Annual Report 1993

Georgia Tech
RESEARCH INSTITUTE

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Cover photograph: This cylindrical antenna array is prepared for measurements at GTRI's compact range facility. The array simulates the behavior of aircraft wings.

The Year in Review

Research support trends at GTRI showed signs of recovery in the fiscal year 1993.

In 1993, we took a fresh look at the direction of our research program in light of changing national needs.

Contract grants and awards rose by 17.1 percent, from last year's $75 million level to an annual volume of $87.9 million. This change represents a return to the range that GTRI averaged over the five years preceding FY 92. The accomplishment is particularly impressive, given the continuing financial problems being experienced by many other contract research organizations in the United States.

Federal government limitations on indirect cost recovery, however, have continued to challenge GTRI and other U.S. research organizations. This overhead cap contributed to the shortage of discretionary funding needed for us to move aggressively into emerging technology areas and to provide support to research professionals during periods of transition. This was one reason that the size of GTRI's research faculty dropped from 646 to 585 during the year. Another factor in the decline has been the phaseout of Department of Defense (DoD) support for some research fields and a lack of corresponding speed in appropriating funding for new priority areas.

Our total expenditures in FY 93 declined by 1 percent to a level of $98.2 million. The distribution of contract sponsors showed relatively small changes. DoD's share of the total sponsorship base dropped slightly, from 82 percent to 77 percent, while industrially supported R&D rose from 11 percent to 16 percent of the total. A more definitive look at this breakdown is shown in the chart on "Major Sponsors" in this section.

Strategic Directions

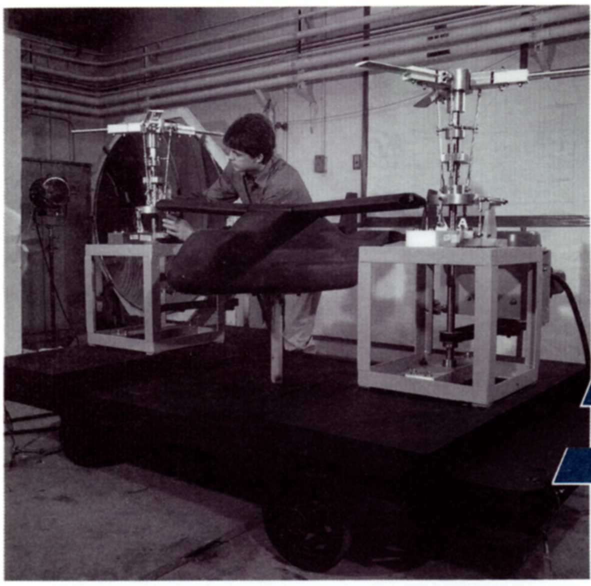
During the winter of 1993, GTRI management took a fresh look at the direction of our operation in the light of changing national defense needs, the increasing competitiveness of the global economy, social crises, and emerging technological trends. We agreed that our organizational vision should be to work more closely with Georgia Tech's academic colleges and interdisciplinary centers in establishing Tech as the premier technological university of the twenty-first century. We also resolved to make GTRI the nation's most respected university-based applied research institute.

The strategic plan that resulted from these intensive discussions identifies 19 goals and 30 strategies for reaching these goals. In broad terms, our approach will be to maintain our current strong base of research in support of national defense, while becoming increasingly active participants in the federal government's efforts to develop commercial uses for defense technologies. The transfer of technology to Georgia and U.S. businesses remains one of our highest priorities, and we plan to maintain strong initiatives in environmental technology, advanced transportation, and electronics manufacturing. More detailed information on GTRI's new research initiatives is contained in the following section of this report.

Shortly after the end of the fiscal year, GTRI undertook an administrative restructuring, so that we are more strongly positioned to pursue our strategic objectives and better able to operate in the current period of financial austerity. This restructuring calls for consolidation of some of our research laboratories as well as a streamlining of the present Office of the Director. The new GTRI administrative and laboratory structure is reflected on pages 19 and 20 of this publication.

Contributions to Education

One of GTRI's key functions is to support the educational program of Georgia Tech. Our primary means of doing so is to provide students with rewarding opportunities for employment. A high priority is to make an increasing number of these student work assignments directly involve research. During FY 93, we provided employment for a total of 181 graduate students, including 133 graduate research assistants, 25 graduate co-ops, and 23 graduate assistants. GTRI also employed 290 undergraduate students, including 103 student assistants, 168 undergraduate co-ops, and 19 work study students.



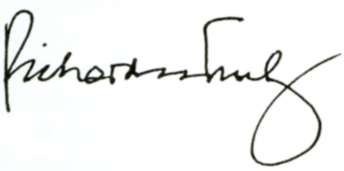
Researchers have developed this tilt-rotor simulation to conduct acoustics studies.

Our staff is actively involved in Georgia Tech's educational programs, as both faculty members and students. Last year, 39 research faculty members at GTRI were pursuing doctoral degrees, while 77 were at work on master's degrees. Twenty-two GTRI researchers held adjunct teaching positions in Tech's academic departments, and 31 had shared or joint appointments. In addition, our researchers served on 32 thesis committees, and 93 taught in numerous continuing education courses.

Service to Georgia

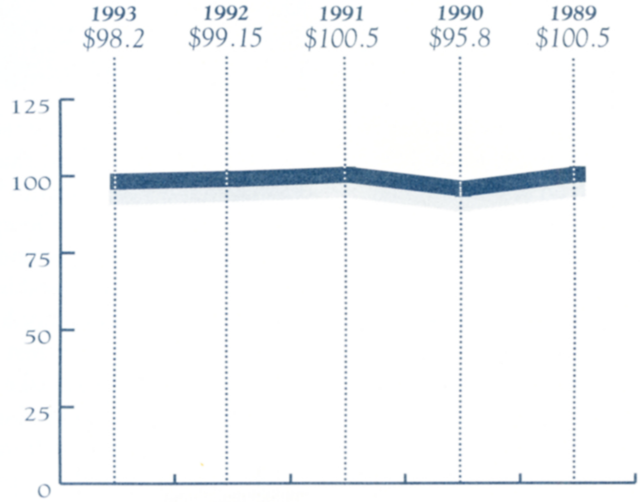
In FY 93, GTRI continued to make a strong contribution to Georgia's economic development. Our industrial extension network, a model for other states, provided 5,500 technical assists to companies and community organizations in Georgia. During the year, we also solidified plans to improve these services, through the merger of our Economic Development Laboratory into Georgia Tech's new Economic Development Institute (EDI). This organization will provide a single entry point to all of Tech's economic development, technology transfer, and new enterprise development activities. Its goal is to improve the accessibility of Georgia Tech resources and enhance delivery of services to the state of Georgia. EDI's management foresees strong, continuing interactions with GTRI in the areas of technology needs assessment, environmental sciences, industrial hygiene, and materials science.

In closing, let me thank GTRI's dedicated staff for their assistance and inspiration during my first year as director of this organization. Together, we will work to meet the challenges facing this university, the state of Georgia, and our nation.

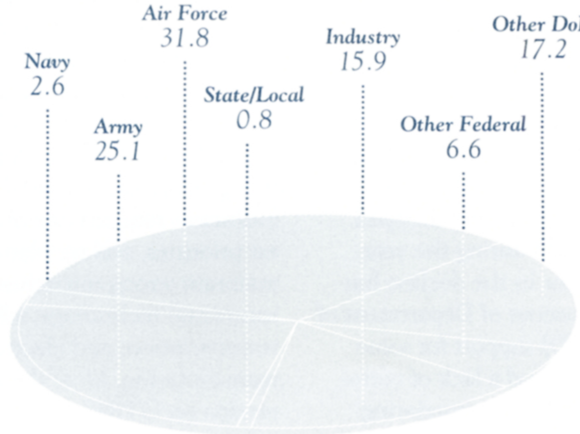


Richard H. Truly
Director

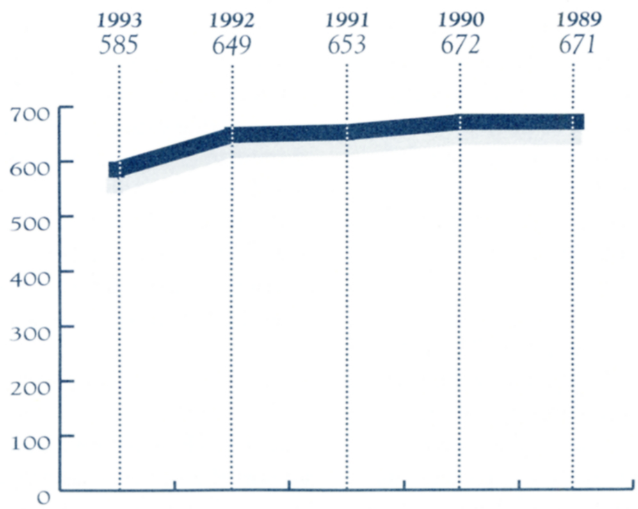
Research Expenditures
(Dollars in millions)



Major Sponsors
(Percent of research expenditures)



Number of Research Faculty Members



Research Initiatives

GTRI has one of the nation's leading university-based programs in defense electronics.

While we intend to keep this base of expertise strong, many of our research initiatives involve the creation of non-military applications of defense technology.

Advanced transportation systems make use of a variety of capabilities that were originally developed here for military purposes. Our researchers are leading a three-year interdisciplinary study that explores how advanced traffic management systems (ATMS) can be made more "user-friendly" to their human operators. Another project has resulted in a neural network system that optimizes traffic light settings on congested urban streets near the sites of special events. In air transportation, defense capabilities have been used to develop radar techniques for detecting dangerous wind shear conditions and to create synthetic vision systems that increase the safety of low-visibility landings.

One of Georgia Tech's most important research initiatives involves telecommunications, and the focal point for this effort is the newly established Georgia Center for Advanced Telecommunications Technology (GCATT). The 1996 Summer Olympics will provide a global stage for Atlanta to demonstrate its potential to become the hub of the new telecommunications industry. GTRI has participated in the creation of GCATT and is developing a variety of technologies of importance in "the new telecommunications." For instance, specialists in wireless communications have developed new, adaptive techniques that allow high-quality communication in the presence of interference. In addition, microelectronics specialists have created an innovative electroluminescence device that promises to improve high-definition displays and new photodiodes for use in high-definition television cameras. Our engineers also have merged Integrated Services Digital Network (ISDN) technology with the NASA Advanced Communication Technology Satellite system. The result has been a multimedia network for voice, data, image, and video information.

GTRI is focusing renewed attention on biomedical electronics.

GTRI is focusing renewed interest on biomedical electronics. In one project, our engineers have extended their expertise in cardiac pacemaker testing to include other implantable devices such as cardiac defibrillators. Efforts also are underway to establish a third-party electromagnetic test facility at GTRI that would rate the susceptibility of electronic prosthetic devices to radiation emitted by electronic article surveillance systems, such as antitheft devices. In another project, we have developed a computer model that emulates the way humans learn tasks calling for hand-eye coordination. This basic technology, created for military purposes, could be used in the biomedical area. One application might be in robots that assist in caring for the elderly.

In manufacturing, one of the most promising production techniques involves the use of modular work cells. GTRI researchers have studied the benefits of modular manufacturing and pinpointed areas where improvements are needed for this approach to reach its potential. Our programs in robotics are helping industry improve quality and reduce workers' repetitive motion injuries. In this area, we are developing new end effectors to manipulate non-rigid objects in food processing, apparel, and composites manufacturing.

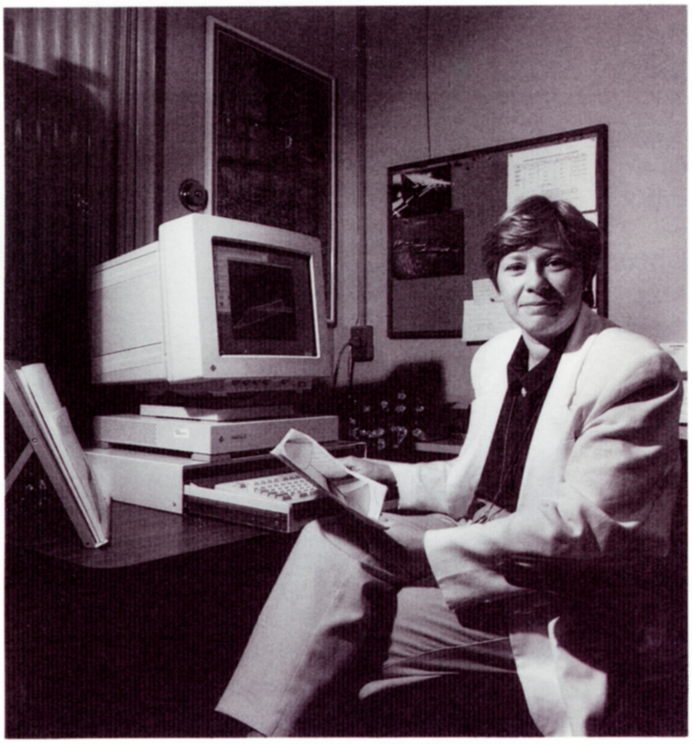
Environmental technology and training are fields of steadily growing strength at GTRI. One recent and innovative project utilizes integrated optics to detect very low levels of pollutants. Researchers have built a laboratory prototype of an integrated-optic interferometer that can sense a variety of chemical contaminants in parts-per-billion concentrations. Sensor fusion and advanced spatial analysis technologies also are being adapted for pollution prevention and environmental clean-up efforts.

Spatial analysis technology developed for defense application is being used at GTRI in a variety of geographical information systems.

Aerospace Sciences and Technology

GTRI's aerospace program covers a broad spectrum of research-related activities that range from aeroacoustics to intermodal transportation systems.

GTRI researchers have developed strong expertise in smart structures for rotary wing aircraft.



Researchers apply computational fluid dynamics and air dynamics to perform coupled aeroelastic computations for whole-aircraft configurations.

Our scientists and engineers specialize in such areas as the application of new technology to advanced transport aircraft, aerodynamic vehicle design and evaluation, and experimental and computational fluid dynamics.

Rotary wing aircraft could play an important role in meeting future regional transportation needs linking urban environments with developing rural centers. Using the 1996 Olympics in Atlanta as a focus, GTRI researchers have surveyed and evaluated the issues related to using vertical flight aircraft as one component of an integrated intermodal transportation system. The innovative system will provide an infrastructure that supports economic development, increases the quality of air transportation services, and reduces ground time for the traveling public. As a test bed for prototype procedures and air traffic control standards, the Atlanta intermodal vertical flight system will help in establishing other systems throughout the United States.

Smart structures are essential in designing the high-performance rotary wing aircraft of today, and GTRI researchers have developed a strong capability in this area. We have used smart structures and new actuation schemes to automatically adjust helicopter blade camber—an approach aimed at reducing drag associated with mast and control links. Our engineers also have developed propagation models, including one that improves rotorcraft damage tolerance analysis techniques.

Using pneumatic-lift and control-surface technology, GTRI researchers are continuing to develop advanced airfoils for use on subsonic commercial transport aircraft. The new airfoils offer much-improved performance over conventional mechanical flaps, while significantly reducing system complexity and aircraft noise in the terminal area. Special subsonic research facilities and techniques are employed to evaluate these advanced airfoils, the design of which was guided by output from computational fluid dynamics codes.

GTRI has developed computational fluid dynamics techniques for interdisciplinary applications. These methods allow the visualization of complex air flow processes and are, in effect, a "numerical wind tunnel." Recently, our researchers developed a two-dimensional, multizonal computational aeroacoustics methodology. Based on first principles, the aeroacoustics code can be used to examine propagation and scattering of elements important in current acoustics research. This methodology can be coupled with high-order computational fluid dynamics codes to examine the impact of aerodynamic phenomena on the noise signature of specified configurations.

In other work, researchers investigated the feasibility of using a novel radio-acoustic sensor technique to detect non line-of-sight targets while maintaining a low probability of intercept for the interrogating platform. The technique, which combines radar signals with acoustic waves, would permit a vehicle to remain fully masked to one side of an obstruction while being able to use radar to look around the masking obstruction.

One of our technical thrusts for the future is in the area of ground vehicle systems integration related to intelligent vehicle/highway systems. This includes systems for collision avoidance, high efficiency internal combustion systems, and hybrid electric/combustion engines. GTRI is well positioned technically to respond to the challenges of future ground vehicles. Many state-of-the-art aircraft systems, for example, can be adapted to ground transportation vehicles to improve both safety and performance.

Another technical thrust lies in the application of pneumatic technology to gas turbines and wind turbines. This could make a significant impact on programs for efficient energy generation for commercial usage, as well as for military usage in turbine engines.

Acoustics

In both quality and range of activities, GTRI's acoustics research program ranks second to none.

Our studies of the effects of sonic booms have received international attention.

Using state-of-the-art, industry-scale test facilities, our researchers explore such topics as aeroacoustics, noise effects, transportation noise, rotor acoustics, computational acoustics, and active noise control, to name only a few.

In the area of aeroacoustics, GTRI researchers are developing innovative methods for reducing noise generated by subsonic and supersonic jets. Some of our more recent attempts at controlling jet noise have concentrated on methods to increase plume mixing. In addition to carrying out further studies on the effect of mechanical protuberances on mixing enhancement, we are examining the use of vibrating splitter plates and miniature air jets injected perpendicular to the jet axis at the nozzle lip. This technique shows promise for accomplishing the same goals but with improved results.

Our work on noise effects, especially those related to sonic boom, received international attention this year. We operate a unique speaker system with 40,000 watts of power that allows us to simulate various types of noise, including sonic boom, at frequencies from 3 Hz to 4000 Hz. The speaker system has been used to study the effects of sonic boom and other loud noises on human subjects and building structures.

In transportation noise, GTRI is conducting a pioneer study to rank automotive wind noise sources. An automobile equipped with a sophisticated computer system and fitted with nearly 100 pressure transducers is being used to make routine on-road noise measurements. The instrumentation can also be utilized to establish the effect of a given component design change on the interior or exterior noise environment of the vehicle.

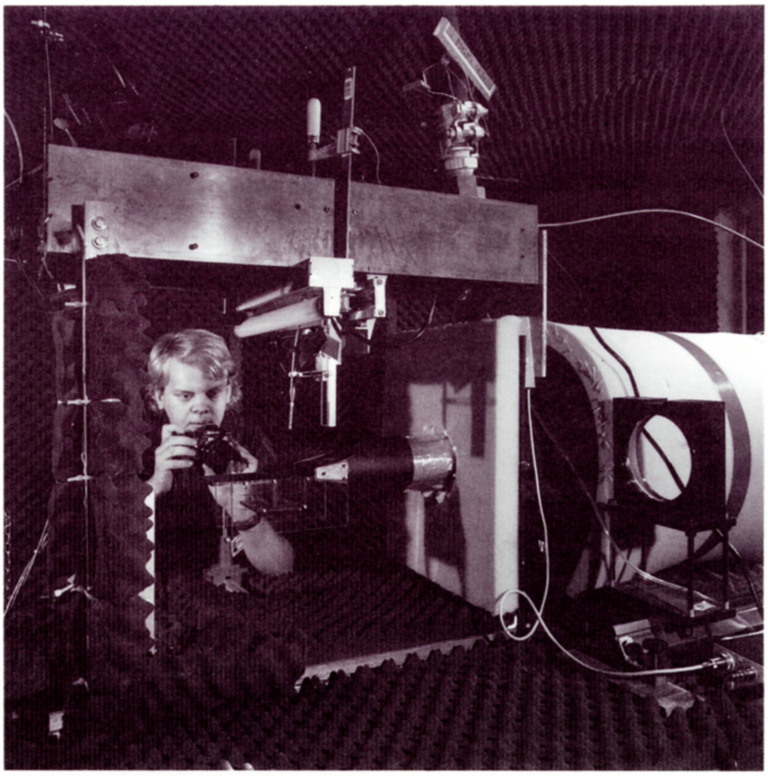
One early spin-off from this work was the development of innovative microphone fairings that allow accurate measurement of the fluctuating pressures on a surface moving in the flow. Another potential spin-off could be the development of a unified code for the prediction of noise from future transportation vehicles, including trains, tanks, and buses.

To better examine issues related to rotor noise, GTRI researchers have developed a model tilt-rotor system with the capability of simulating supersonic tip speeds. They also developed enhanced computational acoustics capabilities, and are applying the new methodology to better understand the fountain flow effect associated with tilt-rotor models.

Active noise control, a strategy to control noise by imposing additional noise of equal intensity but of opposite phase, is also being developed at GTRI. Various algorithms to implement active noise control have been tested for a range of noisy scenarios.

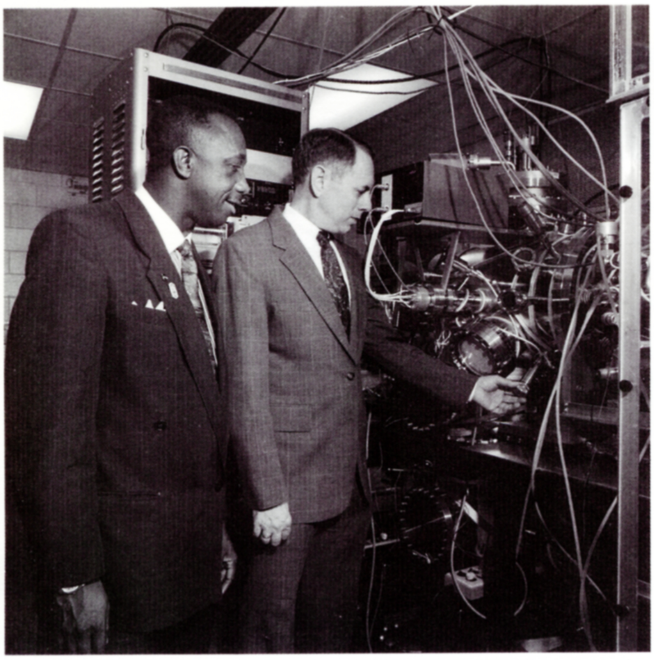
In other work, researchers are investigating new high temperature liners for acoustic applications. We are currently testing an innovative ceramic liner potentially capable of absorbing a wide range of sound frequencies at temperatures over 2000° F. A theoretical model to account for temperature and pressure gradients in a complicated suppressor nozzle surrounded by an ejector is also being developed.

In the years ahead, our researchers will continue to investigate issues concerning the generation and propagation of noise, along with its effects upon humans and the environment. We shall seek new ways to reduce or control noise, and explore the application of acoustics tools to a host of practical problems in such diverse fields as biomedicine and agriculture.



Cavity flow research may lead to reductions in pressure waves that generate noise and cause structural problems.

Microelectronics and Applications



Clark-Atlanta University and GTRI have teamed to investigate issues related to the storage reliability of gallium arsenide components used in smart munitions.

GTRI will extend its research in high-definition displays through the Phosphor Technology Center of Excellence.

GTRI researchers have established a broad range of capabilities for the design, growth, fabrication, and characterization of advanced semiconductor device structures.

We have established expertise in the development of infrared detector materials, advanced structures for high-definition television (HDTV) cameras, millimeter-wave devices, and new phosphor materials.

Improvements in phosphor materials technology are essential in efforts to create high-definition displays. Our researchers have designed a specialized metalorganic molecular beam epitaxy system (MOMBE), in which phosphor materials can be grown. In this system, n- and p-type doping would be performed in zinc sulfide thin films grown on silicon, zinc sulfide grown on gallium arsenide, and also in novel silicon/calcium fluoride heterostructures and superlattices designed for new optoelectronics and resonant tunneling devices. In addition, the MOMBE and other related growth systems would be used for rare-earth doping of zinc sulfide and strontium sulfide structures in order to optimize the luminescent efficiency of electroluminescent devices made from these materials.

GTRI will dramatically extend its work in phosphor technology through management of and participation in the Phosphor Technology Center of Excellence. The organization, recently created under the sponsorship of the Advanced Research Projects Agency, will support five primary phosphor research areas relating to cathode ray tubes, thin-film electroluminescent displays, plasma display panels, back lights of liquid crystal displays, and field-emission displays. Six universities and research organizations are participating in this research and technology transfer initiative: Georgia Tech, the University of Georgia, David Sarnoff Research Center, University of Florida, Oregon State University, and Pennsylvania State University. Headquarters of the center is Tech's Manufacturing Research Center.

GTRI has also strengthened its capability for developing infrared detector materials. This base of expertise grew out of our pioneering efforts to develop the MOMBE technique for growing mercury cadmium telluride thin layers. Future efforts in this area are likely to involve a partnership with several industrial firms to develop MOMBE for use in flexible manufacturing of advanced mercury cadmium telluride materials structures for infrared focal plane arrays.

HDTV is another technology of note in which our researchers actively work. We have developed a number of avalanche photodiode detector (APD) structures, which will be combined with charge-transfer devices (CTD) and acoustical charge transporters (ACT). These components are currently being optimized and together will form the key components of a new high-definition mini-camera. In this concept, light is detected and amplified by the APD, and then stored and transferred by the CTD into the ACT device for rapid frame readout. This scheme would allow current television cameras to be replaced by lightweight, compact solid-state devices. Other potential applications for this technology include medical imaging and manufacturing processing.

In the area of millimeter-wave devices, GTRI activities have continued to focus on the refinement of a quasi-optical device that combines the output power from an array of solid-state microwave and millimeter-wave devices. We have successfully demonstrated the principle of grid oscillation at frequencies between 25 and 50 GHz, as opposed to previous work below 15 GHz. Additionally, the physical mechanisms that control the performance of the grid array oscillator have been elucidated for both low- and high-frequency operation and its different power output modes identified. This research is expected to result in lightweight, low-power, millimeter-wave power sources, which can be used for target tracking and commercial activities related to collision avoidance in the air and on the highways.

Infrared/Electro-Optics

Research programs in infrared/electro-optics at GTRI focus on instrumentation development as well as evaluations of electro-optical materials and system-level performance.

GTRI and Georgia State University are designing a telescope array with 5,000 times more resolving power than existing optical telescopes.

We also develop mathematical models that predict the performance of electro-optical systems and the infrared signatures of targets and backgrounds. Modeling efforts simulate the flyout of optically guided missiles against targets and countermeasures, while synthetic 3-D scene generation programs continue to be innovative. Our researchers investigate infrared and aural signature phenomenology as well as radar signatures.

In recent years, we have developed several notable target/missile software simulations. For instance, the Georgia Tech Signature Prediction Code obtains extremely accurate, spatially resolved target/plume/background temperature and radiance values for a variety of conditions. Other simulations include the Georgia Tech Visible and Infrared Synthetic Imaging Testbed algorithm, the Digital Infrared Seeker and Missile Simulation series, and the Georgia Tech Synthetic Image Missile Simulation.

Field measurement projects at GTRI explore the effect of environmental and other conditions on target or background radiation; collect data to generate or validate signature models; record radiometric imagery of test scenes for use in interpretation of test results; and generate digital imagery of real-world scenes for use in computer simulations. Despite the apparent autonomy of modern guided weapons, most of these systems still rely on human observers to review possible targets and decide whether to pursue them. For this reason, our researchers have developed a model that mimics how a weapon-systems operator picks out targets on a busy landscape. The algorithm is a low-level vision processing routine, capable of pattern perception, visual search, and target detection. This knowledge could provide invaluable clues for making military vehicles less visible to enemies through better camouflage or low-observables technology.

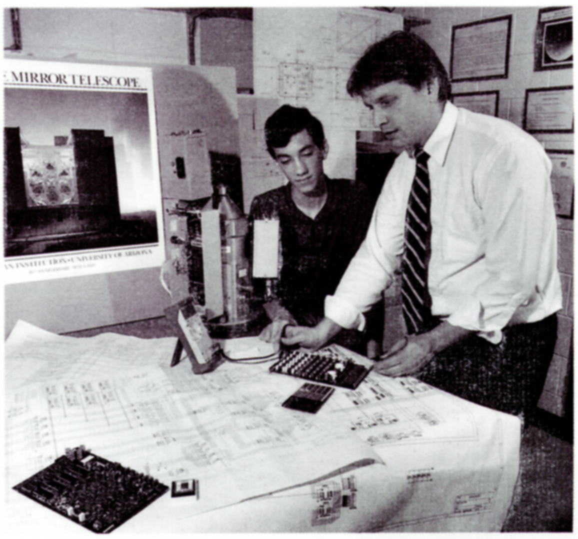
Astronomy is a research area of growing interest. With support from the National Science Foundation, researchers from GTRI and Georgia State University are developing an astronomical observatory that will have 5,000 times better resolving power than existing optical telescopes. With its array of seven individual telescopes, the observatory will overcome the distortion caused by turbulence in the Earth's atmosphere.

To assist industry in its pursuit of enhanced productivity, GTRI is adapting modern optics to industrial processes. Integrated optics offer great reductions in optical sensor size and cost—and, most importantly, innovative sensing approaches. Our engineers have developed an integrated optic chemical sensor that can detect a chemical species with high sensitivity. We also have applied integrated optics technology to surface motion measurements, torque sensing on rotating shafts, electric field and current measurements, and magnetic field measurements.

In cooperation with the Georgia Department of Transportation, our research staff will develop, install, and evaluate a prototype Adverse Visibility Warning System for real-time applications. Other studies have demonstrated the main components of the prototype: its sensors, variable message signs, and real-time controller.

GTRI's work in infrared signature analysis has concentrated on advanced airborne engagement scenarios. These differ significantly from conventional engagements, where the high contrast between aircraft and background facilitates detection and tracking. Low observability requires a re-examination of the infrared sources, detection methodology, tracking strategies, and their impact on system performance. To meet these needs, we are developing advanced analytical, numerical, and experimental capabilities.

Traditionally, most of GTRI's support has come from the Department of Defense; however, the breadth and diversity of our present research staff has prepared us to undertake the necessary shift to greater civilian interests. Our goal for the next five years is to develop one of the nation's top 10 optics research groups. We also expect to influence the direction for the next generation of advanced aircraft. While maintaining our base in infrared signature technology, we plan to apply this expertise to medical imaging, infrared phenomenology, and system diagnostics through radiometric measurement.



GTRI is testing the electronics that drive a new high-speed, low-noise CCD camera being developed for astronomical adaptive optics.

Communications

GTRI researchers conduct a variety of research and development programs in communications that range from basic research of fundamental phenomena to the fielding of turnkey hardware/software systems and networks.

Our researchers are developing adaptive techniques for high-quality communication in the presence of interference.

These activities concentrate on topics such as network design and application integration, radio system development and testing, support of business cases by technology assessment, radio location and direction finding, simulation and modeling, and application of telecommunications technology to distance learning and intelligent vehicle/highway systems.

Our researchers are conducting multiple sponsored research programs covering the full spectrum of technologies required to implement state-of-the-art communications and information systems.

GTRI recently added to its extensive experience in wireless communications systems and networks by developing new, adaptive techniques to allow high-quality communication in the presence of interference in crowded parts of the radio spectrum. Our researchers have also concentrated on privacy and security issues in wireless information networks to allow use of these modern, flexible systems in critical business and government applications. Another key focus has been the development of automated design tools that allow wireless service providers to cost-efficiently design and deploy wireless networks for personal communication services.

In the area of advanced digital networks, GTRI has concentrated on integrating advanced satellite communications services with Integrated Services Digital Network (ISDN) technology. One such effort involves the use of landline ISDN with the NASA Advanced Communication Technology Satellite system to establish a multimedia network for voice, data, image, and video information. This project is illustrative of a broader focus in GTRI on interoperability of various types of telecommunications media including broadband services and techniques such as asynchronous transfer mode. We have also focused on the development of pilot networks to demonstrate broadband information service concepts. These projects have involved support network developments for distance learning applications; connection of multiple test and evaluation ranges to allow distributed, real-time test operations; and connectivity of multiple law-enforcement agencies to allow more effective cooperative investigation.

GTRI is focusing on integrating advanced satellite communication services with Integrated Services Digital Network technology.

Another area of increased activity involves telecommunications technology assessment. Our engineers are supporting industrial and government sponsors in characterizing the performance of various communications systems and techniques. This information is used by industry and government alike to guide investment strategies for information systems and related components. Evaluation of design techniques and approaches to system elements such as switching and multiplexing equipment, modulation and coding subsystems, protocols, network management systems, and information security schemes allows sponsor organizations to stay on the leading edge of communications system design. Modeling and simulation are used as key elements of technology assessment and performance evaluation studies. GTRI-developed models are used to characterize system and network performance before committing to design details, resulting in cost-efficient and effective designs for a variety of communications applications.

In the future, GTRI will continue to apply advanced telecommunications technology to product designs for the vendor community in the areas of wireless systems and advanced digital transport systems and networks. We also will support the development of new services by service providers in the telecommunications marketplace by resolving technical issues that are critical to business cases and deployment plans. In keeping with GTRI's focus of meeting the needs of industry, our engineers will extend support to the educational, medical, and business communities that enhance competitiveness and spur economic development.

Computer Science and Technology

Research programs in computer science and information technology focus on topics such as decision support, imagery processing and compression of data, network management, and artificial intelligence.

These efforts involve stand-alone workstations as well as networks of cooperating database and simulation systems, including multi-level secure networks and embedded systems. Our researchers also have extensive experience in information system design as well as development and life-cycle support.

A variety of software engineering projects are in progress, with special emphasis on basic research in methodologies, languages, and management. Through these activities, we are establishing methods for application and standardization in government and industry. One recent program applied these principles to the development of multiple software-intensive products and also supported external organizations in assuring that the appropriate software engineering methods are used in other programs.

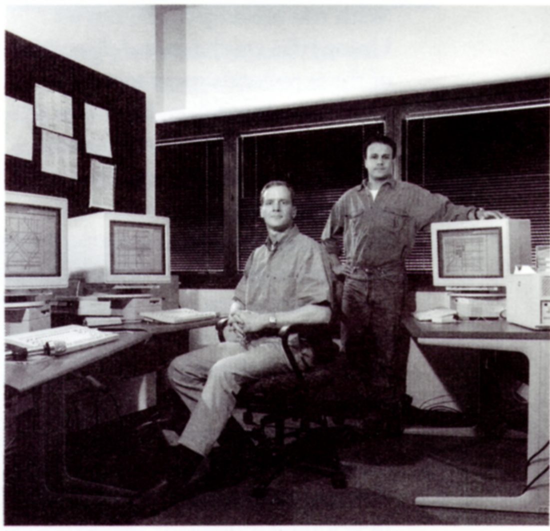
GTRI has enhanced its expertise in decision support systems by fielding more than 700 TEMPEST-certified workstations throughout the world to support intelligence analysis. These workstations have introduced technical innovations in geo-referenced data display, image manipulation, and advanced networking architecture. Our researchers developed the primary software for the Tactical Air Forces Mission Support Systems. This software applied optimization principles to penetration analysis, threat processing, and autorouting components, as well as to the design and development of portions of the flight planning software. GTRI also assisted in developing the Heuristic Route Optimization (HERO) program to aid in sophisticated threat/penetration interaction and route analysis for force level applications.

A neural network approach is being used for advanced traffic management.

In artificial intelligence and neural networks research, we have built expertise in autonomous vehicle systems, knowledge-based route planning, image understanding systems, intelligent data fusion, and heuristic planning and scheduling. Generic expert system tools previously developed by GTRI for the military have been incorporated into prototype systems that solve traffic routing problems. These tools allow real-time simulation and analysis of complex traffic flow. The goal of this research is to reduce congestion and travel time, and to provide real-time alternate route options for travelers.

Modeling and simulation are critical technologies for development at GTRI. These methodologies have proven beneficial in understanding, assessing, and demonstrating a wide range of technical disciplines, including electronic circuit design and computer architectures. Our researchers gained valuable experience in this field by enhancing an advanced modeling and simulation system that evaluates avionics designs for the Army's proposed Light Helicopter.

In human factors studies, our researchers have applied ergonomic principles to improvements in manufacturing processes and equipment performance. We also implemented an environment for aiding test engineers in the creation and maintenance of test program sets for analog and hybrid circuit cards. This Automated Test Equipment Software Support Environment (ATESSE) simulates performance of normal and faulty circuits, aids in determining proper testing tolerances, automatically generates software from test-specification flowcharts, and compares circuit simulations to actual circuit operation.



Researchers have designed a neural network system called TERMINUS for adaptive real-time control of traffic lights.

GTRI's experience in communications and systems engineering includes all aspects of high-speed wide area network design and implementation; network standards, software, and protocols; network management systems; leased communications services; video and audio conferencing systems; switching and multiplexing equipment; and military and commercial specifications. We also are developing an automated intelligence processing local area network that incorporates imagery, automated cartography, database distribution, and electronic mail. This system has been used to connect tactical intelligence nodes to national intelligence systems.

Simulation Systems

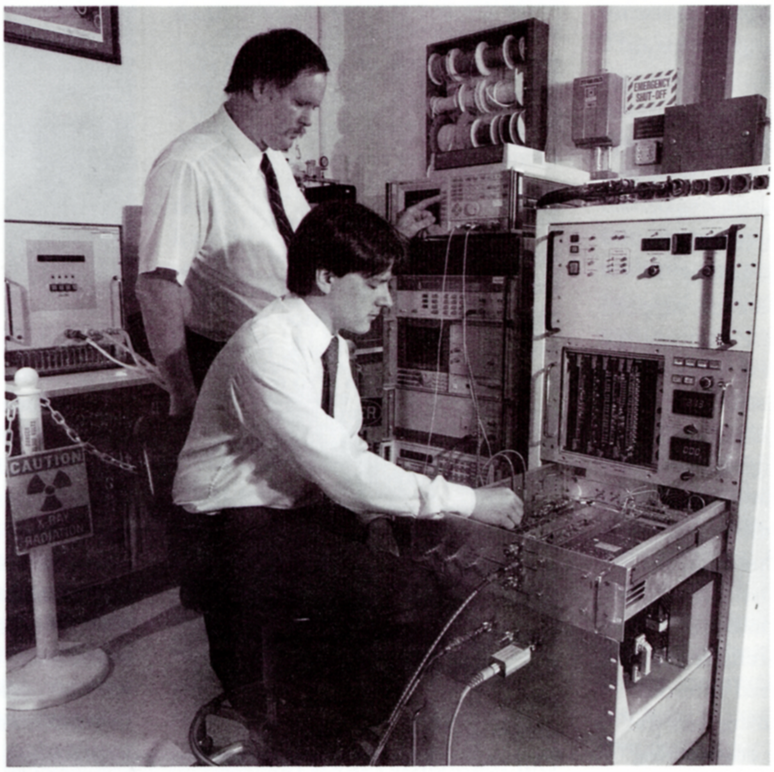
GTRI is widely known for its work in analyzing and simulating foreign weapon systems.

We have achieved large savings in testing costs by integrating advanced microwave technology, digital signal processing, and innovative structures.

With the breakup of the Soviet Union, the emphasis and direction of these research programs are rapidly evolving from hardware prototypes to computer simulations. Our engineers and scientists are staying abreast of this changing environment so that we can continue contributing to America's national security.

GTRI has responded to decreased U.S. defense budgets by developing innovative methods for reducing the cost of testing advanced electronic systems. The development of "smart" signal sources allows researchers to replicate realistic signals in space and evaluate the response of electronic systems. We also have achieved significant savings in testing costs by integrating advanced microwave technology, digital signal processing, and innovative system structures into GTRI simulation programs.

The sophistication of threat radar systems imposes stringent requirements on transmitters in current threat simulations. To meet this need, our researchers are designing and developing a variety of coherent, highly stable, and high-power threat transmitters. GTRI is supporting these programs through modernization of a high-power laboratory facility where transmitters and other high-power systems can be developed and tested in a safe, controlled environment. This facility supports both coherent and non-coherent systems with multiple megawatts of peak RF power and multiple kilowatts of average RF power capabilities. It also is equipped with highly accurate instrumentation for testing and characterizing a full spectrum of transmitted waveforms.



GTRI researchers are developing high-power transmitters for advanced radar systems.

In other programs, our engineers are designing threat emitter systems to meet the nation's test and evaluation requirements. These systems range from high-power tracking signal sources to low-power training assets. Multi-purpose emitter systems are expected to play a vital training role by providing a single system that economically replicates a wide range of threat waveforms.

We also are placing strong emphasis on embedded computer systems for system control and data acquisition. Computer control is needed so that system parameters can be reconfigured without hardware redesign and increased system complexity can be fully simulated.

Finally, GTRI has developed a new antenna array technology for former Soviet Union (FSU) simulators. This technology is based on the troughguide, a component that has been used in FSU antenna arrays but not in Western antennas. The troughguide is an extremely durable unit, not subject to failure due to vibration or shock.

Although the breakup of the Soviet Union has significantly changed the nature of the threat to America's national security, many areas of the world continue to be susceptible to political and military instability. This volatility is especially evident in a number of Third World countries, some of which pose a threat to American national interests, if not its national security. Many of these nations have acquired, and continue to acquire, modern weapon systems from various client nations. Because U.S. forces may face such threat systems in some future military confrontation, simulation research is an ongoing requirement. GTRI expects to continue helping the Department of Defense in strengthening its knowledge of potential adversaries.

Radar

GTRI researchers use extensive radar systems engineering and analysis capabilities to support both government and the private sector by developing new radar systems and by enhancing existing systems to satisfy increasingly stringent mission requirements.

Our researchers use computer simulations to predict radar performance under the full range of environmental conditions.

Our researchers have experience in surface-based and airborne systems, including both tactical and strategic radars. Specific capabilities include large low-frequency surface-based surveillance radars for defense against aircraft and missiles, air traffic control precision approach radars, airborne intercept pulse Doppler radars, and millimeter-wave sensors and seekers.

Researchers at GTRI use computer tools and simulations to predict radar performance under the full range of environmental conditions including benign weather, inclement weather, and jamming conditions. We are also active in the development of millimeter-wave radars for delivery to the government, design and testing of radar simulators for electronic counter-countermeasure evaluation and missile threat simulators, and conceptual designs for new surveillance and point defense radars based on free electron laser-powered transmitters.

GTRI has a broad base of expertise in the modeling, simulation, and signal processing aspects of radar. Our researchers are well versed in the technologies associated with mathematical modeling and computer simulation of radar phenomenology and radar system performance, modeling and prediction of radar target and clutter signatures, radar signal processor analysis and design, and sensor fusion. We have developed sophisticated computer codes that permit modeling of the radar cross section of complex targets such as ships, tanks, fixed and rotary wing aircraft, and missiles. We have also designed and evaluated signature control techniques for application to those targets.

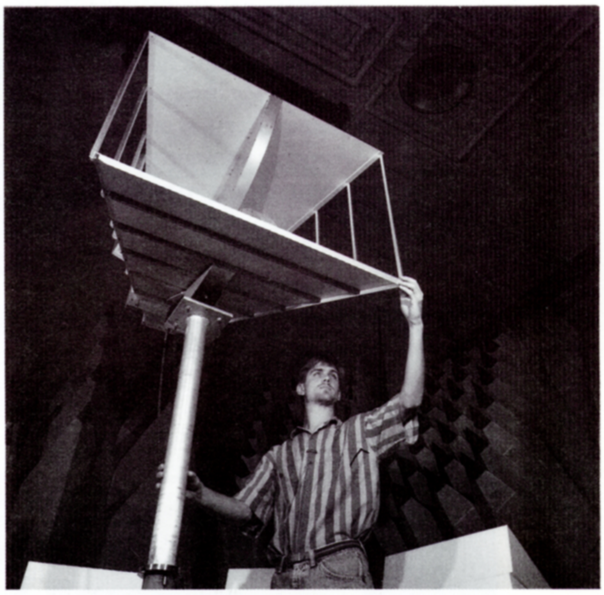
GTRI's imaging-radar expertise has led to the development of signal processing techniques applicable to a visual landing aid for use in commercial and military aircraft for landing in poor visibility conditions. The technique uses a real-aperture millimeter-wave radar to map the scene along the glide slope and display it on a pilot's head-up display.

Researchers at GTRI have investigated both single-mode and dual-mode seeker performance, developed sensor-fusion techniques, and provided technical expertise for several smart-weapons development programs. A major GTRI contribution was the development of a technique that allows the adverse effects of millimeter-wave and infrared scene misregistration to be compensated through use of measurements made by the seeker during flight.

Our researchers have also developed and demonstrated an enhanced dual-mode signal-processing algorithm for target detection and discrimination. This algorithm utilizes target range information from a millimeter-wave sensor to optimize the target-detection and target-feature-extraction performance of an infrared sensor. The algorithm also utilizes scene-registration data to correlate detections in order to maximize the probability of detection while keeping false alarms at a very low rate.

Other areas in which GTRI researchers are very active include basic research in the fundamental constraints on radar detection and tracking performance, and the use of radar-like signals to characterize the electromagnetic scattering by complex objects. We have established unique capabilities in the use of ultra-wideband signals and finite difference time domain modeling techniques for radar signature characterization.

In the future, we will continue to explore new areas where our broad strengths in radar systems engineering and analysis can be applied. New initiatives include intelligent vehicle/highway systems applications such as the automated highway system, microwave powered vehicles, and run-off-road collision avoidance systems. We will also continue to emphasize the further development of modeling and simulation capabilities to offset the high cost of hardware development and testing.



GTRI maintains a facility that measures electromagnetic emission and reflection characteristics of materials in the UHF spectrum.

Electronic Defense

Outstanding capabilities in electronics theory, software design, and hardware development have enabled GTRI to make important contributions to national defense for more than four decades.

Today, GTRI continues to play a key role in developing many electronic defense concepts from basic research through all phases of development to integration into operating forces.

As defense budgets decline, new emphasis is being placed on modifying existing systems rather than designing, manufacturing, and fielding expensive new systems. GTRI has developed a strong capability for inserting new technology into older electronic systems by redesigning major portions of these systems to take full advantage of the latest technological developments. Through such improvements, the reliability, maintainability, and performance of older systems can equal that of newly designed systems but at a small fraction of the cost.

Another alternative to the development of new systems is the integration of existing defensive and offensive avionics systems. A major concern, however, is the interoperability of electronic warfare systems that were designed independently of one another, especially when several such systems are needed in the same aircraft. GTRI researchers have performed detailed analyses of the intersystem interference that can result, and have designed and built interfacing hardware and software to make these systems operate compatibly. In addition, our software engineers and human factors specialists have developed integrated systems that consolidate electronic warfare controls and displays, and coordinate system responses.

GTRI researchers are helping defense agencies save development costs through modification of existing systems.

GTRI is developing innovative auditory display concepts. This interactive task evaluates the listener's ability to identify complex audio coding of control room processes.

GTRI researchers have designed and built numerous support stations to aid in the laboratory testing, development, and maintenance of both software and hardware for electronic warfare systems. We have constructed integrated support stations and engineering support stations for radar warning receivers, chaff and flare dispensers, and complex defensive avionics suites. Using these stations, logistics professionals can test existing hardware and software as well as proposed changes that could enhance system performance, reliability, maintainability, and supportability.

GTRI researchers have extensive experience in the mathematical modeling and analysis of electronic warfare systems, including coherent radars and countermeasures. Since 1984, for example, we have performed fundamental analyses of spread spectrum, pulse compression, and pulse-Doppler radars. We have also developed several new electronic countermeasures techniques for these types of radars and performed parameter sensitivity analyses to evaluate the most effective parameter settings.

As the electromagnetic environment becomes more densely populated, the study of intrapulse characteristics and measurement techniques will become increasingly important. Over the past decade, our researchers have collected and analyzed the intrapulse characteristics of a large number of radar systems. We have also designed and built an advanced radar signal simulator capable of simulating radar pulses with almost any desired intrapulse characteristics.

In other work, our researchers are applying neural network technology to a particularly difficult problem of pattern recognition by engineering and simulating selected paradigms for comparison with existing algorithms for classical techniques. A variety of neural networks have been simulated and modified for use, alone and in combination.

While electronic defense will remain an important part of our research program, we will continue to look for civilian applications for our expertise in defense technology. In the medical field, for example, our unique signal processing algorithms for Doppler processing can be applied to processing of magnetic resonance imaging waveforms. Currently, this capability is in use for research on Alzheimer's disease. Similar waveform capture and analysis capabilities are applicable to development of devices for physically disabled persons.

Electromagnetic Environmental Effects

A long-term research specialty at GTRI involves the control of undesirable electromagnetic interactions between individual elements of electronic systems and between those systems and their environments.

Our researchers have built sensor-based monitors for measuring stresses caused by lightning, radar, and power system transients.

GTRI specialists in electromagnetic environmental effects stress practical approaches to problems encountered in the development, use, and maintenance of electronic systems. Recent programs have focused on sensor development, shielding effectiveness, program management, education, and the electromagnetic susceptibility properties of complex integrated circuits.

Today's command, control, communications, and intelligence systems are disrupted by temporary environmental extremes. In many instances, a system will return to normal operation with no cause for failure ever found. Future hardware will incorporate time stress measurement devices to monitor, in real time, environmental stresses such as temperature, relative humidity, corrosion products, vibration, and power supply over and under voltage conditions. Our researchers have developed a capability for building sensor-based performance monitors that measure the electromagnetic stresses produced by lightning, radar, and power system transients. These capabilities will be added to time stress measurement devices.

One means of protecting the avionics systems in highly complex aircraft is to install sophisticated shielding. Our researchers are experienced in evaluating the shielding effectiveness of fixed- and rotary-wing aircraft and have created a novel testing technique for these purposes. We also have developed a dual, transverse electromagnetic (TEM) cell that can be used to evaluate the shielding effectiveness of planar materials and electromagnetic interference gaskets. The dual TEM cell was validated with calibration samples and was shown to provide accurate measurements of both electric and magnetic field shielding effectiveness.

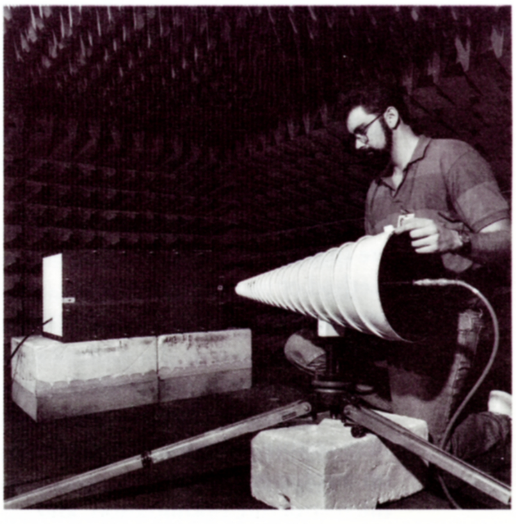
Managers of programs that oversee complex systems often need more knowledge to ensure that undesirable electromagnetic interactions do not occur. GTRI engineers have compiled various written and video-based materials to guide managers through this process. Recent work addresses the techniques that managers need to deal with evolving electromagnetic threats such as high-power microwave and ultra-wideband environments.

Our educational efforts have not been restricted to the development of handbooks. GTRI researchers recently hosted and trained visiting scientists from the Society for Applied Microwave Electronics Engineering and Research Centre of Electromagnetics in Madras, India. Six of these scientists participated in a three-month fellowship covering a variety of electromagnetic environmental effects disciplines.

Another base of research experience involves engineering and management support for upgrading the electromagnetic compatibility features of helicopters. GTRI also actively supports industrial companies that manufacture electronic equipment or operate in a dense electronic environment. A more recently developed capability is enabling our researchers to shed light on the electromagnetic susceptibility properties of complex integrated circuits.

GTRI is placing increasingly strong emphasis on civilian applications of defense-oriented technology, and specialists in electromagnetic environmental effects are working actively in this area. One topic of strong interest is the smart home, which incorporates a complex array of electronic systems into a single residence. Electromagnetic compatibility will be critically important to the success of smart homes, and our researchers have gathered experience that is highly applicable to these developments.

Electromagnetic environmental effects is also a major concern in advanced traffic management. For intelligent vehicle and highway systems to work reliably, traffic control equipment must be protected from the effects of transients. GTRI researchers have designed a set of procedures, handbooks, training manuals, and videotapes to help explain the principles of transient protection technology to traffic engineers and technicians. Traffic control systems are expected to grow even more complex in the near future, and we expect to be involved in helping to protect them.



Researchers study the electromagnetic shielding effectiveness properties of composite materials.

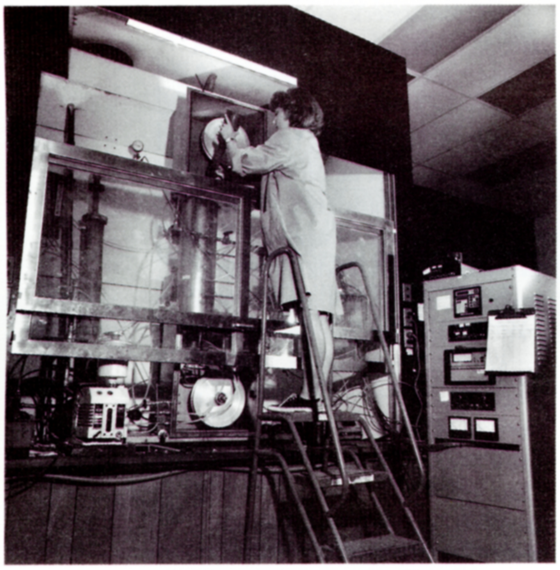
Materials Science

For more than 45 years, GTRI researchers have maintained a strong capability in advanced materials research.

GTRI has revamped its zeolites and clays research program and is generating microporous solids for the petroleum and chemical industries.

Our researchers work in diverse areas such as advanced synthesis and processing, composite ceramics, advanced coating/deposition technology, materials characterization, microporous solids, metallurgy, and polymers.

Research in advanced synthesis and processing has focused on self-propagating, high-temperature synthesis (SHS) and reaction bonding techniques. The SHS program has developed a low-cost method of producing high-quality ceramic materials such as titanium diboride and titanium diboride/aluminum oxide composites. These materials offer high-temperature strength, toughness, and wear resistance. We are studying reaction bonding as a method of incorporating new ceramic fibers into a silicon nitride matrix.



This continuous fiber-coating furnace is allowing GTRI researchers to improve methods for coating advanced composites.

GTRI's ceramic composites research program involves ceramic fiber testing, microstructural effects on mechanical properties, microstructure optimization, and chemical vapor infiltration (CVI) modeling. Through fiber testing, we have worked with industrial clients to improve single filament strength and modulus at room temperature and elevated temperatures to 1400°C. Another objective of these tests has been to measure thermal expansion and the bend-stress-relaxation qualitative creep characteristics of different fibers. Studies of microstructural effects and optimization have dealt mainly with particulate reinforced matrices. Our researchers have used CVI modeling to create a predictive computer code for the densification of ceramic matrix composites. This model has enabled us to propose new processing conditions that speed densification and uniformity of the final composite.

CVI and chemical vapor deposition (CVD) are two methods for preparing ceramic coatings and composites. Our research stresses materials preparation for structural, tribological, electrical, optical, and corrosive/oxidation protective applications. For instance, carbon coatings and matrices containing oxidation inhibitor phases such as boron- and silicon-bearing compounds are being prepared by CVD and CVI techniques, respectively. Extending CVI/CVD technologies beyond high-performance defense-based applications is an important new R&D direction for GTRI. We are pursuing biological applications such as preparation and evaluation of diamond and diamond-like carbon coatings for mechanical heart valves and other prostheses.

GTRI researchers are at the forefront in the numerical modeling, formulation, and characterization of artificial dielectric materials for electromagnetic applications. These materials have applications to composite structures such as radomes, windows, and absorbing materials or structures. Recent materials formulations include fiber composites, ferrites, periodic surfaces, and resistive films and fabrics.

GTRI has revamped its zeolites and clays research program and is focusing on the generation of microporous solids of interest to the petroleum and chemical industries. We are investigating environmentally benign methodologies of catalyst preparation, giving particular attention to projects dealing with the preparation of catalysts capable of generating transportation fluids in compliance with clean fuel regulations. Research is also focusing on the synthesis of novel zeolites, expanded clays, and chemically modified materials that can be part of catalysts used in hydrocarbon conversion reactions, sulfur and nitrogen oxide abatement, and the production of chemicals from natural gas.

Materials characterization specialists participate in research and provide problem-solving assistance to Georgia industry. Areas of expertise include interfaces, thin films, and small particulates and phases. Specific capabilities include electronic interconnects, ceramic composites, clay, paper, asbestos, electroless nickel, carbon systems, and catalysts. A $1.5 million grant from the National Science Foundation for a high-resolution analytical electron microscope has significantly enhanced our characterization facility.

The polymers and coatings program conducts research in a wide range of polymeric materials and organic coatings. Recent projects have focused on polymeric tactile sensors for robots, low volatile organic compound coatings, low observable materials, infrared identifier tapes and materials for military vehicles, and liquid crystal display devices.

Manufacturing Technology

GTRI conducts comprehensive programs in manufacturing R&D including basic materials and process-level investigations, controls research, systems planning, and pilot-scale production.

Programs in interconnect technology and electronic packaging benefit from GTRI micromechanics labs.

Our researchers work with government and industry to address challenges in manufacturing competitiveness. We are responsive to the needs and schedules of our sponsors and draw on multidisciplinary talents from research and academic faculty throughout Georgia Tech. GTRI benefits from major new facilities in Tech's Manufacturing and Microelectronics Research Centers.

In microelectronics, our researchers have contributed to the manufacturability of numerous microelectronic devices in III-V and II-VI compound semiconductors, as well as in silicon. These include high-speed electronics, multichip modules, display devices, laser diodes, microwave and millimeter-wave sources and receiver elements, and infrared and visible receivers.

Strong capabilities in optoelectronics have led to research on manufacturing integrated optoelectronic devices for sensing, signal processing, and photonic interconnects. These devices, in turn, are being developed for prototype manufacturing control sensors and sensor systems.

Programs in interconnect technology and electronic packaging benefit from unique GTRI micromechanics laboratories. Our researchers are studying the durability and manufacturability of very small solder bonds as well as the fine leads and traces that are characteristic of electronic packaging.

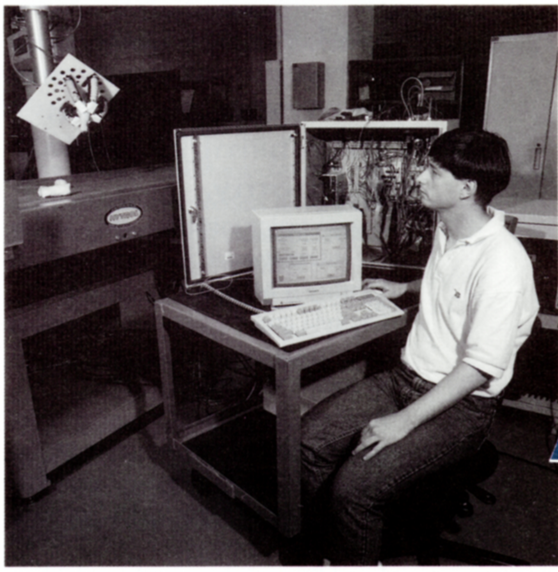
Research in life-cycle engineering has led to the development of computer-aided engineering systems for use in the design of electronic systems and automated test plans. These concepts are being extended to incorporate models of mechanical performance and electronic reliability and durability. Computer-aided engineering tools have also addressed other areas such as diagnostics and plant layout and design.

Ceramic composites development is another focus of manufacturing research at GTRI. High-temperature aerospace components based on these high-performance materials often come in complex shapes that require special process controls. Models developed here are helping manufacturers greatly reduce the level of trial and error in preproduction experiments. Our researchers also conduct research on new material synthesis and production scale-up, not only for ceramic composites, but also for polymers and a wide range of other materials.

In machine vision research, black and white, gray-scale, and full-color applications have been developed for the food processing, apparel manufacturing, and electronics industries. Special sources and cameras spanning infrared to x-ray frequencies are being used.

GTRI robotics research addresses important challenges in industries that are intent on improving quality and reducing workers' repetitive motion injuries. In food processing, apparel, and composites manufacturing, new end effectors are under development to manipulate nonrigid objects. We also conduct research in advanced material handling systems, such as automated guided vehicles. For these, we have developed new guidance and control systems.

Microfactories are a research interest of growing importance at GTRI. As part of a Department of Defense ManTech program, we have developed the Apparel Manufacturing Technology Center that includes a microfactory for experimental production of military uniforms. Similar facilities exist for food processing and are under development for electronics manufacturing.



Researchers are developing adaptive grasping devices for handling deformable and slippery objects in robotics applications.

GTRI's food processing program emphasizes poultry industry needs. Researchers are developing an integrated-optics, rapid microbial detection biosensor that promises to speed food safety analysis. Other projects focus on the use of robotics for removal of food products from assembly lines and safety studies aimed at reducing cumulative trauma injuries to workers.

As GTRI looks to the future, we recognize the importance of the manufacturing dimension in new technology development. To that end, we are positioning ourselves for a leading role in manufacturing research for industries vital to the state and national economies, including electronics and communications products, textiles and apparel, and food processing.

Economic Development

GTRI offers a variety of economic development and technical assistance programs, which are helping business and industry in Georgia to be more competitive in an increasingly global economy.

GTRI economic development specialists are helping Georgia businesses to learn more about international quality standards.

GTRI engineers assisted Tomco Equipment Co. and Volumatic, Inc. in Loganville in developing a carbon dioxide cleaning system for industrial applications.

In one major initiative, the Center for International Standards and Quality is helping exporters in Georgia and the Southeast improve their knowledge about international quality standards in other nations. This center has established an ISO 9000 Users Network in metropolitan Atlanta and launched its international standards retrieval and information service (SQUIRE). In addition, it has conducted 20 training courses attended by more than 500 representatives of Southeastern firms.

Industrial extension activities continue to have a positive economic impact on Georgia, with approximately 5,500 assists to companies and communities in the last fiscal year. To cite just a few examples, the Georgia Procurement Assistance Center helped a small electronics firm win a $312,000 contract from Warner Robins Air Logistics Center. In addition, the Southeastern Trade Adjustment Assistance Center provided 33 technical assists to regional firms hurt by competition with imported products. Finally, implementations of plant layout recommendations made by our Savannah Regional Office contributed to a $3 million expansion at Carson Products.

GTRI continues to play a role in the state policy-making process. Our researchers have completed a study for the State Office of Planning and Budget that assessed how neighboring states' incentives policies affect Georgia's competitive position for industry location. We also performed additional work on a benefit-cost model for the state and seven Georgia metropolitan statistical areas. The Georgia Power Company and the Department of Industry, Trade, and Tourism already have requested runs of the model to assist in their industrial recruitment efforts.

Technology transfer is a major objective of our economic development efforts. To this end, we have launched a pilot program, the Technology Transfer Initiative, which is designed to identify and assess the research and development requirements of Georgia firms and to determine ways that GTRI can help to meet these needs. The program promises to increase our involvement in Georgia's commercial/industrial sector, a significant transition in this era of declining defense contracts.

GTRI's economic development and technical assistance program is merging into a new Georgia Tech Economic Development Institute (EDI). This entity will provide a single entry point to all of Tech's economic development, technology transfer, and new enterprise development activities. EDI's goal is to improve the accessibility of Georgia Tech resources and enhance delivery of services to the state of Georgia. It also seeks to encourage student and faculty participation in the economic development process and implement innovative economic development partnerships with the private and public sectors. EDI will give Tech's economic development efforts greater focus and visibility. Its management foresees strong, continuing interactions with GTRI in the areas of technology needs assessment, environmental sciences, industrial hygiene, and materials science.

Environmental Science & Technology

In indoor air quality research, a 53-liter chamber is used to test a variety of materials for volatile, organic, and other types of ambient emissions.

Indoor air quality specialists are developing methods to detect contaminants in ambient air, building products, and furnishings.

GTRI provides research and development services, technical assistance, and technology transfer on issues related to environmental and occupational safety and health.

Through these programs, our researchers stress sustainable development in seeking technological solutions that reduce waste or natural resource degradation. We address environmental issues in a holistic way, combining environmental science and engineering approaches.

With growing pressures on the global environment, GTRI's expertise is in demand in Georgia, the nation, and the world. In cooperation with the U.S. Environmental Protection Agency's Hazardous Substance Research Centers, we perform basic and applied research to solve contaminated-sediment and other hazardous-substance problems. Our researchers also participate in the Georgia Environmental Technologies Consortium, seeking environmentally sound economic development. In addition, we work with Electricité de France to promote environmental research and education and in the city of Bourdeaux, France, we are helping to use plasma-arc technology for waste destruction. Finally, we promote environmental training in Central America and the Caribbean, and assist Eastern European and Asian countries in designing models for environmental recovery, management, and policy implementation.

Environmental engineering research emphasizes treatment and use of technologies for pollution prevention and waste reduction. Areas of focus include industrial wastewater treatment, municipal solid waste treatment, industrial waste-reduction processes, plasma-arc technology, and energy-reduction technologies. Our researchers are designing technologies to return byproducts of wastewater treatment systems, such as sludge and biogas, to the system, for use as energy. We are using plasma-arc technology to process municipal solid waste and ash from incinerators, for later use as construction materials. Researchers also are using environmental sensors for direct detection of ammonia and complex organics.

Indoor air quality researchers are developing new methodologies for detecting contaminants in ambient air, building products, and furnishings. Through this research, we are defining detection limits and capabilities to more refined levels of precision. We are also designing systems to remove airborne contaminants, including one that uses hydrogels to trap airborne contaminants.

For the past 15 years, GTRI scientists have studied the earth's atmospheric chemistry, increasing knowledge of environmental issues such as climate modification, depletion of the stratospheric ozone layer, and acid rain. Recent investigations have focused on the sulfur chemistry of the troposphere, the halogen chemistry of the stratosphere, and the free radical chemistry in cloud water. Another notable GTRI capability has involved the development of techniques and instrumentation for measuring trace chemical species. A mass spectrometric instrument is being improved for measurement of the hydroxyl radical, the atmosphere's most important cleanser. In addition, our researchers have used chemical ionization mass spectrometry for measuring the lower atmosphere's ion clusters, as well as important neutral species such as sulfuric acid, methane sulfonic acid, and dimethyl sulfoxide.

Our researchers are active in the occupational health and safety field, providing technology transfer and technical assistance to private and public-sector organizations. Services include site assessments involving safety, industrial hygiene, and ergonomics, with emphasis on hazards in manufacturing, construction, and agriculture. Ergonomics research focuses on the effects of equipment design and workstation layout on worker health, along with causes and prevention of carpal tunnel syndrome and work-related musculoskeletal disorders. Training is another area of emphasis, with continuing education courses in respiratory protection, construction trenching and excavation, environmental toxicology, industrial hygiene, lead abatement, and asbestos abatement.

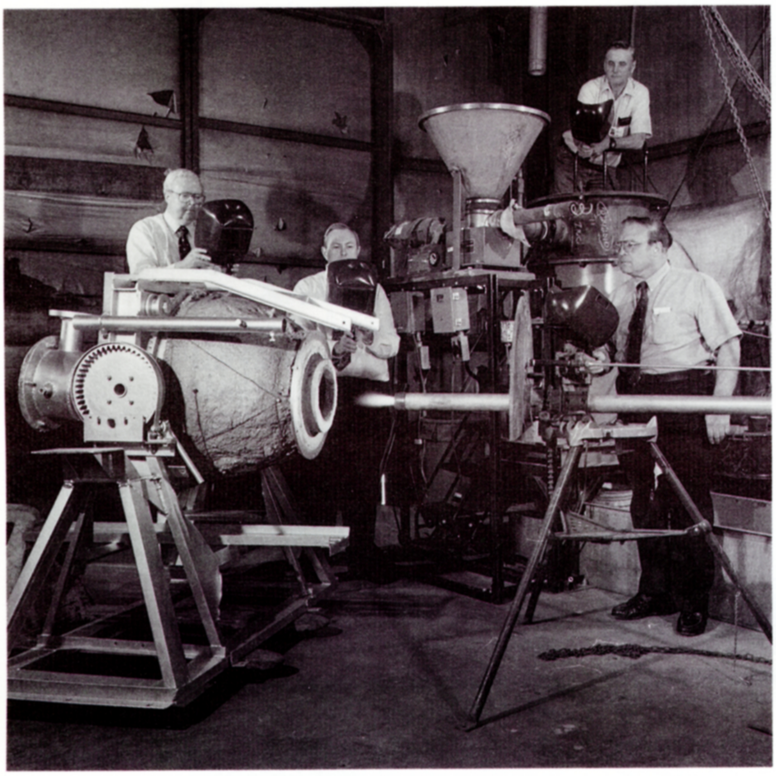
GTRI environmental communications specialists provide a variety of materials for technology transfer. Activities include publications development, workshop and conference facilitation, preparation of proceedings, and the writing and production of course notebooks.

Our researchers also are adapting electronic weapons expertise to environmental uses. One good example is our adaptation of integrated-optics technology to a highly sensitive environmental sensor. Other efforts are using sensor fusion and spatial analysis technologies in pollution and environmental clean-up efforts.

Energy Development

Energy research once again is assuming a high profile at GTRI, with renewed national concern for developing alternative technologies.

Researchers are developing an application of plasma-arc technology that converts waste materials into synthetic gas.



Using helmets for safe viewing, researchers test a rotary furnace with the plasma-arc torch in preparation for asbestos vitrification tests.

These programs are emphasizing the essential link between clean energy and environmental quality. One of our organization's strengths is its ability to link diverse technical skills in research groups that focus on energy use and environmental protection.

Plasma technology for energy and environmental applications is a capability under development by an interdisciplinary team from GTRI and Georgia Tech's Construction Research Center. A plasma is an ionized gas that allows for the conversion of electrical energy into thermal energy without the large volume of gases produced by conventional combustion systems. Researchers are developing an application that would convert waste materials such as municipal solid waste and sludges produced from paper recycling into energy in the form of synthetic gas and other byproducts. The resulting gas could be burned to produce electricity for the torch operation or converted into methanol for use as a transportation fuel.

Another technology under development at GTRI is anaerobic biological waste treatment. These systems eliminate or reduce the pollutant levels of wastes and produce biogas that can be used in energy generation. They can be used to treat wastes from agricultural operations, food processing, and other industrial processes.

Biomass conversion is another of our major research interests. Working with the American Society for Testing and Materials, a GTRI laboratory has developed standard testing procedures for biomass conversion systems that generate energy for raw material feedstock and wastes. Twelve standards have been approved through this procedure to date. New standards are under development in cooperation with the U.S. Department of Energy, the National Renewable Energy Laboratory, and the National Institute for Standards and Technology.

GTRI engineers not only develop new energy-generating technology, but also look for methods that directly aid companies and other organizations in reducing energy use. Two programs for helping companies understand their energy conservation needs are the Industrial Energy Extension Service and the Energy Analysis and Diagnostic Center. The Energy Management Assistance Program (EMAP) assists public school systems in making optimal use of their energy efficiency budgets. In one recent case, GTRI helped Dodge County High School upgrade its lighting and central energy management system, with $120,000 of the total $350,000 costs provided through the EMAP.

We plan to increase our involvement in energy development in the next few years. Strategic planning efforts have identified energy systems and environmental technologies as two of the seven research areas Georgia Tech will focus strongest attention on for interdisciplinary work. Some of the applications of high interest include: photovoltaics, alternative transportation fuels, improved heating and air conditioning systems, geographic information systems, advanced sensors, and entrained flow pyrolysis. In addition, GTRI energy conservation specialists are ready to assist electric power companies in adopting integrated resource planning, which requires utilities to consider all possible options, including conservation, for meeting the state's energy needs.

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Seated from left: Richard H. Truly and Robert G Shackelford. Standing from left: Charles E. Brown, Patrick J. O'Hare, Devon G. Crowe, Edward K. Reedy, and Donald W. Wilmot.

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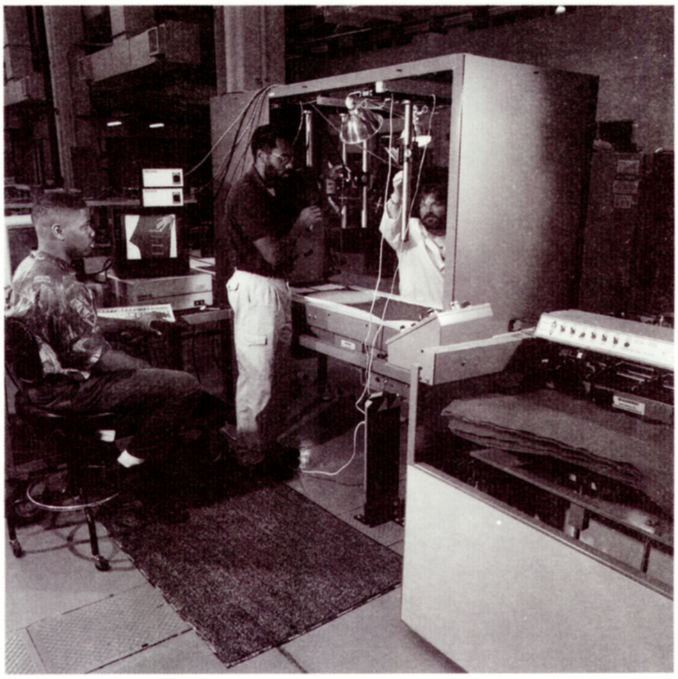

GTRI assists the textile industry by developing on-line inspection systems that utilize computer-vision technology.

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Credits
Editor: Mark Hodges
Graphic Design: Adele Llop
Photography: Rae Adams

Georgia Tech is a unit of the University System of Georgia
$11,800.00/8K/10-93

GT94-018