But when GTRI maintenance and construction manager Rusty Embry organizes a golf game with GTRI colleagues, family, friends, and customers, it's not just good fun, it's good fundraising for a great cause.

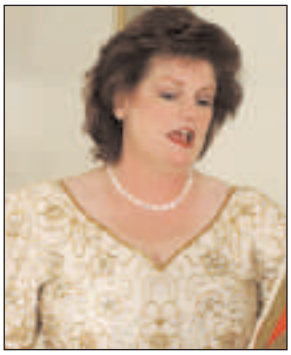
For the past several years, Embry has arranged the GTRI Research Scramble tournament, which benefits GTRI's Shackelford Graduate Fellows Program. Named in memory of Robert G. "Bob" Shackelford, the program provides financial support to graduate students who are working at GTRI.

Embry plans the event, locates a course to play, publicizes the tournament, arranges for winners' trophies and helps people set up foursomes to play the scramble. This year's tournament at The Frog at the Georgian Resort in Villa Rica, Georgia, raised $2,300 for the Shackelford program. That is roughly equal to a semester's worth of tuition, with some funds left over for fees, for a full-time, in-state graduate student at Georgia Tech.

Combining Culture, Language, and High-tech Research

Ask Jennie Lincoln about her most recent work travel and you'll hear about exploring research opportunities in Panama, lecturing on the U.S. electoral process for the U.S. Department of State in Costa Rica, or about coordinating information technology support for multinational counter-drug efforts of the U.S. Department of Defense and the Organization of American States. Her job is to bring a global viewpoint and access to GTRI projects with an international component. Lincoln's Spanish language skills, expertise in Latin American politics, and work with senior U.S. government officials on democracy, peace, security, and international cooperation make her an excellent person to open doors for research technology partnerships for GTRI.

Lincoln's projects have helped Latin American countries integrate information technology to promote data sharing, cooperation, and policy development. On her own time, she also educates U.S. Department of Defense officials on Latin American policy and issues, as well as cross-cultural communication, and serves as an international election monitor with former president Jimmy Carter and other colleagues.



Taking Care of Business and Making Beautiful Music

When she is not keeping GTRI director Steve Cross on schedule and planning special events, Cross's executive assistant, Marie Little, is singing operatic roles and oratorio solos in Atlanta and elsewhere, as well as being honored for her stellar talents.

Little, a dramatic coloratura soprano, was among ninety-eight singers from the United States and abroad to attend a prestigious six-week American Institute of Musical Studies (AIMS) program in Graz, Austria. The AIMS program is the leading European summer vocal program and most comprehensive course of its kind, bringing together the world's future opera and concert performers with an eminent faculty and the prestigious AIMS Festival Orchestra.

At AIMS, Little was a soloist for a variety of operatic and oratorio concerts and studied with internationally renowned artists, directors, and conductors, including maestro Edoardo Müller. Also in 2004, Little was named a semi-finalist in the first annual Classical Singers Convention Competition, and was a soloist for the American Symphony Orchestra League Conductors' Workshop hosted by the Atlanta Symphony Orchestra. She also is a member of the Atlanta Symphony Orchestra Chorus and the sixty-member Chamber Chorus, whose members are auditioned by and selected from the symphony chorus by invitation only.

Making Atlanta Strong and Compassionate – One Person at a Time

Nine years ago James "Dani" Wilson's wife, Sherry, was dying of cancer. He began assisting her with her volunteer work, helping abused women and children make a new start in life.

Today, Wilson has surpassed even his late wife's vision for making the world a better place. An office automation specialist at GTRI, Wilson has become a minister and has established a non-profit corporation, Hutsville Ministries Inc., based on the program of volunteer work his late wife started. Today, Wilson and his second wife, Amy Burgess-Wilson, spend evenings and weekends helping the homeless and abused get a new start in life.

Every second Saturday, Wilson organizes a dinner and fellowship session for the women and children at the Atlanta Union Mission shelter; every fourth Saturday, he does the same at the men's shelter near Atlanta's Centennial Olympic Park. He leads at least six chapel services among the two shelters, personally visits those who need encouragement and comfort, and tries to help them make connections to improve their lives. In addition, Wilson organizes Thanksgiving and Christmas dinners for the homeless.

Wilson's Georgia Tech colleagues nominated him this year for the university's prestigious Don Bratcher Human Relations Award, but he says his favorite recognition is seeing those he has helped succeed and then go on to assist others.

Enhancing the Amber Alert System

While working on a project to enhance information sharing for the national justice and public safety community, research scientist Christina Medlin used her team's work to facilitate a revised XML specification for rapidly distributing information to locate missing children.

Medlin has been working on the Global Justice XML Data Model (GJXDM), a data model for sharing information among numerous agencies in the U.S. justice and public service communities quickly, efficiently, and consistently (see p. 8). Global JXDM defines terms, formats, and standards that enable agencies to create databases that can more easily exchange data with one another.

After helping design and build the GJXDM, she used components of this model to help develop a proposed baseline for a national Amber Alert XML message standard, which codifies information disseminated to emergency management services, law enforcement, public works offices, transportation agencies, and broadcasters.

GTRI Employee Named One of Top Forty Future State Leaders under Forty

For seven years, the editors of *Georgia Trend* magazine, with input from their readers, have selected a list of the forty best and brightest Georgians under forty years old. This year, GTRI research scientist Leanne West is on that roster of outstanding contributors to society.

West's area of expertise is electro-optics. Among other work, she's contributed to the design of next-generation, ozone-monitoring technology that will make such tracking continuous, affordable, and Internet-accessible in real time. She also is doing work on novel medical imaging techniques, such as a camera that detects the beginnings of pressure ulcers and bed sores.

West also is leading work toward adapting the television closed-captioning concept for the deaf and hard-of-hearing to allow them to participate in activities in businesses, schools, theaters, and elsewhere. Users of the technology would use personal digital assistants with wearable micro-display glasses to view a streaming-text transcription of the audio messages.

Keeping GTRI in Good Shape!

Time is of the essence to GTRI senior research engineer George Whitley. As a typical GTRI researcher, he directs and manages multiple programs with extremely time-critical schedules. Atypically, during his off-hours, he's also beating the clock—with his running times in races around the city, state, and nation.

A dedicated athlete, as well as radar and sensor systems researcher, Whitley believes fitness is the key to an enjoyable, productive, and quality-driven life. He encourages others to continue or start fitness programs by participating in run-walk events. For the last twenty years, he has been a driving force in organizing a GTRI team to compete in the Corporate Run/Walk 5K held annually in Atlanta. In the past two years, he has joined forces with Susan Paraska, who works in Georgia Tech's Academic Affairs office, and together they have organized a Georgia Tech team to participate in the event. The new team is made up of full-time Georgia Tech faculty and staff.

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Georgia Tech Research Institute

Creating Solutions Through Innovation

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- GTRI serves the Georgia Institute of Technology and, as such, helps realize the university's vision.
- GTRI serves the state, the nation, and the world by maturing selected technologies, and by developing innovative engineering solutions to important and challenging problems of government and industry.

OUR CORE VALUES

Integrity - Trusted working relationships at GTRI, within the university, and with our customers are key to our success. We are open, honest, and fair. We respect others and keep our commitments. Our communications and actions reflect these values. We base our decisions on facts as far as we can know them. We admit when we are wrong and make appropriate changes. We do what is right even when it is difficult. We have no hidden agendas. We hold ourselves accountable for adhering to these principles, and we expect and encourage others to hold us accountable, too.

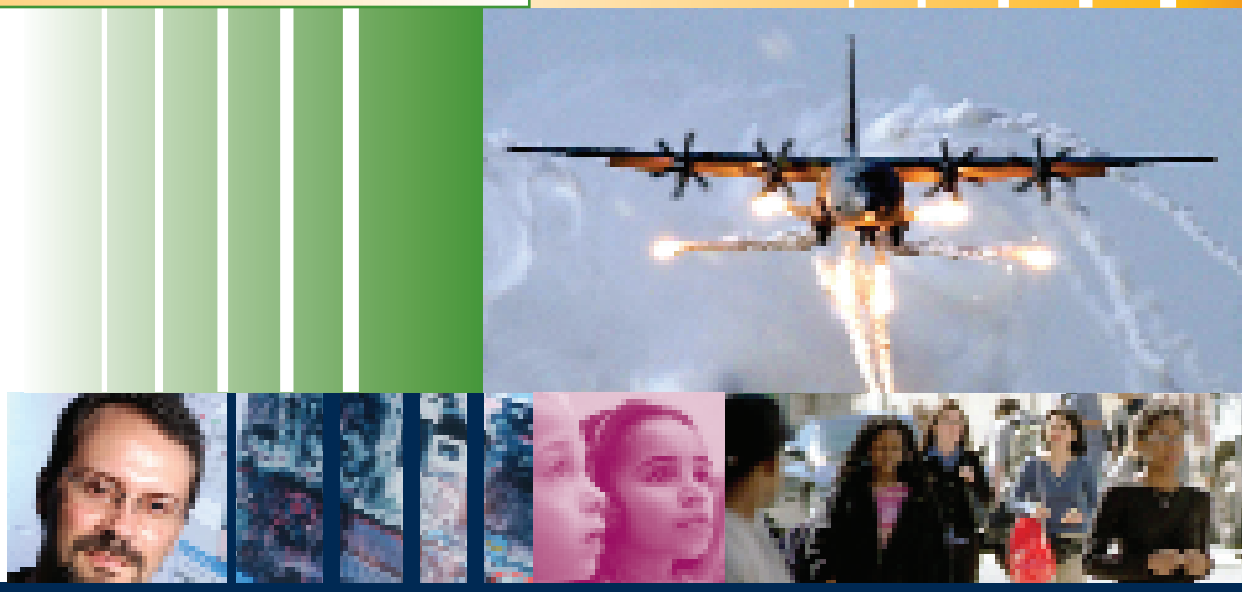
Innovation - We value, encourage, and support intellectual curiosity grounded in fundamental knowledge and a systems context. We foster an entrepreneurial culture that blends insight and invention with prudent risk-taking to create leading-edge solutions to important and challenging problems. We value partnering and teaming since working with others leads to new ideas, insights, and opportunities.

Excellence - We strive for excellence in everything that we do. While others benchmark against us, we are never satisfied. We continually seek ways to improve. We understand that our business and technical environments are dynamic. Hence, we constantly assess ourselves and learn and do what is necessary to master a situation, instead of just reacting to it. We learn from our mistakes and our successes, and use that knowledge to help ourselves, and GTRI, improve.

OUR PURPOSE

As an integral part of Georgia Tech, GTRI's conducting of world-class applied research and its delivery of industry-scale solutions are critical components of the model of the successful research university.

www.gtri.gatech.edu



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