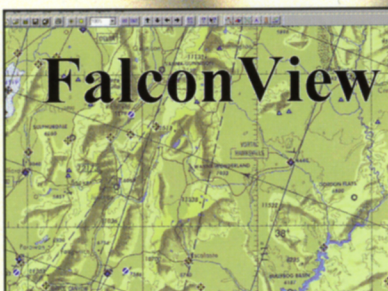


# 1997 Georgia Tech Annual Research Institute Report





pg. 3 .....	<u>The Year in Review</u>
pg. 5 .....	<u>Our People</u>
pg. 8 .....	<u>Service to Georgia</u>
pg. 10 .....	<u>Research for Industry</u>
pg. 12 .....	<u>Collaboration with Academic Researchers</u>
pg. 14 .....	<u>New Initiatives</u>
pg. 16 .....	<u>Internal Research</u>
pg. 18 .....	<u>Continuing Research</u>
	- Acoustics
	- Aerospace Sciences
	- Antennas and Electromagnetics
	- Communications
	- Electro-Optics/Infrared
	- Electronic Combat
	- Environment, Safety, and Health
	- Food Processing
	- Information Technology
	- Manufacturing and Materials
	- Modeling and Simulation
	- Radar
	- Test and Evaluation
	- Transportation
pg. 28 .....	<u>External Advisory Council</u>
pg. 30 .....	<u>Senior Staff Directory</u>

**ON THE COVER:** *The growing importance of information technology is the theme for the cover of this year's GTRI Annual Report. Shown, top to bottom, are: (1) the "Home of the Future" laboratory that simulates a residential environment for testing home-oriented technologies, (2) the Georgia Institute of Technology page on the World Wide Web, (3) news staff from Atlanta-based Cable News Network, (4) FalconView, a portable mission planning system developed for military pilots, and (5) the Georgia Courts Automation project, which will improve information flow to court officials.*



# 1997 Georgia Tech Research Institute Annual Report

## The Year in Review

The Georgia Tech Research Institute closed the books on another tremendous year in fiscal 1997, setting a new record for research awards—which exceeded \$100 million for the first time in our history. The researchers and staff of GTRI continued to perform cutting-edge research for our customers, paving the way for new and exciting opportunities. Other Georgia Tech units also set records for research awards during fiscal 1997, with academic college research units receiving \$94.2 million in new grants and contracts.

As I look back over this year, I am thankful to our many customers throughout U.S. government agencies, the state of Georgia, private industry, and elsewhere. They are the reason that we exist, and it is through them that we have been able to make the advances in science and technology that are vitally important to all of us.

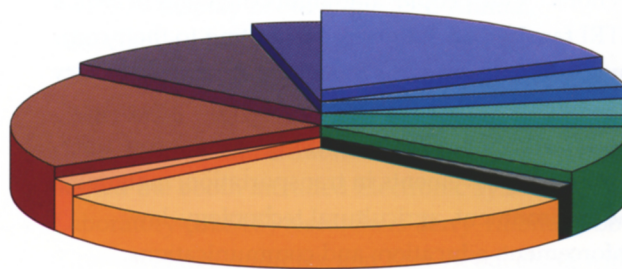
While research awards provide a highly visible and easily measured record of our success, they are just one component of it. Other significant milestones from the year include:

- GTRI held its first Industry Day to inform local companies about how our capabilities might help their business operations.
- With start-up funding from the Georgia Department of Transportation, we launched the Georgia Transportation Institute to conduct research, development, education, and technology transfer activities pertaining to all forms of transportation in Georgia.
- GTRI welcomed two new laboratory directors: George Harrison as head of the Electronic Systems Laboratory and Jeffrey Sitterle as head of the Systems Development Laboratory. We thanked their retiring predecessors, Bud Sears and Joe Parks, for their many years of dedicated service. In December 1997, George Harrison accepted the position of director of Research Operations.
- FalconView, a portable mission planning system developed by the Information Technology and Telecommunications Laboratory for the U.S. Air Force, was one of five finalists in the Sixth Annual Windows World Open Competition.

- With researchers from Georgia Tech colleges, we gained worldwide attention through the First International Conference on Emerging Technologies for Micro Air Vehicles. These vehicles, with a wing-spread of six inches or less, have a variety of exciting potential applications.

- We added two new members to the group of GTRI researchers holding the prestigious title of IEEE Fellow—Bob Trebits and Michael Tuley. Bob Zimmer was selected as the recipient of the Association of Old Crows' Pioneer Award for his sustained and prominent work in the field of electronic defense.

- GTRI researchers coordinated the team marketing efforts that resulted in a \$2 million AT&T grant to speed up the integration of technology into K-12 classrooms throughout Georgia. Led by the Morris Brown Research Institute, the Foundations for the Future program also involves researchers from the University of Georgia.



**GTRI 1997 Major Customers**  
(% of research expenditures)

- Air Force 28.3%
- Army 17.8%
- Industry, Fed. Subcontract 19.3%
- State of Georgia 10.3%
- Other Dept. of Defense 9.3%
- Federal Non-DoD 4.8%
- Industry Commercial 1.6%
- Navy 3.8%
- Other 3.7%
- NASA 1.1%



- GTRI continued to enhance the work of U.S. government agencies through Intergovernmental Personnel Act Assignments (IPA). Don Bodnar, currently on an IPA to the U.S. Air Force, was named chief scientist for the Sensors Directorate of the Air Force Research Laboratory. Joseph Eash, Arlington Research Laboratory, began an IPA in the U.S. Department of Defense as deputy under secretary for Advanced Technology.
- GTRI's External Advisory Council met twice during the year to review our business plans and make recommendations on how we should deal with the challenges ahead of us.
- GTRI hosted the Ninth Annual Electronic Protection Workshop, sponsored by the Electronic Combat Branch of Wright Laboratory.
- Researchers completed the H2Fuel bus and delivered it for long-term testing by the public transit authority in Augusta, Georgia. The electrically powered hybrid bus uses a hydrogen-fueled engine to recharge its electric batteries.
- Krishan Ahuja, Eric Barnhart, and Mark Richards were elected to serve as members of the GTRI Fellows Council, as we thanked Larry Corey and Bill Rhodes for their service on the Council.

This 1997 *GTRI Annual Report* includes two new sections. "Our People" highlights the ways in which GTRI faculty and staff are contributing to their communities and their professions through a wide variety of service activities. "Service to Georgia" describes the contributions GTRI is making to our home state through improvements in transportation, materials, the environment, agricultural technology, law enforcement, education, and communications.

I trust you will enjoy reading this report of our activities during fiscal 1997. As these pages present only the briefest of highlights, I urge you to contact me or members of the GTRI senior staff if you would like additional information on any work mentioned here. Our site on the World Wide Web, [www.gtri.gatech.edu/](http://www.gtri.gatech.edu/), also contains additional information that may be of interest.

During the last few months of fiscal 1997, I served as interim director of GTRI and vice president of Georgia Tech, following the departure of Admiral Richard Truly, who had served us as GTRI director since 1992. Working with him during this time gave me a strong respect for his leadership and appreciation for how he moved GTRI forward during his nearly

five years with us. Under Admiral Truly's leadership, we built strong foundations that will serve us well as we move into the next century. Best wishes from all of us went with him to his new assignment as director of the National Renewable Energy Laboratory in Golden, Colorado.

With appreciation for all those who have gone ahead of me in this office, I am thankful to Georgia Tech President Wayne Clough for the opportunity to lead GTRI as its new director and vice president. I will do my very best to be worthy of the trust he and many others have placed in me.

As we move rapidly toward the next century, I am confident that GTRI will continue to meet the needs of our customers with the very best in research and development. My thanks go to all members of our faculty and staff whose hard work made possible the accomplishments described in these pages.



A handwritten signature in black ink, appearing to read "E. Reedy".

**Edward K. Reedy**  
Vice President,  
Georgia Institute of Technology

Director,  
Georgia Tech Research Institute



## Our People

GTRI people are involved.

The Georgia Tech Research Institute's culture of commitment shows in its employees' daily lives—in the laboratory, in the field, and in the community.

**GTRI people go the extra mile:**

- James "Dani" Wilson, an office automation specialist with GTRI's Signatures Technology Laboratory, works with the homeless at Atlanta's Cosmopolitan AME Church. Continuing a tradition started by his late wife, Dani organizes a number of events yearly. His group served Christmas Day breakfast to 500 homeless people and 100



*James "Dani" Wilson*

- young people at the Fulton County Youth Detention Center, as well as a Thanksgiving Day meal. Quite a number of GTRI employees have helped Dani help others.
- A number of GTRI employees, led by Sharon Mattson, program specialist with Management and Project Support, created an entry for the Festival of Trees, which benefits Egleston Children's Hospital. The GTRI tree won third place and was quickly purchased by Julian Price, storekeeper with the Systems Development Laboratory (SDL).
- Suzzette Willingham, program coordinator with the Electro-Optics, Environment, and Materials Laboratory (EOEML), and Matthew Malok, a program coordinator/supervisor with EOEML, helped register participants for "Christmas in April," a program to help inner-city elderly and disabled homeowners with property renovations. Myrtle Turner, EOEML research scientist; Laverne Spearman of Supply Services; and Gloamy Lee Sang of Research Security were among those who volunteered for the "Christmas in April" labor force.

- Todd Deterding, research scientist in EOEML, helped organize his laboratory's donation of toys and clothing to the Atlanta Day Shelter for Women and Children. As a result of his work and the contributions of others in Atlanta, the shelter was able to assist more than 700 homeless women and children at Christmas.

**GTRI employees received many honors in fiscal 1997:**

- Bob Trebits, director of the Sensors and Electromagnetic Applications Laboratory (SEAL), was named a fellow of the Institute of Electrical and Electronics Engineers (IEEE), the organization's highest rank. He also serves as administrative vice president of the IEEE Aerospace and Electronic System Society, and is an IEEE Radar Panel member.
- Michael Tuley, a principal research engineer with STL, was also named an IEEE fellow recently. GTRI now has nine IEEE fellows among its researcher ranks.
- Chris Summers, a principal research scientist with EOEML, received a presidential citation from the Society for Information Display, recognizing his "outstanding leadership as Program Committee chair for the Second International Conference on the Science and Technology of Display Phosphors."
- GTRI's display booth at the 33rd Annual Association of Old Crows (AOC) International Electronic Warfare Technical Symposium and Convention was ranked tops among all exhibitors in the Small Booth Exhibitors Category. Those who staffed the booth included Electronic System Laboratory (ELSYS) researchers Terry Tibbitts, Bob Zimmer, Harry Andrews, and Kim Wood, along with Ron Smith and Ken Haynes from the Arlington Research Laboratory (ARL).



- Leigh McElvaney, a research scientist with EOEML, won the Award of Excellence from the Society for Technical Communication for the handbook *Understanding the Small Quantity Generator Hazardous Waste Rules*.



Leigh McElvaney

- GTRI's Communication and Training Technology Branch won distinguished technical communication and merit awards in the "Information/Reference" category from the Atlanta Chapter of the Society for Technical Communication. The awards were made for the branch's work on Web sites for the U.S. Environmental Protection Agency's Hazardous Substance Research Center Program.

- "GTRI Connected"—a World Wide Web site—kept GTRI and Georgia Tech informed of up-to-the-minute Olympics-related information during the heady, hectic 1996 Olympic summer. This Research Communications Team project won a Special Merit Award for Institutional Relations Projects in the CASE District III competition. Working on the project were Lea McLees, research associate; Rick Robinson, information specialist; Lisa Mullikin, graduate student intern; and Bob Baggerman, ELSYS research engineer.

- EOEML's Web site <[eoeml-www.gtri.gatech.edu](http://eoeml-www.gtri.gatech.edu)>, administered by Research Associate Dara O'Neil, won the Editor's Choice Award from *LookSmart*, a *Reader's Digest* subsidiary. The award is given to "useful, high-quality Web sites."

GTRI is deeply involved in professional service activities:

- Ron Smith, a senior research scientist in the Arlington Research Laboratory (ARL), has been serving on the White House Commission on Aviation Safety and Security. Ron was selected for his expertise in widebody aircraft and aircraft self-protection measures. Vice President Al Gore sent him a letter of thanks, on behalf of the president, for valuable service that made a significant contribution to the success of the commission.

- Robert Michelson, principal research engineer with the Aerospace and Transportation Laboratory (AERO), is on the non-profit Board of Trustees for the Association of Unmanned Vehicle Systems International. Rob was on hand at Dobbins Air Force Base in Marietta, Georgia, at the dedication ceremony for "Sweet Eloise," one of only 12 restored World War II B-29 Superfortresses.



Robert Michelson

- Jim Cofer, a principal research engineer who leads GTRI's Business Development Office (BDO), is a member of the Board of Directors of the International Test & Evaluation Association, where he chairs the Educational Committee and coordinates numerous short courses.

- Jim Coleman, a senior research scientist with the Information Technology and Telecommunications Laboratory (ITTL), is serving as Georgia regional vice president for Armed Forces Communications and Electronics Association International (AFCEA), an information technology professional association. He is also a member of AFCEA's General Council.

- Tom Horton, a senior research associate with the BDO, has served for several years as an associate director of AFCEA International. He has also been appointed to the Membership Committee, and he serves on the board of his local AFCEA chapter.

- John Nemeth, a principal research engineer with EOEML, serves as national coordinator for the Technical Outreach Services for Communities Program of the five U.S. EPA Hazardous Substance Research Centers. He also serves on the Board of Trustees of the Academy of Board Certified Environmental Professionals, and is a member of that group's Certification Review Board.



- Jennie Lincoln, special assistant for international projects in BDO, served as working group facilitator at the Western

Hemisphere Strategy Symposium, sponsored by the U.S. Southern Command in Miami. She also participated in an event co-hosted by former presidents Jimmy Carter and Gerald Ford: the Carter Center Conference on "Latin America in the 21st Century."



*Jennie Lincoln*

- Dan Parker, a senior research associate with Huntsville Research Operations (HRO), was invited to be an advisory group member of the Army Science Board's Logistics and Sustainability Panel, helping to determine processes and procedures for enhancing the Army's logistics function.
- At the invitation of NASA's High-Speed Civil Transport Nozzle Design Team, Krishan Ahuja, a regents researcher in AERO, joined a 10-person peer review committee to provide future directions for the program.
- Bud Sears, principal research engineer in the Electronic Systems Laboratory, contributed to the work of a Defense Science Board task force that has been focusing on the potential synergy between low observables and electronic warfare technologies to improve aircraft survivability.

#### **GTRI serves customers directly:**

- GTRI works directly with customers through Intergovernmental Personnel Act Assignments (IPAs). This program lets scientists and engineers support federal agencies while retaining faculty status. Fourteen GTRI personnel served as IPAs this year, including:

— EOEML's Donald Wilmot, who serves as acting chief for the Army Research Laboratory's Electro-Optics and Photonics Division.

— Don Bodnar of GTRI's Sensors and Electromagnetic Applications Laboratory (SEAL), who serves as chief scientist for the Sensors Directorate of the Air Force Research Laboratory.

— ARL's Joseph Eash, who works with the Department of Defense as deputy under secretary of Defense for Advanced Technology, and ARL's Eric Sundberg, who is working with the National Reconnaissance Office.



*Don Bodnar*

**GTRI has placed IPAs with a number of agencies, including:**

- Wright Patterson Air Force Base: Don Bodnar and Patricia Ryan
- The National Center for Atmospheric Research: Fred Eisele
- Phillips Laboratory: Thomas Davis
- The Army Research Laboratory (Atlanta): Vernessia Callahan
- Rome Laboratory: Joe Bruder, John Cotton, and Robert McMillan
- The Army Research Laboratory (Washington): Harold Breaux, Dana Ulery, and Don Wilmot
- The Department of Defense: Joseph Eash
- The National Reconnaissance Office: Eric Sundberg
- The Office of Naval Research: Ben Riley



## Service to Georgia

The Georgia General Assembly chartered GTRI in 1919 as the Engineering Experiment Station. Applying research capabilities to Georgia's development needs was to be the station's primary purpose. Today, the organization provides expertise across Georgia in a variety of technological areas, from helping manufacturers meet environmental regulations and develop new products to automating court records and expanding the use of technology in K-12 schools.

### **Transportation:**

GTRI is helping develop an Intelligent Transportation Systems (ITS) Strategic Deployment Plan that will organize the application of ITS technology to Georgia's transportation system. Researchers also completed guidelines for designing enhanced computer graphics displays and incorporating automated systems to help Advanced Traffic Management System operators perform their jobs.

In cooperation with the Georgia Department of Transportation, GTRI is helping develop a capability to allow trucks enrolled in Advantage-I-75 to bypass weigh stations just like trucks that do not require permits because they meet standard weights and sizes. In south Georgia, design and construction drawings for a fully automated fog detection and warning system on Interstate 75 were completed.



Developed jointly with the Georgia Department of Transportation, the system will notify authorities of visibility problems and post messages for motorists.

Operation Heli-STAR, a study conducted by GTRI with government and private industry partners during the 1996 Olympic Games, demonstrated the viability of using helicopters tracked via the Global Positioning System for urban transportation. Cargo volume and cost data gathered will help with economic decision making on future systems.

With start-up funding from the Georgia Department of Transportation, GTRI led efforts to establish the Georgia Transportation Institute to conduct multidisciplinary research, development, education, and technology transfer.

### **Materials:**

A new generation of coatings with essentially no volatile organic content is in development for a major Georgia-based company and the U.S. Air Force Corrosion Office in Warner Robins, Georgia.

### **Environment and Industry:**

Persons who handle hazardous materials or deal with spills in Georgia and the Southeast receive OSHA-defined Hazmat Technician training at GTRI-taught courses. Approximately 75 to 100 Georgians are trained each year, making the state a safer place to live and work.

GTRI researchers are part of a statewide experts network that helps food processing plants adopt techniques for conserving water, address oil and grease issues, and control pH in wastewater discharge. They also are analyzing data on ammonia release from refrigeration systems for risk management plans that food processors submit to state regulators. Finishing touches are in progress on a pilot test unit that evaluates dissolved air flotation (DAF) wastewater treatment technologies, process control, and available add-on hardware for Georgia food processors.

Technical Outreach Services for Communities (TOSC), a part of the U.S. Environmental Protection Agency's Hazardous Substance Research Center Program, helps communities across 13 states that are faced with hazardous-substance contamination problems participate in environmental decisions affecting them.

*Persons who handle hazardous materials or deal with spills in Georgia receive OSHA-defined training through GTRI.*





*GTRI researchers have developed the Intelligent Integrated Belt Manipulator to help move food packages on the factory floor.*

Georgia businesses benefit from environmental technical assistance provided by the Waste Reduction and Environmental Compliance (WREC) program. During FY 97, WREC staff helped more than 1,400 Georgia industry professionals and their companies meet regulatory requirements, improve processes, and develop environmental management systems to reduce their environmental liabilities and improve their economic competitiveness. WREC also collaborated with strategic partners, including the U.S. Environmental Protection Agency, the Georgia Environmental Protection Division, the Georgia Environmental Partnership, and Georgia trade associations to constructively help companies with their environmental issues.

#### **Law Enforcement:**

The Georgia courts system will benefit from a real-time, on-line, integrated, and secure management information system designed by GTRI. This year, researchers created a prototype for the system, which initially will serve state, superior, and juvenile courts, as well as the Administrative Office of the Courts.

#### **Education:**

Technology use in Georgia's K-12 classrooms will be maximized via the Foundations for the Future Program. GTRI, Morris Brown Research Institute, the University of Georgia, and an industry liaison

will provide tailored training, training support, and technical assistance to ensure that participating schools adopt the most suitable technologies.

A CD-ROM-based, interactive nutrition and menu management tool GTRI developed for the Georgia Department of Education will be distributed to food managers in Georgia public school nutrition programs to supplement traditional classroom continuing education.

#### **Communications:**

GTRI researchers have established a new facility in the Georgia Center for Advanced Telecommunications Technology (GCATT) for studying high-speed cable modems. With Georgia-based Hayes Microcomputer Products, GTRI is testing Hayes' cable modem performance. Researchers also plan to test a new device, a "telemouse," with University of Georgia colleagues. The device would allow parents of Athens, Georgia, middle school students to see their children's work on the World Wide Web using only their home televisions on cable and their telephones.



*Researchers are studying cable modem technology as part of work being conducted at the Georgia Center for Advanced Telecommunications Technology (GCATT).*



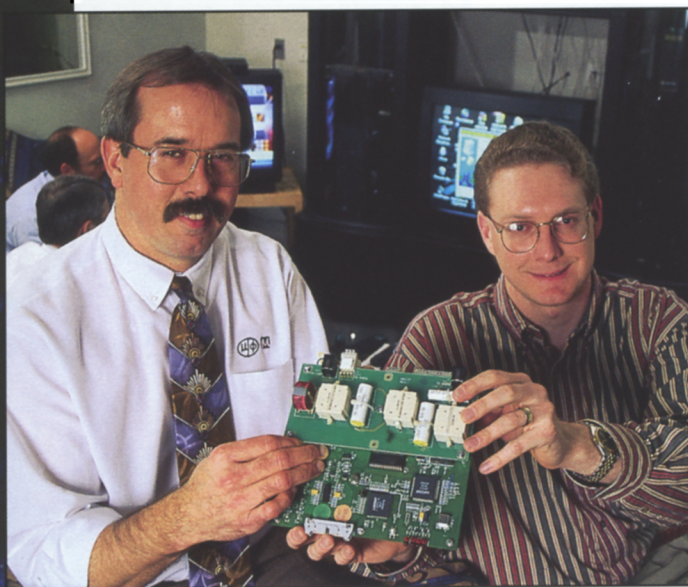
## Research for Industry

During fiscal 1997, a team of GTRI telecommunications engineers worked closely with researchers from Connecticut-based mPhase Technologies Inc. on the development of a new technique for delivering high-quality digital video over standard telephone lines. The unique all-in-one system allows digital video, digital data, and voice signals to be sent simultaneously.

The mPhase product uses advanced Digital Subscriber Line technology to provide broadcast quality MPEG2 digital video to home televisions via twisted-pair phone lines. Plans call for initial testing by mid-1998.

The work is part of GTRI research under way in the Broadband Telecommunications Center and the Network Applications Integration Laboratory. Both research units are located at the Georgia Center for Advanced Telecommunications Technology (GCATT), a research center supported by the Georgia Research Alliance.

The mPhase project demonstrates the benefits of strategic partnerships being developed between GTRI and private industry. Through a simplified basic ordering agreement (BOA) put into place during fiscal 1997, companies can more easily take advantage of GTRI's expertise in many areas of science and technology. Development of this BOA streamlines contractual arrangements, allowing companies to work with GTRI research staff on time-sensitive tasks.



Combined with a proven ability to meet deadlines and complete complex research projects under strict budgetary controls, the streamlined contractual system makes GTRI an attractive partner for industrial companies developing new products or technical areas. GTRI researchers can provide direct support to companies in activities such as new product development, product enhancement, process improvement, process cost reduction, and independent evaluation.

Over the past five years, GTRI has worked with more than 350 companies and research consortia. GTRI's success in meeting industrial needs has contributed to the Georgia Institute of Technology's consistent ranking among the top 10 U.S. colleges and universities in the amount of industry-sponsored research performed. Of particular note are long-standing programs in these GTRI-based research centers:

- At the Phosphor Technology Center of Excellence, researchers work with multiple company partners in a team that includes the American Display Consortium, the David Sarnoff Research Center, the U.S. Defense Advanced Research Projects Agency, and four other universities. The goal is to develop new enabling technologies for the high-definition display industry.
- Makers of implantable electronic devices such as pacemakers and defibrillators share information developed at the Electronic Article Surveillance Medical Device E3 Test Center. The Center studies the potential interactions between these medical devices and electromagnetic energy from inventory control and tracking systems installed in many retail stores.
- Companies needing materials characterization expertise have relied on GTRI's Materials Analysis Center for nearly 50 years. Research staff at this center use their experience in electron microscopy, surface analysis, metallurgy, failure analysis, X-ray analysis, optical microscopy, diffraction, thermal analysis, and many other areas to provide companies with testing research services necessary for new product development.

*A team of GTRI engineers worked closely with researchers from mPhase Technologies on a new technique for delivering high-quality digital video over standard phone lines.*





*To highlight its expanded programs of direct industry assistance, GTRI held its first Industry Day. The event attracted representatives from 28 organizations.*

- A public-private partnership of university, government, and industrial participants is applying new technology to the food processing industry through FoodPAC. The research is aimed at improving product quality and boosting the efficiency of the industry.

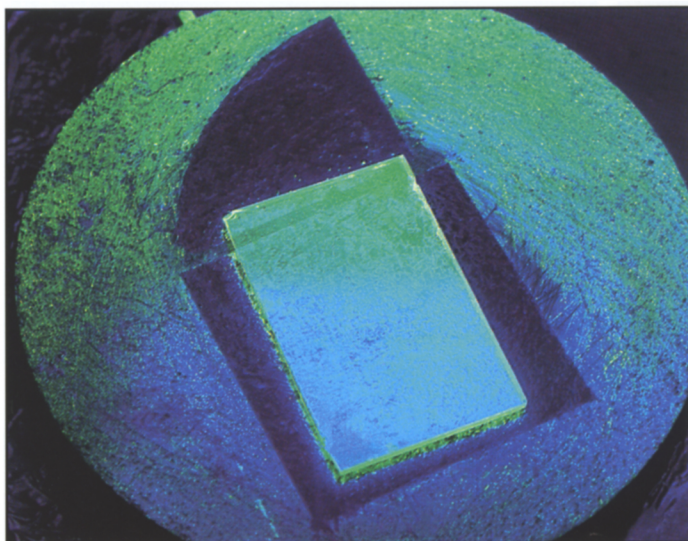
For more than a half-century, GTRI has conducted cutting-edge research in broad areas of science and technology, building a solid foundation of research expertise. Researchers have identified many areas of GTRI experience relevant to industrial companies, including:

- Acoustics
- Aerospace Sciences and Technology
- Communications and Information Technology
- Electromagnetic Environmental Effects
- Food Processing Technologies
- Human Factors
- Infrared and Electro-Optics
- Law Enforcement, Corrections, and Judicial Technologies
- Learning Technologies
- Manufacturing Technologies
- Materials Sciences
- Microelectronics and Applications
- Modeling and Simulation

- Occupational Health and Safety
- Optoelectronics and Photonics
- Radar and Electronic Systems
- Secure Information Systems
- Test and Evaluation
- Transportation Technologies

To highlight its expanded programs of direct industry assistance, GTRI held its first Industry Day in June 1997. Some 40 representatives from 28 organizations attended the event, which included demonstrations of GTRI capabilities in prototype development, acoustics, transportation, industrial sensors and environmental engineering, telecommunications, information systems, manufacturing, and materials.

GTRI's strategic plan calls for expanding its direct research support for industrial companies as they develop the products and technologies necessary to be successful in the 21st century.



*At the Phosphor Technology Center of Excellence, researchers are developing new materials for the display industry.*



## Collaboration with Academic Researchers

GTRI draws on many resources to maintain its status as a top research organization, including ongoing collaborations with researchers in Georgia Institute of Technology academic colleges. Beyond their talented faculty and researchers, Georgia Tech's academic colleges also offer the enthusiasm and fresh ideas of their students—the next generation of engineers. Students, in turn, gain valuable, hands-on experience in their own fields of study, and in related fields that help broaden their scientific base of knowledge.

Each year, these partnerships result in projects that push the boundaries of technology. One example is Georgia Tech's 1997 hosting of the First International Conference on Emerging Technologies for Micro Air Vehicles—tiny, unmanned aerial vehicles small enough to fit in a human hand, yet sophisticated enough to search damaged buildings for survivors or detect toxic chemicals on a battlefield.

To make micro air vehicles a reality, researchers across several disciplines are developing innovative technologies to address challenges in aerodynamics, flight control, power sources, and communications.

In GTRI's Aerospace and Transportation Laboratory (AERO), researchers have collaborated with the College of Engineering on internationally recognized aeroacoustics research and aviation infrastructure projects with the Federal Aviation Administration.

Projects designed to improve product manufacturability and missile flight control are conducted for both commercial and military sponsors by researchers in GTRI's Electronic Systems Laboratory (ELSYS) and Information Technology and Telecommunications Laboratory (ITTL), as well as Georgia Tech's School of Mechanical Engineering (ME) and Manufacturing Research Center (MARC).

The Georgia Center for Advanced Telecommunications Technology (GCATT) has encouraged collaboration between researchers in ITTL, the College of Computing, and the School of Electrical and Computer Engineering (ECE). In addition to work done in the Broadband Telecommunications Center, other projects include development of test satellites for



*In a collaborative project with three other organizations, GTRI researchers conducted acoustics experiments in China's Yellow Sea during FY 1997.*

NASA's Advanced Communications Technology Satellite program and new low-profile antennas for the U.S. Army.

Acoustics research is conducted by the School of Mechanical Engineering, School of Electrical and Computer Engineering, and the Undersea Research Program Office of GTRI's Sensors and Electromagnetic Applications Laboratory (SEAL). Work includes development of new ways to measure properties of viscoelastic materials and detect land mines. With colleagues from the People's Republic of China, researchers also measured acoustic propagation, reverberation, and the effects of internal wave solitons in the Yellow Sea.

Through the Phosphor Technology Center of Excellence, GTRI's Electro-Optics, Environment, and Materials Laboratory (EOEML) coordinates projects with several academic schools to develop new processes for phosphor deposition in electroluminescent, flat-panel, and field-emission displays.

Other EOEML projects include the Agricultural Technology Research Program, where researchers are working with several colleges to develop robotic



and sensor systems for the food processing industry, and the interdisciplinary Georgia Tech Center for Geographic Information Systems, which conducts research and develops software in numerous areas, including city planning, earth and atmospheric sciences, and economic development.

In the area of electromagnetics and antennas, Signatures Technology Laboratory (STL) and ECE researchers are modeling new electromagnetic materials, structures, and components and investigating techniques to measure the surface currents on objects illuminated by electromagnetic fields.

Other collaborative STL projects include exploring ways to improve target detection by using sophisticated radar signal processing algorithms and finding novel ways to measure the infrared signatures of materials and scale models.

GTRI's collaboration with Georgia Tech academic colleges offers more than research benefits. More than 250 students participated in GTRI activities, providing hands-on research experience that complements their academic course work. During fiscal 1997, GTRI's staff included 112 undergraduates from Georgia Tech's Cooperative Program, 76 undergraduate student assistants, 2 Graduate Co-op students, 16 Shackelford Fellows, and 45 other graduate research assistants.

*GTRI's scanning measurement system determines the electromagnetic signature of objects.*





## New Initiatives

### **Logistics:**

GTRI is developing a new initiative that coordinates research activities within Georgia Tech to provide a multidisciplinary research approach to solving logistics-based problems.

During this initiative's first year, GTRI provided logistics re-engineering, research, and development support to U.S. Army and U.S. Air Force organizations at various major commands. In keeping with the objective of a multidisciplinary approach, these efforts included GTRI laboratories and Georgia Tech academic units.

Government and industry requirements in logistics operations include:

- Conducting research and analysis of current logistics operations for the development of metrics and logistics control;
- Developing innovative approaches to logistics problem-solving using a multidisciplinary approach of technology insertion and business management; and
- Designing distribution networks and decision support tools to determine the effectiveness of logistics support structures and facilitate management of support systems.

### **Learning Technologies:**

The Learning Technologies Initiative, now in its fifth year, brings multidisciplinary research to bear on instructional technology, software engineering, computer graphics/visualization, interface design, and electronic performance-support systems. During the past fiscal year, GTRI researchers have:

- Established Foundations for the Future, a collaboration of higher education institutes and industry representatives with the support of key agencies and educators. The collaboration is using telecommunications technology investments and learning/training expertise to improve K-12 educational practices in Georgia.
- Worked with Georgia State University in developing a World Wide Web-based collaborative learning tool on environmental issues for grades 3 through 5.
- Continued development of a voice-activated, wireless, "wearable" computer that allows workers on the factory floor to view data in special-purpose safety glasses while maintaining an unimpeded view of the task and full use of their hands.



*A voice-activated, wireless, "wearable" computer provides factory workers convenient access to information.*

- Worked with other Georgia Tech units, the University of Georgia, Georgia State University, and industrial partners to develop multimedia courseware and Internet applications to strengthen education in multiple disciplines.

### **Secure Information Systems and Internet Security:**

Interest in Internet security has intensified in recent years because of the increased accessibility of the Internet to the public, the emergence of electronic commerce, and the global nature of the medium. Vulnerability issues have been recognized recently as the Internet assumes a key role in critical national telecommunications, banking and finance, transportation, power distribution, and emergency services infrastructures.

As an active participant in addressing these issues for both government and business, GTRI has:

- Worked as a member of the Defense Intelligence Agency's (DIA) Joint Information Warfare Threat Analysis Working Group, helping U.S. intelligence agencies, the FBI, and the Departments of Energy and Commerce in assessing the global threats to the Internet.
- Conducted projects developing advanced capabilities in network intrusion detection and performing security assessments of electronic commerce products.



- Participated with the Council on Competitiveness and the President's Commission on Critical Infrastructure Protection.
- Worked with the FBI's Infrastructure Protection Task Force and an associated industry consortium, the Manhattan Cyber Project, to provide education and training on Internet security.

#### Modeling and Simulation:

GTRI's internal research in modeling and simulation fosters the interoperability of distributed simulations for defense and other applications. Current efforts include:

- Developing test procedures and automated test tools for evaluating defense simulations for compliance with the Defense Modeling and Simulation Office's High-Level Architecture.
- Supporting testing of distributed defense simulations, including application and integration testing as well as functional and scenario testing.
- Assisting GTRI and Department of Defense simulations in identifying issues and approaches to achieve compliance with the High-Level Architecture.

#### Law Enforcement, Corrections, and Judicial Technologies:

GTRI's Law Enforcement, Corrections, and Judicial Technologies Initiative continues to grow and develop new technology areas as it enters its third year. Major work areas include:

- Judicial Technologies:
  - A GTRI team is developing a database for the Georgia courts system, working with juvenile and superior courts on creation, interface, and networking issues.
  - GTRI has performed information technology work for the Prosecuting Attorney's Council and an automation requirements analysis for all Georgia superior court judges.
- Law Enforcement Technologies:
  - GTRI is a research and development associate of the Southeast Regional Law Enforcement and Corrections Technology Center in Charleston, South Carolina, one of five regional centers in the National Institute of Justice network.

- A GTRI computer sciences team is supporting the Burruss Institute at Kennesaw State University as it works with Greater Atlanta Project PACT to develop the Georgia Data Center, a regional information-sharing system for metro Atlanta police departments.
- GTRI researchers are applying neural net technology to crime pattern and forensic analysis.
- Photonic sensor technologies based on Georgia Tech research are being developed to detect minute amounts of drugs, explosive materials, and chemical agents. These efforts are receiving support from the Office of National Drug Control Policy, the National Institute of Justice, and the Department of Defense.
- Researchers are applying radar and RF-based sensor technology that has strong potential for law enforcement due to its ability to remotely detect and monitor concealed humans.
- Corrections Technologies:
  - Many technologies important to judicial and law enforcement personnel can also assist corrections officers. GTRI is studying the use of sensor technologies in this field and pursuing other relevant research and development initiatives.



*Judges and other court officers will have better access to records thanks to a GTRI-developed database system.*

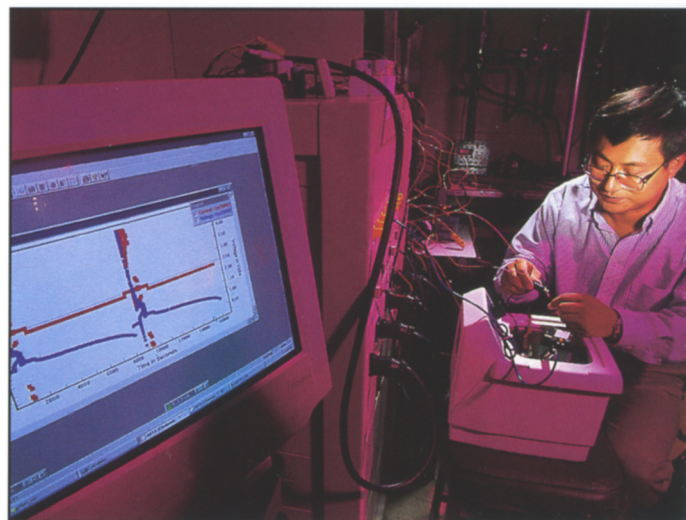


## Internal Research

The Fellows Council oversees the GTRI Internal Research Program. Composed of staff chosen from among the organization's most senior and distinguished research faculty, the Fellows Council reviews internal research and development proposals and makes recommendations to GTRI's director. The council also reviews the progress of selected projects through to their completion, assists in technology forecasting and assessment, and works toward campus research collaboration goals.

Each year projects are selected for their technical strength, applicability to the GTRI strategic plan and research thrusts, and potential return on investment to GTRI. In fiscal 1997, GTRI supported four internal research and development projects:

- Multiple Target Tracking Enhancement for Ballistic Missile Defense: a project to develop and validate a fragmentation model, generate simulated ballistic trajectories, and produce a ballistic target model in a well established MATLAB-language tracking benchmark program. This effort formulated multiple-target tracking performance measures applicable to the closely spaced object (CSO) tracking problems encountered in ballistic missile defense.
- High-Level Architecture Simulation Interface: a project to demonstrate a federate-to-run-time infrastructure (RTI) interface capability and produce needed performance data on the RTI, which will provide GTRI customers with an advanced conceptual foundation for transitioning to high-level architecture.
- Space-Time Adaptive Nulling of Complex Signals: a project to investigate space-time adaptive processing capability to reject terrain-scattered interference generated from multiple interference sources.
- Application of Ultrasonic Field to Improve Battery Charging Efficiency: a project to increase battery charging efficiency and reduce charging time through the use of ultrasonic fields to reduce electrode polarization while charging.



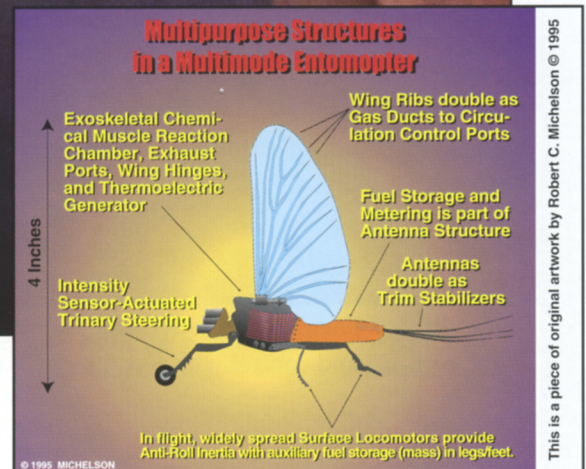
*GTRI researchers are using ultrasonic fields to increase battery charging efficiency and reduce charging time. The work could be important to the future of electric vehicles.*

During fiscal 1998, GTRI supported these internal research and development projects:

- Demonstration of Basic Locomotion in a Robotic Insect and the Development of Autonomous Navigation Scheme
- Design and Development of a Neural-Based Approach to Computer Intrusion Detection
- High-Level Architecture Simulation Interface, Phase II
- Combined Tracking and Weather Phased Array Radar
- Optical Signal Modulation Using Novel Physio-Chemical Properties

*As part of its research program in micro air vehicles, GTRI researchers are developing the "entomopter," a robotic insect that uses a reciprocating chemical muscle for flight and ground locomotion. During FY 97, a prototype with flapping wings was developed (top-right), while additional work continued toward the full system (inset).*





This is a piece of original artwork by Robert C. Michelson © 1995



## Continuing Research

Over the past four decades, GTRI has developed national and international standing in many areas of science and technology. Developments in these long-term areas of research are described below.

### **Acoustics:**

GTRI's Undersea Research Program Office is developing new acoustic transducers and submarine sonar systems for the U.S. Navy, as well as innovative, in-situ techniques to measure the dynamic properties of viscoelastic materials.

Also in fiscal 1997, researchers measured propagation, reverberation, and the acoustic effects of internal wave solitons in the Yellow Sea, through a joint project with researchers from the University of Washington and the National Academy of Sciences from the People's Republic of China.

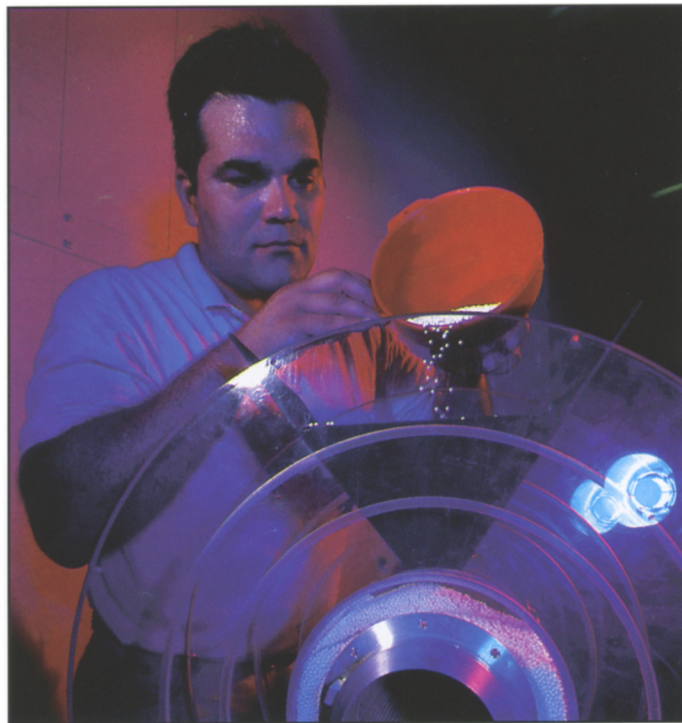
In the area of aeroacoustics, researchers are conducting studies designed to measure and control aircraft cavity noise, control jet noise by manipulating nozzle-exit velocity profiles, and model air-cooled and water-cooled engine test cells to improve performance.

As part of Operation Heli-STAR, GTRI researchers gathered extensive acoustic data from around two heliports before and during the 1996 Olympic Games, and surveyed local residents for their reaction to the increased helicopter activity.

Researchers also have patented a new acoustic liner material that can withstand temperatures of more than 2,000 degrees Fahrenheit, while absorbing noise at both low and high frequencies. Made with tiny hollow spheres, the new material could be poured easily into the walls of buildings or the bodies of hair dryers, automobiles, or aircraft.

### **Aerospace Sciences:**

GTRI continues to advance research on tiny, self-piloted micro air vehicles that could fly to targets and send back information. Innovative propulsion technologies include a flapping-wing design that uses a reciprocating chemical muscle for actuation. For flight control, researchers are studying electrically actuated piezoelectric structures that differentially alter lift, and pneumatic aerodynamic technology that gives lift and control with few moving surfaces.



*A new acoustic liner material under development at GTRI uses tiny hollow spheres that can be poured into hollow spaces.*

Researchers also are developing an aerial robot for traffic surveillance, with support from the Georgia Department of Transportation and the Federal Highway Administration's Priority Technology Program. This surveillance drone will relay live video and two-way audio from the sites of roadway incidents to an Advanced Traffic Information System (ATIS).

Through Operation Heli-STAR (Helicopter Short-Haul Transportation and Aviation Research), GTRI helped showcase vertical flight as a viable alternative to ground transportation in crowded urban areas. Analysis of data gathered during the 1996 Olympic Games showed that communications, navigation, and surveillance equipment based on the Global Positioning System could reliably track helicopters operating in large metropolitan areas.

Researchers continue to incorporate technology enhancements into the helicopter Structural Integrity Computer Program (SICP) of the U.S. Air Force's Warner Robins Air Logistics Center. This program uses both safe-life and fail-safe approaches to force management, including damage tolerance analysis of some critical MH-53J structural components and safe-life analysis of all MH-53J dynamic components.



Researchers also are involved in helicopter Health and Usage Monitoring Systems (HUMS), including conducting an actual mission usage spectrum survey using six HH-60Gs, two each from three different U.S. Air Force bases. Survey data will provide an actual usage spectrum for resubstantiation of dynamic component retirement times.

#### Antennas and Electromagnetics:

GTRI researchers developed a new method of modeling the electromagnetic properties of periodic structures using finite-difference time-domain techniques. The method results in significant time savings when computing electromagnetic properties over a wide range of frequencies. In addition, a patent was issued this year on a new type of dielectric antenna based on photonic bandgap materials.

Investigations are in progress to determine currents on a body illuminated by an electromagnetic field. This work will help researchers control the electromagnetic behavior of an object. A new technique has been developed for determining radar cross section from a series of localized scattering measurements; a prototype to demonstrate the concept was built.

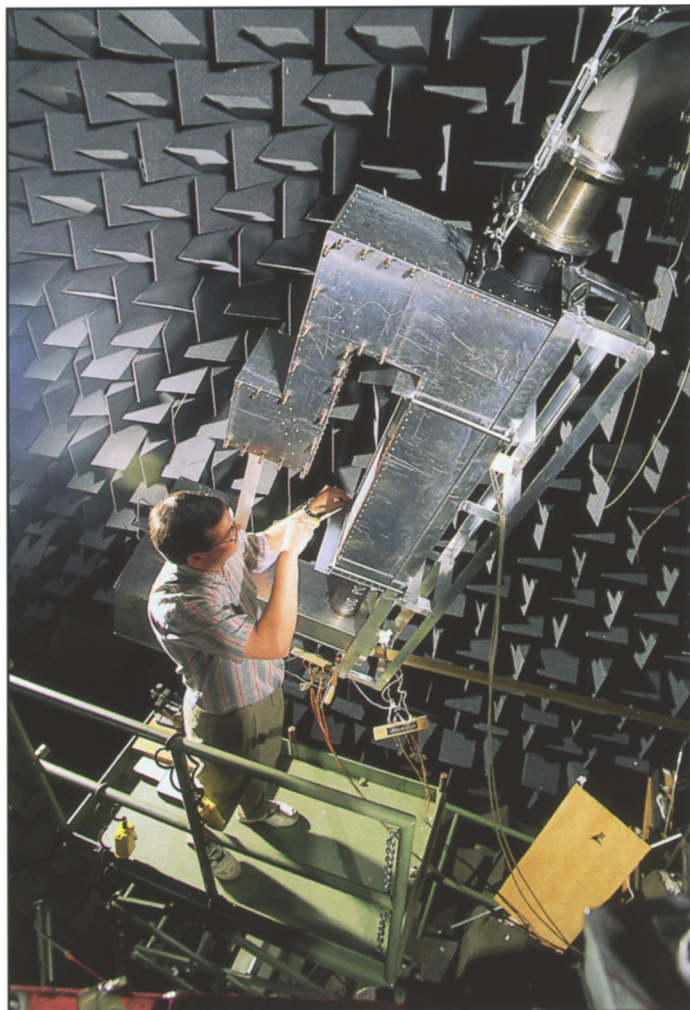
During fiscal 1997, researchers also developed a novel design for a phased-array radar of 10,000 square wavelengths that radiates two kilowatts at X-band and scans in two dimensions. The radar tracks more than 30 targets, weighs less than 1,500 pounds, and consumes less than 15 kilowatts of prime power. Two novel aspects of the design that reduce power consumption are a shifter resolution of only two bits and grating lobes allowed in the elevation principal plane.

GTRI has designed, developed, proved the concept validity of, and fabricated an antenna embedded in composites that could be used as a structural part of a ship's topside. The array that was built includes approximately 100 elements and operates at X-band. The work is important because radar system antennas are one of the major contributors to the radio frequency signatures of ships.

#### Communications:

GTRI researchers are helping advance communications technology through several projects, including a unique communications waveform that can adapt to the radio frequency environment. This new technology could reduce production costs; advance avionics data and voice communications through the use of high-speed, digital signal processing devices and algorithms; and offer substantially improved immunity to detection and jamming.

Researchers also are developing an innovative network transport technology designed to make the transfer of data more reliable, secure, and manageable. Called spread routing, it blends aspects of networking technology with state-of-the-art spread spectrum technology used in wireless communications, particularly by the military.

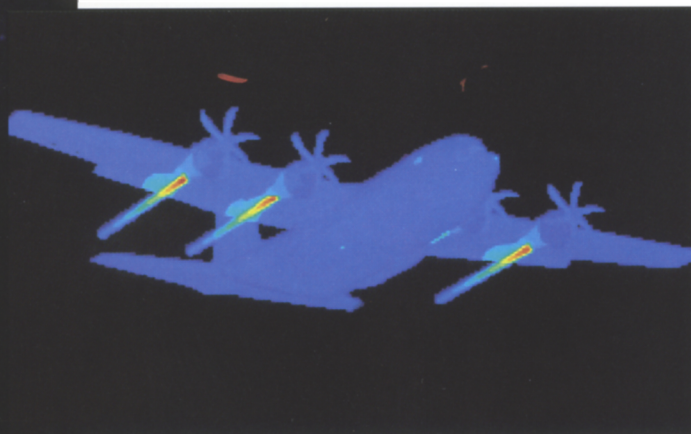


*Acoustics researchers are modeling air-cooled flow and acoustic engine test cells to find ways of improving their performance.*



GTRI is helping prepare today's children for tomorrow's technologies through the Foundations for the Future program. This higher-education, government, and industry collaboration will coordinate and improve educational technology in K-12 classrooms through a professional training facility, model classroom, learning technology testbed, and technology transfer center.

Researchers also are widening the field of advanced high-speed, digital data service through a project designed to use emerging Digital Subscriber Line (DSL) technology to bring broadcast-quality digital video to home televisions via telephone lines. This new system would allow telephone companies to compete with cable and broadcast satellite companies in this rapidly developing field.



*GTRI researchers are developing a computer model of the C-130J for the GTSIMS flight simulation and missile engagement environment.*

#### **Electro-Optics/Infrared:**

Building on its extensive experience in infrared and electro-optics, GTRI supported development of the Advanced Threat Infrared CounterMeasure/ Common Missile Warning Sensor/ Advanced Infrared Countermeasure Munition protection suite. Researchers worked with the systems' prime contractor—Sanders, a Lockheed Company—to provide a comprehensive software environment in which digital models of the system hardware, also developed by GTRI, could be realistically exercised. The task involves development of digital models for the suite of countermeasures, as well as upgrades to a software environment known as the Georgia Tech Simulations Integrated Modeling System (GTSIMS).

During fiscal 1997, researchers also assisted the Air Force Operational Test and Evaluation Command (AFOTEC) in developing a computer model of the C-130J aircraft for its GTSIMS flight simulation and missile engagement environment. GTSIMS is a series of electronic combat analysis tools that provides a complete digital simulation environment for testing the performance of missiles equipped with infrared and electro-optic sensors against targets such as ground vehicles, helicopters, ships, or fixed-wing aircraft in the presence of background clutter, active countermeasures, and evasive maneuvers. The model will provide information used to protect the C-130J, the newest model of this widely used transport aircraft.

GTRI researchers also continued development of a non-Doppler optical sensor used to make accurate measurements of crosswind speeds over long distances. The single-ended, long-path laser wind sensor could be used for monitoring pollution and measuring wind speeds at airports.

#### **Electronic Combat:**

During fiscal 1997, GTRI researchers collected and characterized data on specific sources of false alarms in the AAR-47 Missile Warning System. Going beyond signature measurements, the program gathered video in the ultraviolet and visible bands to provide a more detailed picture of false alarm sources and their environments. The information will become part of a database to assist development of algorithms for other missile warning systems.

To improve efficiency and response time while reducing crew workload and mission preparation time, engineers developed the Electronic Warfare Bus and Consolidated Display System for U.S. Air Force Special Operations Command C-130 aircraft. The system networks radar warning, missile warning, and electronic countermeasure equipment, providing the aircraft's electronic warfare officer with an integrated display that includes information about threats and the status of key systems.

Thanks to a serial interface unit and software developed by GTRI engineers, technicians on the flight line can use laptop computers to reprogram, verify, and generate reports on the B-1 aircraft's





*A serial interface unit developed by GTRI allows technicians to reprogram the ALQ-161 system on the flight line using laptop computers.*

ALQ-161 electronic warfare system. Commercial off-the-shelf parts make up 80 percent of the interface unit, reducing costs. The project was sponsored by the Warner Robins Air Logistics Center.

GTRI continued its long-term support for the U.S. Air Force's ALR-69 radar warning receiver with a program to improve detection sensitivity through use of GTRI-developed hybrid components. Engineers also continued programs to replace cathode ray tubes with flat-panel displays, and to develop combat software that will allow use of the ALR-69 in B-52 aircraft, thus eliminating maintenance support required for the separate system the bomber now uses.

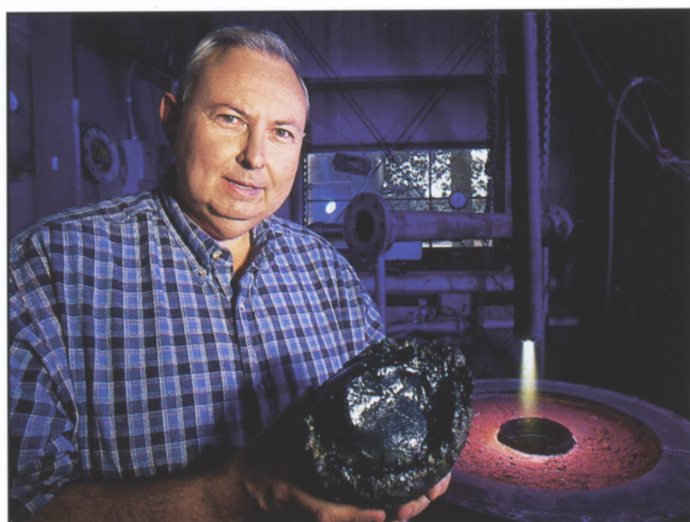
GTRI is designing, fabricating, testing, and installing a polarization test set (PTS) in an anechoic chamber at Robins Air Force Base. The PTS will transmit polarization-controlled, simulated radar signals and will receive and evaluate responses from electronic warfare systems housed within the chamber. The PTS will be the most accurate device of its kind in existence and will be capable of full statistical analysis of the responses. The PTS will be used for verification of the end-to-end operation of the systems under test to include software functionality and hardware component performance.

**Environment, Safety, and Health:** Through the Plasma Applications Research Facility, GTRI and Georgia Tech scientists are conducting research at the Savannah River Site using a one-megawatt plasma torch. For the U.S. Department of Energy, the study is examining the use of plasma torch vitrification for dealing with contaminated soils at the site. In addition, for the U.S. Department of Defense, researchers are studying plasma torch use for treatment of wastes at temporary military bases.

Work continues on development of new chemical/biological sensors and their applications in environmental and occupational safety and health. Discussions are under way regarding commercialization of these sensors.

In a project funded by the National Institute of Occupational Safety and Health (NIOSH), GTRI is working with Emory University to examine ergonomic characteristics of video display terminal workstations. More than 500 such systems have been evaluated thus far.

GTRI is helping industry comply with government regulations on environmental and occupational safety and health. Working with the U.S. Environmental Protection Agency, GTRI is taking a major role in that agency's Environmental Benefits Initiative. In addition, GTRI has taken a leading role with the U.S. Department of Labor/Occupational Safety and Health Administration in the development of a Comprehensive Assistance in Safety and Health (CASH) Program.



*GTRI researchers are collaborating with researchers from other units on a project that will use a plasma torch to vitrify waste materials.*



Researchers are developing an automated system that will allow the carpet industry to reuse dyebath water, heat, and chemicals. A trial system installed in a north Georgia carpet plant is producing dye- and energy-cost savings as well as environmental benefits.

#### Food Processing:

GTRI is exploring new technologies for Georgia's food and agribusiness industries through two innovative research programs—the Agricultural Technology Research Program (ATRP) and the Georgia Program to Enhance the Competitiveness of the Food Processing Industry (FoodPAC).

ATRP researchers completed a robotic packaging system and a computer vision grading system for quality control, both of which will be field tested this coming year. They also began field testing the Ergonomics Work Assessment Analysis System (EWAS) to isolate high-risk movements contributing to cumulative trauma injuries in poultry plant workers.

A design team finished a multimedia CD-ROM that explains poultry industry operations to middle school and high school students, while reinforcing the importance of math and science skills to this industry.

ATRP engineers also successfully field demonstrated the hands-free collection of quality control data from the factory floor using a second-generation "wearable" computer system.

FoodPAC completed construction of a 500-gallon, pilot-scale, dissolved air flotation (DAF) system, currently being used to help food processors optimize wastewater treatment. Researchers also finished a state-of-the-art biosensor to help monitor food safety in processing plants. The biosensor can detect specific species of microorganisms, such as salmonella, at sensitivities far below those of current commercial technology.

#### Information Technology:

Through its involvement in the Broadband Telecommunications Center (BTC), GTRI is helping bring advanced digital services—including distance learning, telecommuting, and interactive television—into homes.

Researchers are exploring new physical, networking, and application technologies for homes via a "Home of the Future" laboratory that simulates a typical residence. GTRI engineers are using specialized research facilities for studying cable modems, digital subscriber line modems, Ka/Ku band satellite communications, and wireless broadband and cellular access technologies.

GTRI is also exploring how to coordinate hybrid fiber-coaxial (HFC) and fiber-to-the-curb (FTTC) systems with video servers and Asynchronous Transfer Mode (ATM)-based networks.

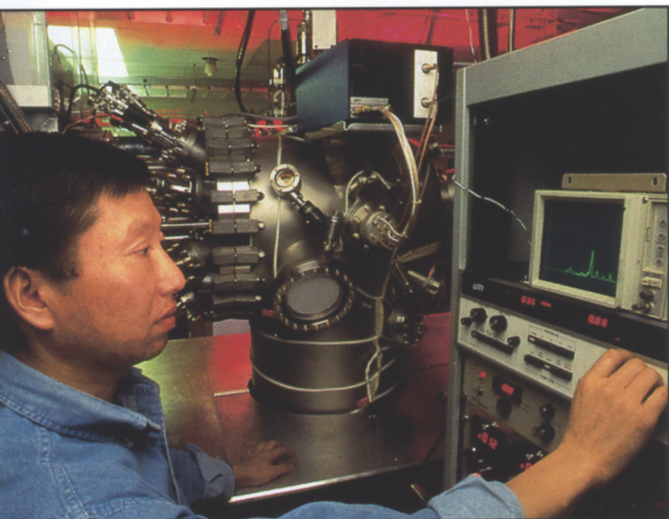
For the U.S. military, GTRI added enhancements to FalconView, a portable and inexpensive system of integrated map and imaging tools designed to assist pilots in flight planning. FalconView includes a Global Positioning System moving-map display, as well as tools that display satellite intelligence information, perform intervisibility calculations, and create and display different types of maps and geographically referenced overlays.

FalconView was one of five finalists in the Core Business Systems category of the 1997 Windows World Open Competition, used by the Microsoft Corporation to recognize innovative applications on the Windows platform.



*GTRI researchers added enhancements to the FalconView flight planning system that will allow its use in large aircraft, such as this C-130.*





*Through the Phosphor Technology Center of Excellence, researchers are studying the properties of new display materials.*

#### **Manufacturing and Materials:**

GTRI researchers in the DARPA-funded Phosphor Technology Center of Excellence are developing and testing new phosphors, particularly for high-intensity green and blue colors for future flat-panel displays. The Center also collaborates with manufacturers on new process technologies for phosphor deposition. In one program, researchers are developing blue phosphors for the next generation of electroluminescent displays with Planar America; another effort, with Raytheon and Motorola, involves developing low-voltage phosphors for field emission displays.

GTRI is working with the Department of Defense and with industry on technology insertion and manufacturing plans for advanced electronics and photonics components such as multi-chip modules, microwave/millimeter-wave circuits, integrated optical circuit sensors, and smart focal plane arrays. As part of GTRI's initiative to increase contract work with industry, new research has begun on soldering process reliability and hybrid electronics packaging.

In addition, GTRI engineers are assisting industry in commercializing microelectromechanical micro-jets developed by Georgia Tech researchers for cooling integrated circuits.

Development of reliable products requires a thorough knowledge of materials and the effects of manufacturing processes. To further that goal, GTRI researchers are working with heterojunction bipolar transistor (HBT) device technology, which offers performance and production cost advantages in transmit/receive (T/R) modules for future active phased array radars. Researchers are investigating gallium arsenide (GaAs) bipolar devices to determine whether HBTs are subject to specific material and performance degradation. They also are developing electroluminescent analysis techniques to observe light emission from the HBT base-emitter junction.

In another effort, a GTRI team is developing hands-free "wearable" computers and applications to support mobile manufacturing personnel. By integrating an advanced head-mounted communications display with voice recognition and wireless communicators, wearable computers serve as powerful assistants on the factory floor.

In automation areas, researchers continue to make advances in development and use of low-cost robotics capable of high-speed, low-precision movement known as human-level performance. In addition, research and development is under way on the use of color machine vision and smart algorithms for process control and machine guidance.



*GTRI uses the new Center for Board Assembly Research at the Packaging Research Center to prototype advanced electronic assemblies and evaluate improvements in electronics manufacturing.*



Development of new top coatings for aircraft and industrial applications is achieving significant advances in reducing volatile organic content in coatings. This low-temperature, powder-coating technology can be used on aluminum alloy substrates as well as on steels and other metals.

Metallurgists in GTRI and Georgia Tech's School of Materials Science and Engineering are developing critical design parameters for classes of high-strength, scandium-containing alloys that could have transportation applications. One is a weldable alloy strong enough to replace conventional products such as Alclad alloy 2024.

#### Modeling and Simulation:

GTRI is working to establish, identify, and describe models and simulation processes, as well as to define modeling and simulation requirements for the U.S. Department of Defense. GTRI researchers have engaged in a joint feasibility study to address increased use of digital simulation in test and evaluation, and to reduce the cost and time associated with open-air ranges and hardware-in-the-loop testing. The Joint Electronic Combat testing using the SIMulation (JECSIM) program is aimed at determining the degree to which the integrated models can accurately predict real-world missile performance in the presence of electronic countermeasure techniques. JECSIM, which uses only existing models, has completed the feasibility study phase and has been chartered for joint test and evaluation.

Another GTRI study examined the use of modeling and simulation in electronic warfare test and evaluation, then defined requirements and developed a modeling and simulation architecture for electronic warfare test and evaluation. This architecture consisted of the hierarchy of objects to be simulated in an object-oriented programming environment to create a generic, electronic combat digital simulation. The results of the study form the basis upon which the Air Force can plan modeling and simulation investments to support implementation of the test process.



*An F-15 Eagle carries an ALQ-131 pod on a test mission at Eglin Air Force Base. GTRI researchers are developing improved modeling and simulation techniques to utilize information obtained from such testing.*

GTRI researchers are also using state-of-the-art computer systems to support the U.S. Army acquisition process for the Comanche Light Helicopter, formerly known as the LHX. GTRI responsibilities on the Comanche program include the ongoing process and product assessments necessary to ensure that the most reliable system is fielded. A modeling and simulation system has been established to capture, analyze, and assess hardware and software designs.

GTRI is developing and adapting existing Georgia Tech models for use in AEM\*AT (Advanced Electro-Optical Model for Aerial Targeting), a 10-year program of the Wright Laboratory Avionics Directorate aimed at creating an end-to-end model of the aerial targeting situation. In addition, GTRI provides phenomenology consultation and support integration to AEM\*AT.

In other modeling and simulation work, GTRI is currently supporting the Air Force in the high-power microwave area by performing computer modeling and simulation of threat system vulnerability and coupling.



Radar:

GTRI is supporting the second-generation FIRE-FINDER radar, the U.S. Army's long-range artillery-locating radar system. Researchers evaluated two concepts for the radar and are developing related radar and signal processing analysis tools.

SWITCH, an interactive software tool developed at GTRI, provides cockpit simulation and system engineering database capability to software developers of operational flight programs for fighter aircraft. It correlates an F-15E aircraft's state as a function of cockpit switch conditions, display window presentations, avionics line replaceable unit modes, and aircraft conditions.

Contributions to missile defense research in fiscal 1997 included developing near-field alignment and calibration techniques, high-resolution tracking implementation, evaluating next-generation digital processing architectures, implementing radar performance testing under electronic countermeasures (ECM), and generating hardware-in-the-loop requirements. GTRI internally funded a study of enhanced tracking techniques for ballistic missile development applications.

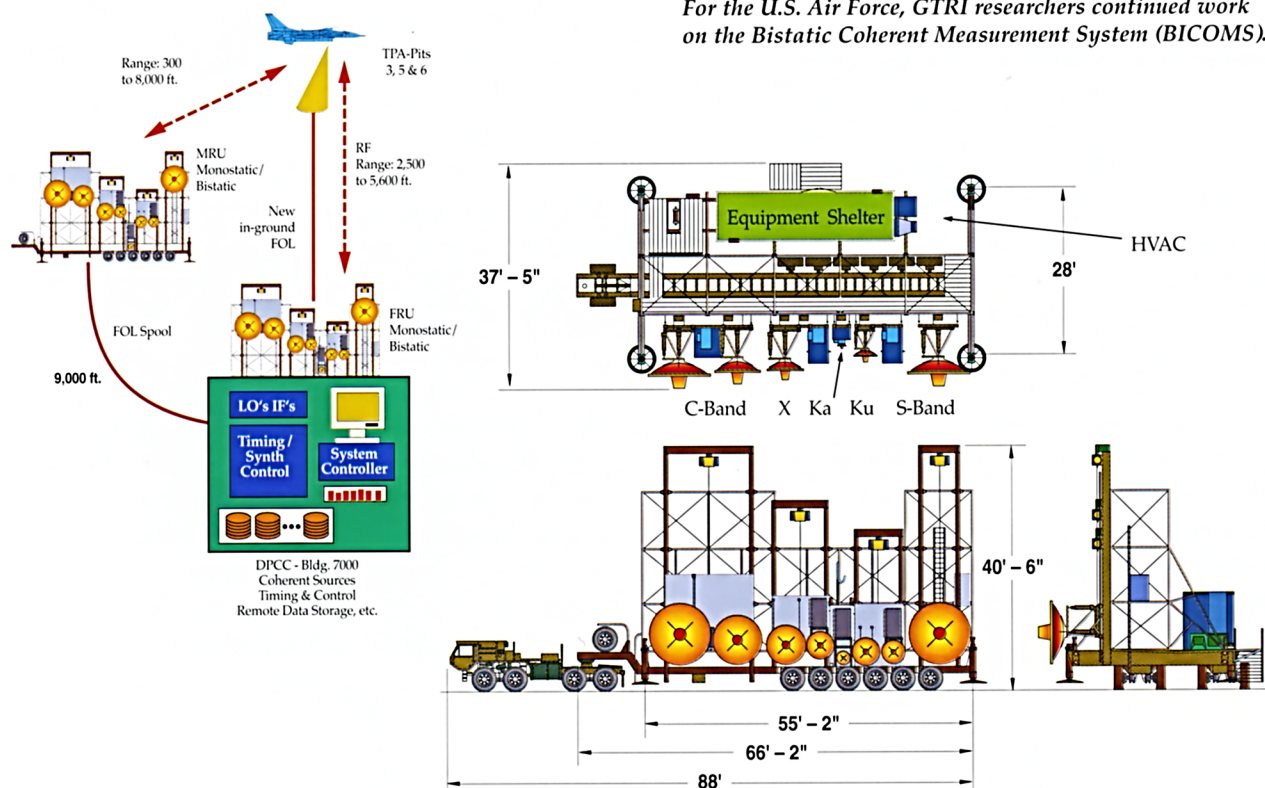
Researchers continued to redesign obsolete hybrid microcircuits in the APG-63 and APG-70 radar systems. They also determined the upgrade approach that will allow the Air Force to use the APG-70 through the year 2025. GTRI is constructing a test bench for the AN/APG-70 airborne pulse Doppler radar. The test bench will provide additional capabilities in system-level testing, electronic protection technique development, and obsolescence mitigation.

GTRI researchers also continued work on the Bistatic Coherent Measurement System (BICOMS), a state-of-the-art instrumentation radar system for the U.S. Air Force Radar Target Scatter Facility Mainsite outdoor ground-plane range. BICOMS system installation and training are planned for 1998.

During fiscal 1997 researchers explored radar concepts that could provide sniper-location estimation with three meters cross-range accuracy at 1,000 meters. They plan a demonstration system combining Doppler profiler and interferometer approaches as the next step in development.

GTRI has found new biomedical and security applications for the non-contact vital signs monitor it produced. The monitor obtains heartbeat information up to 50 feet away from its subject.

*For the U.S. Air Force, GTRI researchers continued work on the Bistatic Coherent Measurement System (BICOMS).*





### Test and Evaluation:

Through Georgia Tech's Test and Evaluation Research and Education Center (TEREC), GTRI researchers studied locational errors in a wide range of military surveillance and weapons-aiming systems. The causes and magnitudes of these errors vary significantly from system to system, depending on the specific measurement methods used.

Under-standing these issues is important for both planning test programs and interpreting the results; therefore, to help test analysts with this complex task, GTRI is producing a comprehensive manual based on the information developed.

Another TERC program is helping to clarify the key issues in modeling and simulation for live-fire weapons testing. GTRI researchers have sponsored a series of workshops that bring together representatives from the modeling, test, and system operation communities to help define the current state of the art and focus attention on areas needing improvements.

For a major Internet service provider, GTRI researchers developed a plan for testing the system's service quality and its ability to reject unauthorized users. Specialists evaluated security measures against users with criminal intent, as well as human-factors issues involving user interface design.

GTRI supported the Joint Advanced Distributed Simulation (JADS) Program Office in evaluating advanced distributed simulation technology for use in weapons systems, electronic countermeasures, and C3I testing. Researchers have already demonstrated that networked but geographically separated test facilities can be used to create "virtual" test environments for simulating integrated air defense systems. GTRI assisted with test planning, design, execution, analysis, and reporting, as well as system engineering, digital system model development, and instrumentation modifications and upgrades for the electronic warfare part of the JADS program.

During fiscal 1997, researchers continued long-standing programs to analyze and develop hardware simulations of foreign threat systems. The work included development of threat-faithful antennas, transmitters, receivers, and mechanical systems to



*GTRI researchers have developed a mobile radar threat simulator.*

accurately emulate the threat's overall radar system characteristics. Recently initiated Air Force programs include airborne simulations of captive-carry missile seekers, in which a fighter aircraft carries the seeker portion of a ground-to-air missile and emulates the missile flight profile toward a victim aircraft.

### Transportation:

GTRI conducts a wide range of transportation research to help the Georgia Department of Transportation (GDOT) improve the performance and safety of state roadways through improved information systems and Intelligent Transportation Systems (ITS).

Other GDOT projects include developing an aerial traffic surveillance drone for low-cost and highly responsive traffic monitoring, and creating a consolidated system to provide credentials and permits to commercial vehicles, in partnership with other state transportation departments.

With start-up funding from GDOT, GTRI led efforts to establish the Georgia Transportation Institute for multidisciplinary research, development, education, and technology transfer. Other state-of-the-art facilities include the Advanced Vehicle Development and Integration Laboratory (AVDIL)—two reconfigurable bays for design, construction, and integration of advanced air, land, and sea vehicles.



Researchers are advancing electric and hybrid vehicle research in conjunction with the Southern Coalition for Advanced Transportation (SCAT) through the DARPA- funded Electric Vehicle (EV) Virtual Testbed. Work includes development of a computer model to improve the management of heating, ventilation, and air conditioning for electric vehicles. Researchers also have developed models for advanced battery electrochemistry and charging techniques, including a rapid-charging pulse algorithm that can recharge batteries more quickly than conventional methods.

GTRI helped put the first hybrid electric, hydrogen-fueled bus onto the streets of Augusta, Georgia, where it will be tested over the next year in public transportation service. The H2Fuel Bus runs on electricity and produces almost no emissions. Stored in

metal hydrides in newly designed tanks, the hydrogen fuels an internal combustion engine that drives a generator to recharge the batteries.

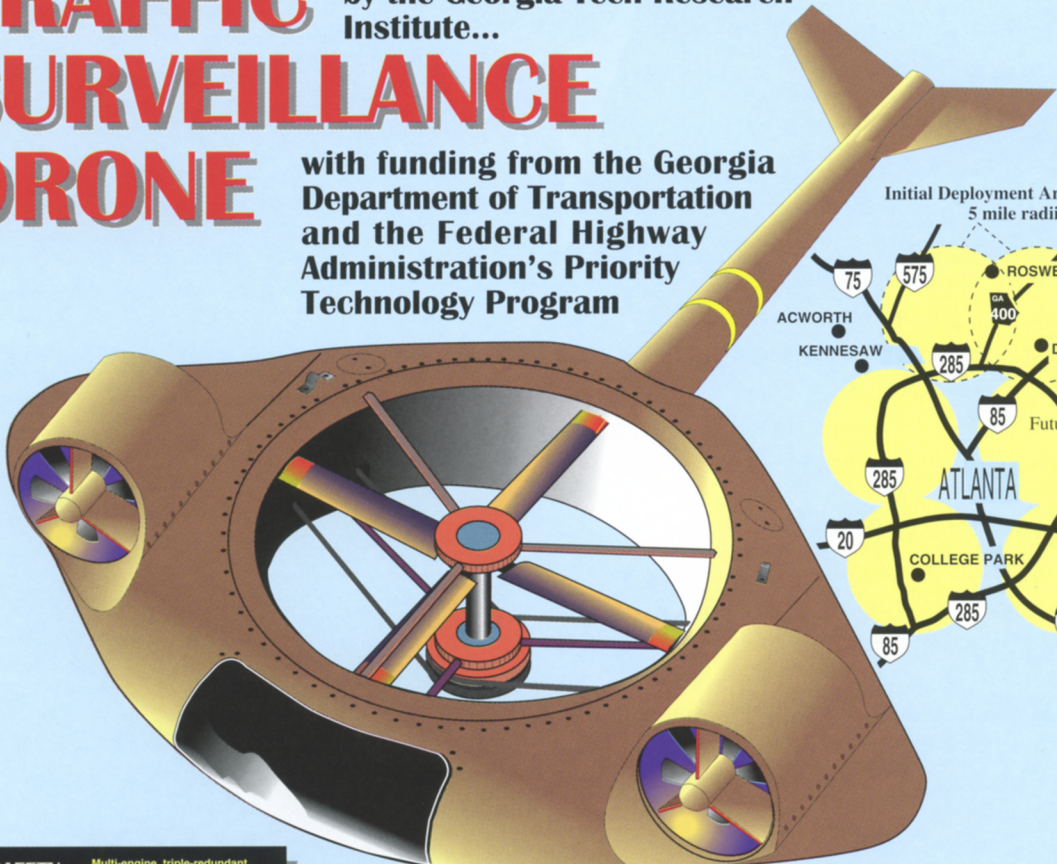
To advance unmanned vehicle technology, one GTRI researcher continued to support the International Aerial Robotics Competition, which has been sponsored by the Association for Unmanned Vehicle Systems International (AUVSI) for the past seven years. Each year, collegiate competitors attempt to create a fully autonomous flying robot capable of navigation, self stability, environmental perception, and the ability to manipulate objects on the ground while in flight.

*With support from the state and federal transportation officials, GTRI researchers are building an aerial robot that can be used for traffic surveillance.*

# TRAFFIC SURVEILLANCE DRONE

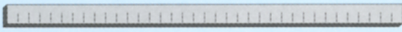
**Prototype under development  
by the Georgia Tech Research  
Institute...**

**with funding from the Georgia  
Department of Transportation  
and the Federal Highway  
Administration's Priority  
Technology Program**




- **SAFETY:** Multi-engine, triple-redundant flight control, shrouded propellers
- **AFFORDABLE:** Simple design for projected fly-away cost of \$60K
- **AUTONOMOUS:** No pilot required—self-stable, goes where directed using Differential GPS

**36 Inches**



- **EFFECTIVE:** Provides live video and two-way audio communication from above
- **RUGGED:** Carbon composite fuselage, all moving parts protected

Initial Deployment Areas (showing 5 mile radii of operation)



Future Expansion Areas



## External Advisory Council

The Georgia Tech Research Institute External Advisory Council advises the organization on strategies and programs that will help GTRI meet challenges and attain goals. The Council is composed of proven local and national leaders in industry, research, government, and academia. The Council normally meets twice a year, with ad hoc meetings on specific issues convened as necessary.

The Council's mission is to:

- Advise and make recommendations on programs that will help achieve objectives specified in GTRI's strategic plan.
- Review the applicability and viability of research and economic thrusts, given national priorities, and provide guidance in strategic business development.
- Offer guidance in recruiting key research personnel and setting standards of excellence for GTRI programs.
- Help determine a balance in allocating GTRI discretionary assets among priorities such as program development, internal research, and equipment allocations.
- Help link GTRI to evolving national research, industry, and educational priorities.

*Shown in the photo are:*

*(L-R, starting in front): John J. Welch, executive vice president, Burdeshaw Associates Ltd.; Joseph Saloom, consultant in technology; Edward K. Reedy, vice president and director, GTRI; Senator James Tysinger, Georgia State Senate; Gen. Gerald Carey, (USAF, retired) and GTRI associate director emeritus; Gerald Dinneen, U.S. National Academy of Engineering (retired); Ben Dyer, president, Intellimedia Commerce Inc.; and John Fabian, president and CEO, Anser Corporation.*

*Not shown are:*

*Robert Cooper, president, Atlantic Aerospace Electronics Corporation; Allen Ecker, chief technical officer, Scientific-Atlanta; William Todd, founding president, Georgia Research Alliance; VADM Jerry Tuttle, (USN, retired) and senior vice president, ManTech International.*









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