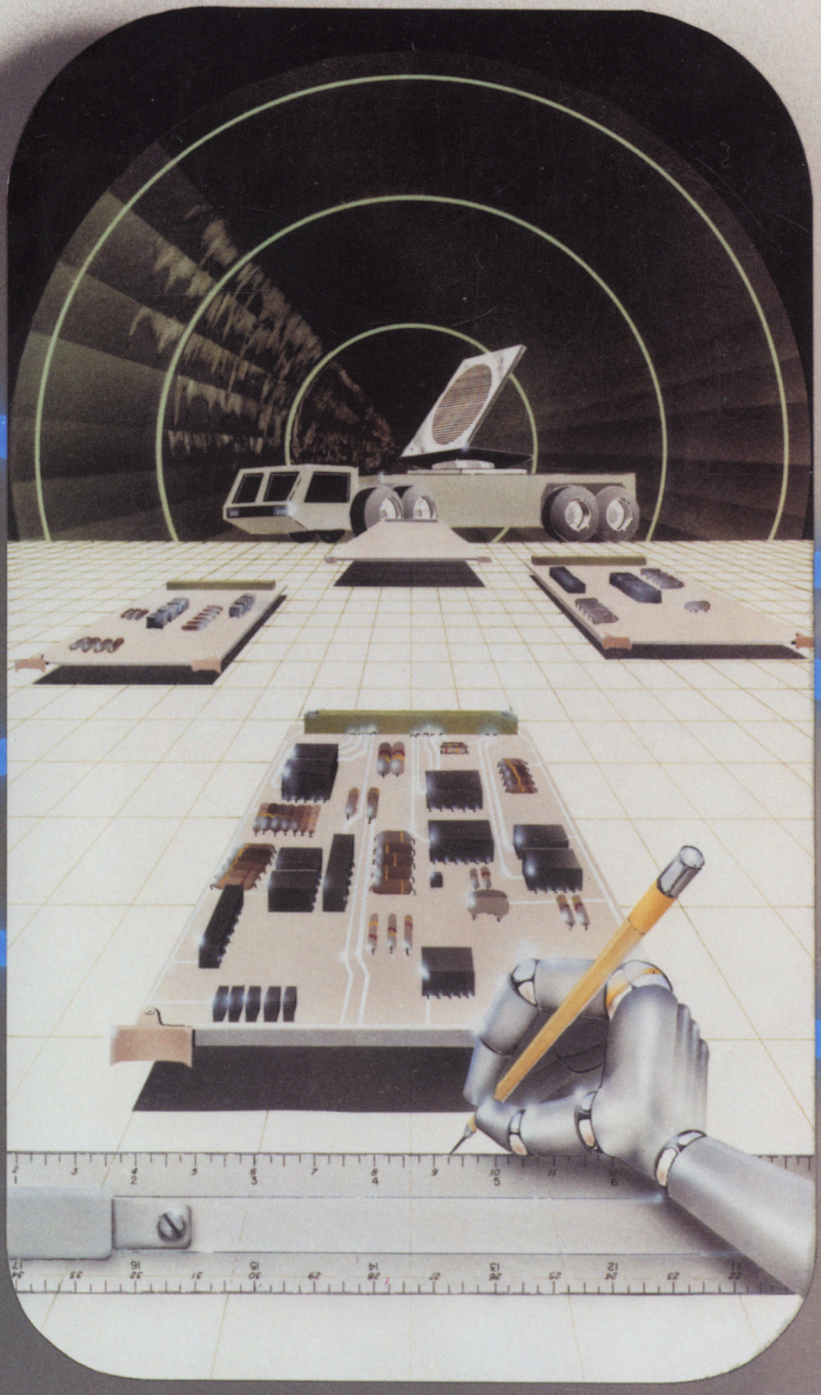
SYSTEMS & TECHNIQUES LABORATORY



GEORGIA TECH RESEARCH INSTITUTE

GEORGIA INSTITUTE OF TECHNOLOGY

CONTENTS

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GEORGIA INSTITUTE OF TECHNOLOGY SYSTEMS AND TECHNIQUES LABORATORY (STL)

STL OVERVIEW

The Systems and Techniques Laboratory (STL) is one of five electronics laboratories within the Georgia Tech Research Institute (GTRI) at the Georgia Institute of Technology. This laboratory has long been active in radar and related technologies. Building on this expertise, STL now has major research initiatives in the following areas:

- Analysis, modeling, postulation, simulation, development, and testing of threat systems
- Foreign technology assessments and system exploitation
- Development of threat radar and threat-related system simulators
- Microwave system developments (antennas, transmitters, receivers, processors, etc.)
- Development of threat C^3 and support systems
- Electromechanical systems design
- Development of instrumentation and measurement techniques
- Hybrid systems integration
- Prototypes and associated manufacturing technology.

The research and development programs of STL are oriented to supporting the national preparedness. A major element of this research is focused to provide foreign radar systems and associated subsystems that are regarded in the U.S. defense community as threats to national security. Conversely, many research programs are diverse to provide a broad selection of important contributions to the test and evaluation requirements of the armed forces. The experience and expertise gained through nearly two decades of dedicated scientists working in foreign systems analysis and development is a rare capability not duplicated at any other university research center. The laboratory enjoys an excellent reputation for their technical achievements in this specialized field and these contributions have resulted in national recognition.

This booklet highlights a number of STL technical achievements, describes areas of expertise, and defines unique facilities. It also defines laboratory relationships within GTRI and connectivities with the Georgia Institute of Technology (all elements established as an integrated non-profit, client-oriented research organization).

RESEARCH AT GEORGIA INSTITUTE OF TECHNOLOGY

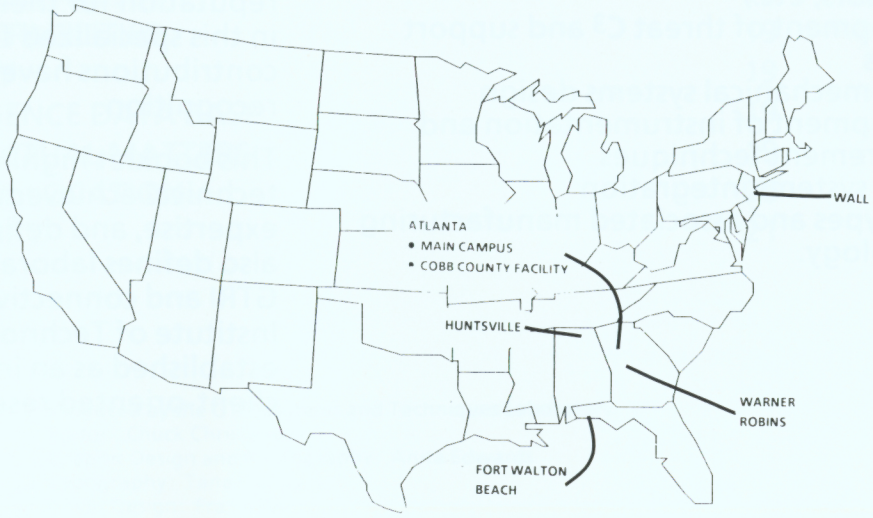
The Georgia Institute of Technology is located in Atlanta and is one of the educational institutions constituting the University System of Georgia. The University System is governed by a 15-person Board of Regents, the members of which are appointed to seven- year terms by the Governor of Georgia. Georgia Tech is pre-eminent among the Nation's high technology schools of higher learning. Georgia Tech ranks third in the nation in the number of degrees granted to undergraduate engineering students and is in the top ten among the Nation's universities in many of the areas of research conducted.

Research at Georgia Tech is conducted within the 17 schools, 12 departments, 20 centers, and the 7 Georgia Tech Research Institute (GTRI) Laboratories. Contracts are administered through the Georgia Tech Research Corporation (GTRC), a non-profit Georgia corporation organized and operated to support the research programs of the Georgia Institute of Technology, including the Georgia Tech Research Institute.

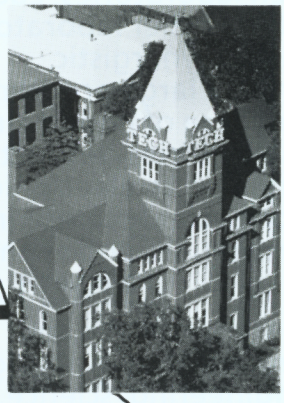
Research by Georgia Tech is conducted in several locations: Five GTRI Laboratories and the academic research activities are located on the main campus, and the Cobb County Facility houses two GTRI Laboratories. A number of test and evaluation facilities, including a unique far-field range complex, are also located at the Cobb County Facility. GTRI also has offices in the following cities:

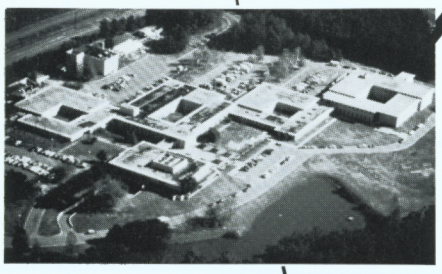
- Huntsville, Alabama
- Wall, New Jersey
- Fort Walton Beach, Florida, and
- Warner Robbins, Georgia.

In addition, GTRI has 12 field offices throughout Georgia that provide extension services for technical and management assistance to Industry and Government.

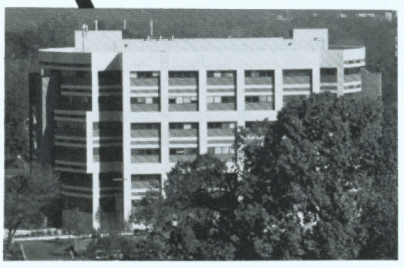


Main Campus





Cobb County Facility



Centenial Research Building

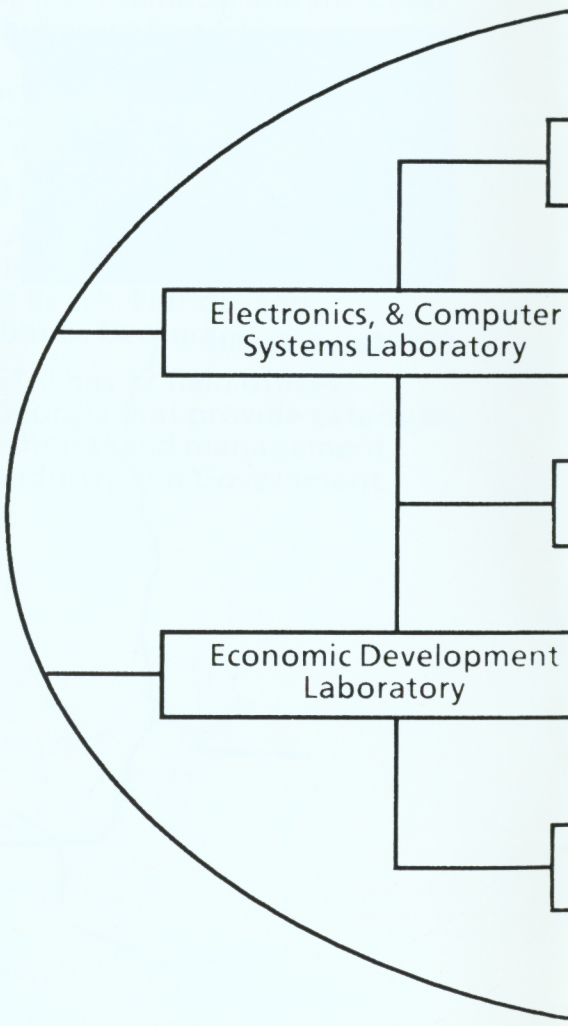
GEORGIA TECH RESEARCH INSTITUTE (GTRI)

For administrative purposes, GTRI is organized into seven laboratories. Each has access to any of the other laboratories' services, thus forming a synergistic network for teaming on large programs. Electronics is a major area of endeavor, and five of these laboratories conduct research primarily related to electronics. Two other laboratories conduct research related to energy, materials, and economic development.

GTRI is a client oriented, analytic and applied research organization carrying out investigations in engineering, science, and economic development for a diversity of sponsors, including federal, state, and local government agencies, industrial firms, and foreign countries. Authorized by an act of the Georgia General Assembly in 1919 and activated in 1934, GTRI was recommissioned by the Assembly in 1960 to:

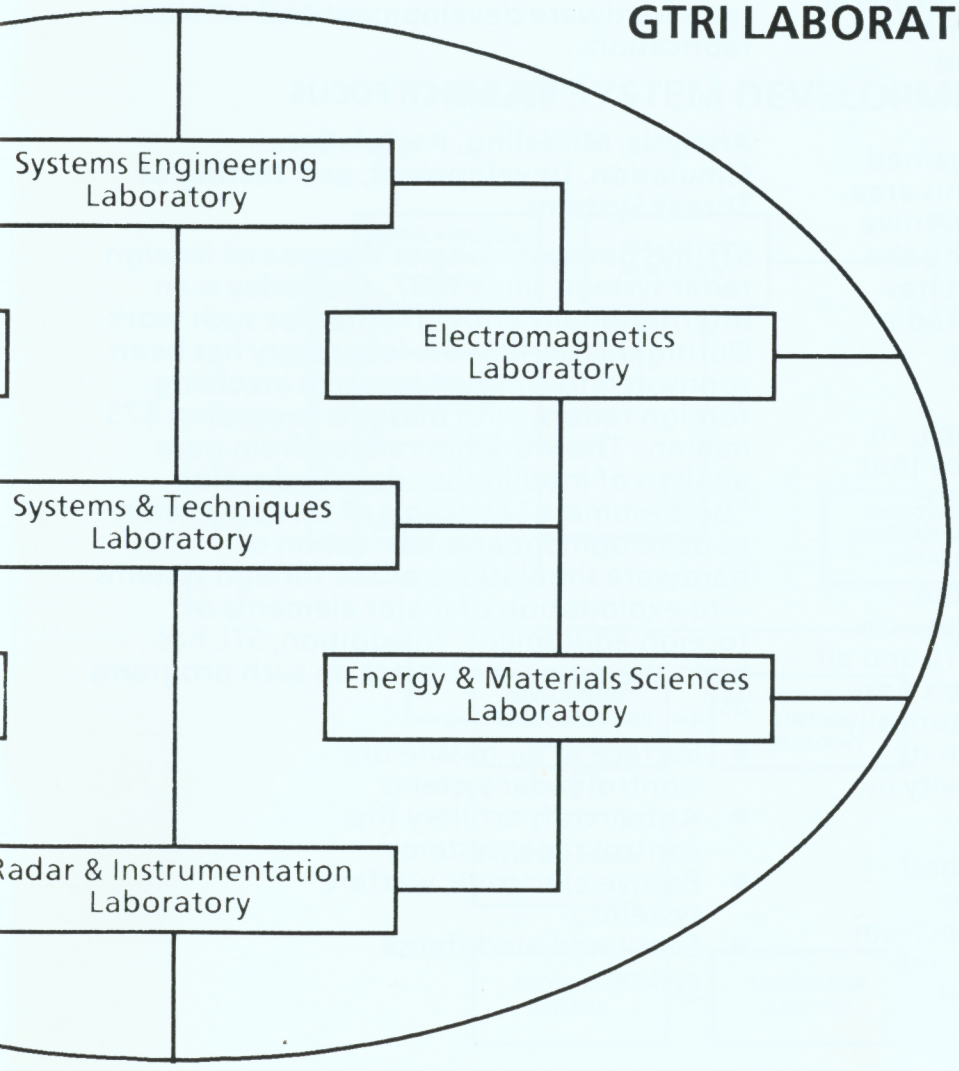
- Aid in the promotion of scientific, engineering, and industrial research
- To advance science, technology, and education, and
- To render assistance to national programs of science, technology and preparedness.

GTRI has been active for decades in most of the recognized fields of science and technology, and has extensive experience in such areas as radar and missile systems, electronic warfare, threat systems, computers, communications, antennas, electromagnetics, optics, material sciences, environmental health science, and associated component phenomenology.



GTRI is also directly linked with the research activities of the Georgia Tech academic colleges through the Vice President of Research, who has cognizance of all research at Georgia Tech. Most of the research at GTRI is supported by contracts with government organizations and with private industry.

GTRI LABORATORIES



STL FACTS AND STATISTICS

Staff and Organization

The staff of STL is uniquely diverse in capabilities and accomplishments. It includes individuals who are well-known nationally in the scientific community for their scholarly achievement and pragmatic contributions to current technology. These individuals are skilled at accomplishing and managing the development of highly functional equipment and systems based on complex design requirements. The technical disciplines represented in the staff include the full spectrum of engineering and fabricating functions. Overlaid on these basic technological capabilities is a knowledge of foreign technology gained through many years of practice in this area. The laboratory's most distinct competitive advantage is the diversity of skills and the expertise represented by a staff that has developed a multiplicity of foreign radar systems during the last two decades.

STL also benefits by its status as a component of GTRI and Georgia Tech. In addition to the prestige bestowed by that affiliation, the access to the corporate expertise contained in the Georgia Tech faculty and staff is an advantage few organizations can offer. Similarly, the excellent facilities and centralized services of GTRI and Georgia Tech benefit STL and all other units. Because of the Institute's non-profit status, the laboratory has historically maintained a close relationship with its sponsors and demonstrated objectivity in solving their problems.

In addition to the 200 professional and support personnel assigned to the laboratory, STL utilizes a broad spectrum of expertise available throughout the Georgia Tech community. Most of the laboratory staff are assigned to divisions specializing in electrical and mechanical engineering disciplines associated with development and prototyping of foreign radars and their support systems.

Large programs may be staffed from the divisions and managed by a program office. This structure enables the laboratory to respond flexibly to contractual challenges ranging from analytical studies to large scale hardware development and fabrication.

RESEARCH FOCUS

Analysis, Modeling, Postulation, Simulation, Development, and Testing of Threat Systems.

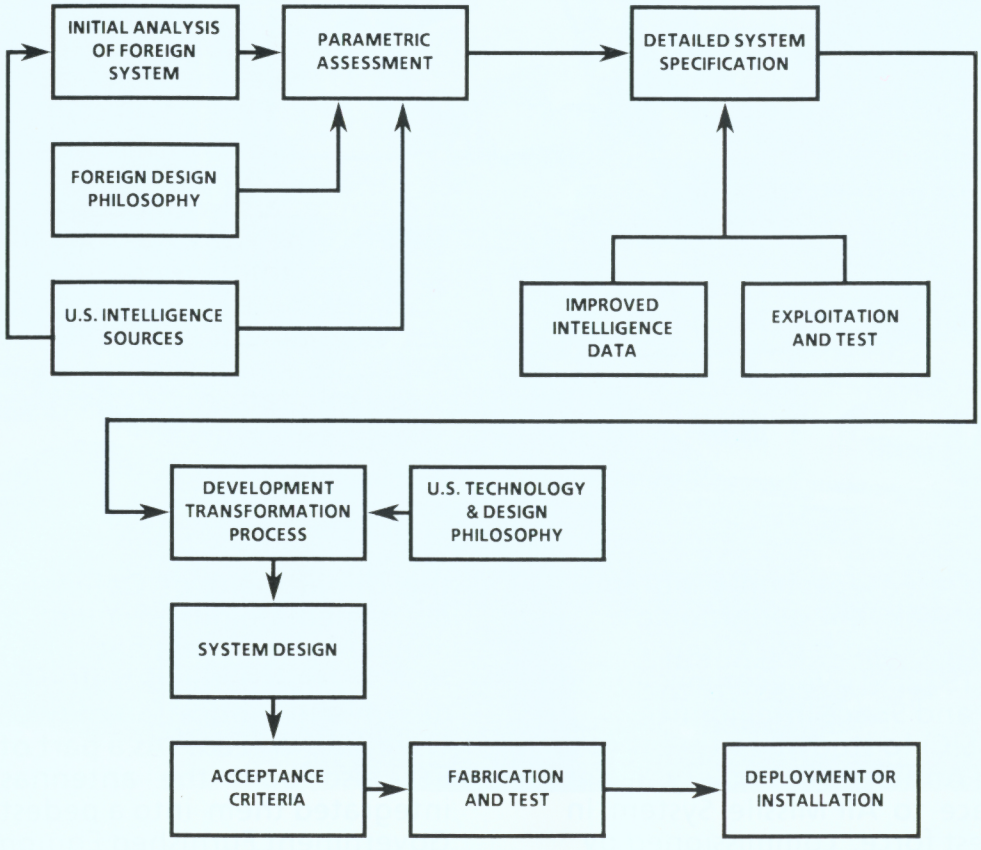
STL has been working in the area of foreign radar systems since 1967, and today is an internationally known center for such work. During this period, the laboratory has been sponsored to conduct research involving foreign radars, with budgets exceeding $75 million. The work has ranged from pure analysis of intelligence data to develop "best estimate" concepts of threat systems -- to development and fabrication of hardware simulations of the foreign systems -- to exploitation of major elements of foreign equipment. In addition, STL has been the prime contractor on such programs as:

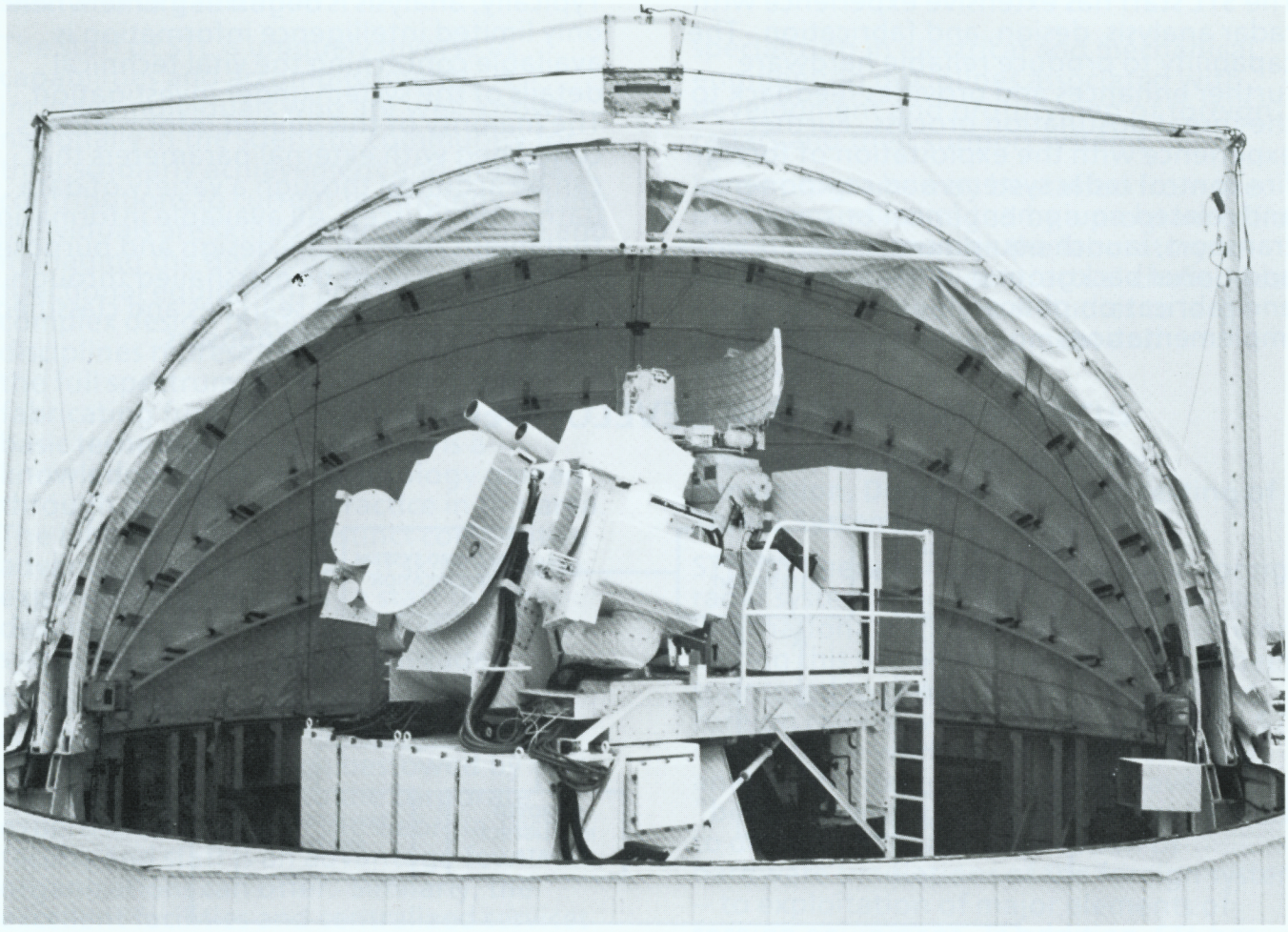
- Surface to air missile fire control radar systems
- Antiaircraft artillery fire control radar systems
- Passive electronic warfare systems
- Simulated air defense systems.

The STL staff has extensive experience with radar analysis, design, and fabrication. The capability to produce reliable hardware further enhances and provides feedback to the threat postulation process. Further experience with the exploitation of foreign fire control radar systems and components and related equipment (missiles, missile transport, launch equipment, etc.), provides additional background in the foreign design and fabrication philosophy and implementation.

Typically, analysis is begun at a time when only limited intelligence information is available concerning the vital technical details of the system under investigation. The majority of this limited information is concerned with external parameters that can be acquired through a variety of data gathering sources. All available information that might bear on the design and purpose of the system must be marshalled through both open literature searches and classified material derived from sponsors.

THREAT SYSTEM DEVELOPMENT CYCLE





Radar Weapons System Simulator

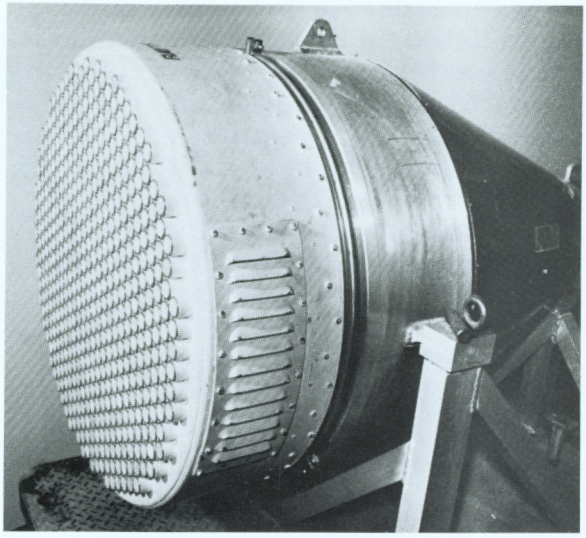
Simulated Air Defense System programs are representative of the evolution of threat postulation and replication programs. In 1972, STL was commissioned by the Missile and Space Intelligence Command (MSIC) to study two threat radar systems -- one Antiaircraft Artillery System and one Surface to Air Missile System. In 1975 a joint test force, commissioned by the Department of Defense, authorized an immediate procurement of the two mobile systems that had been studied. MSIC handled the procurement, and the design and fabrication of two mobile units were authorized. As a part of that effort, STL also built the antennas and integrated them into a pedestal with Government Furnished Equipment provided

by the Air Force. In 1980 the Air Force contracted with STL for further development and fabrication of a fixed site system. Incorporating the latest performance data, this system also provided two simultaneous, real-time missile fly-out models and an additional missile command capability. Subsequent contracts have resulted in alternative configurations of this system and more advanced technology threat systems.

STL has provided technical support for these systems since their delivery to the sponsors and has also performed numerous modifications to update the original design consistent with later performance information.

Using the expertise and background accumulated on these earlier threat systems, STL has extended its range of technical efforts to include advanced threats and all facets of threat-related activities such as C^3 support systems and threat system architectures. These and our foreign technology assessments provide STL personnel with a working knowledge of specific advanced threats, as well as, an ability to perform accurate parametric assessments of systems which are in various stages of test and evaluation or deployment. SLT's involvement in both formal meetings and working groups on specific foreign systems represent a unique capability.

Mobile Radar Weapons System Simulator



Phased Array Polarization Measurement Test Subject

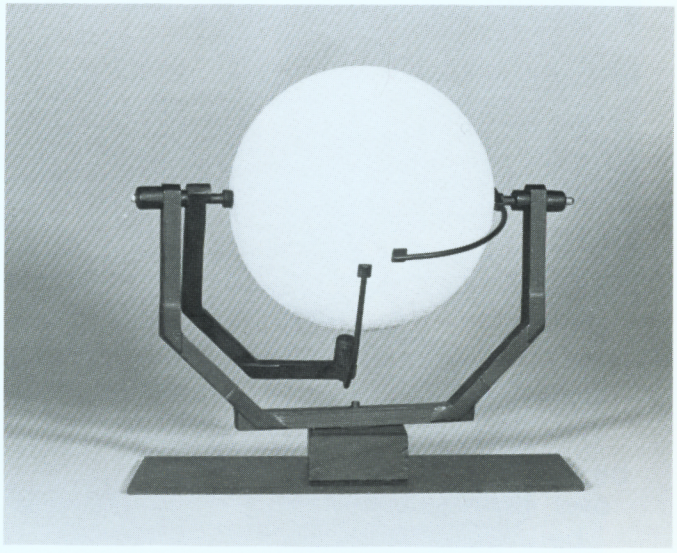
Microwave System Analysis, Design, and Development

STL has extensive experience in the design, development, and testing of microwave subsystems and components. Examples of previous work range from the analysis, design, and development of complex tracking and acquisition antenna subsystems to the design and development of elements for array antennas.

In particular, antennas have been the subject of many programs at GTRI throughout its history, and today GTRI is nationally recognized as a center for antenna research and development.

STL's antenna experience has included analysis of radar antennas and antenna components, and design, development, and fabrication of antennas for varied applications. We have particular experience in the design of electromechanical scanning systems, in antenna design for millimeter applications, and in the use of computer modeling techniques for antenna analysis and design. Antennas have been developed for ground, air, and satellite systems.

Several array antennas have been or are presently being developed by STL. Areas of present activity include the design and development of wideband patch array elements, multiple beam (from a single aperture) satellite ground terminal antennas, variable beam antennas, and multiple object trackers.



GTRI Proprietary

Model of Multiple Beam Antenna Concept

Development of Command, Control, and Communication (C^3) and Support Systems

Communication Antennas:

- Analysis and design capability for reflector antennas with both simple, conical scan, monopulse, psuedo-monopulse, and phased array feeds.
- Patch antenna construction (including studies addressing economical mass production of patch antennas) for ground vehicles to satellite link applications.
- Simultaneous links with multiple satellites from one aperture.

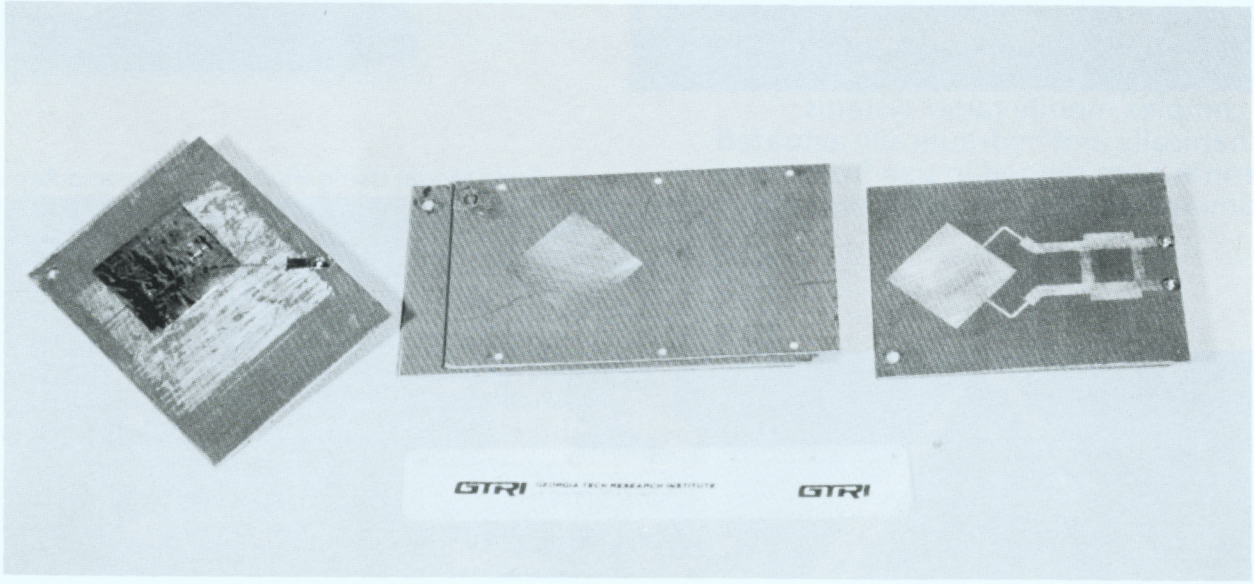
Communication traffic studies for a government agency:

- Addressed digital and analog (for voice and data) needs, nodal analysis, transmission media trade-off studies (for economy, service, and decentralization, including consideration of security requirements).

Real-time processing

Multiple-architecture buss design and application.

STL personnel have had major involvement with point-to-point microwave links in C, X, and Ku bands, mobile shipboard links for telex (TDM, TDMA and SCPC) and voice.



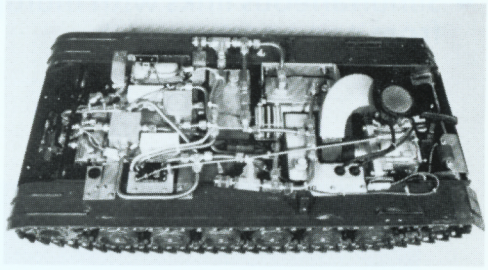
Patch Antenna for a Wideband Microstrip Array

Electromechanical Systems Design

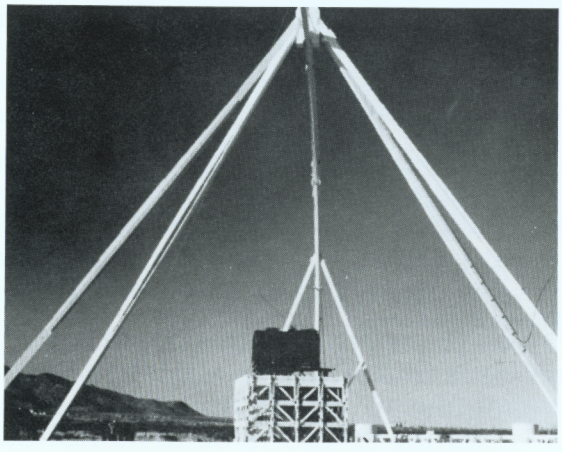
STL's mechanical engineering design and development specialties range from the design, analysis, and fabrication of mechanical components, to the design and development of major integrated electromechanical assemblies.

STL engineers have designed and, using computer-controlled fabrication machining, produced elaborate and precise microwave assemblies such as organ-pipe scanners for radars and precise, vibration resistant beam optics assemblies for airborne laser systems. STL has researched and designed plastic materials (for radars) and foam materials (for antenna reflectors) used in radar and other mechanical protective applications.

Major mechanical systems design experience has included the design and development of mechanically-actuated radar and microwave antenna systems, and the design of vehicles and complex mobile radar systems. Mechanically and hydraulically actuated antennas have ranged in size from a few centimeters to 8 meters (with capability for even larger units). These large systems included complete leveling devices, on-board power generating equipment, and air-conditioning/cooling systems for both the electronic equipment and personnel. Power trains include both hydraulic and hydrostatic designs, driving both tracked and wheeled vehicles.



Scale Model Using Hydraulic Drive and Remote Control for Army Training

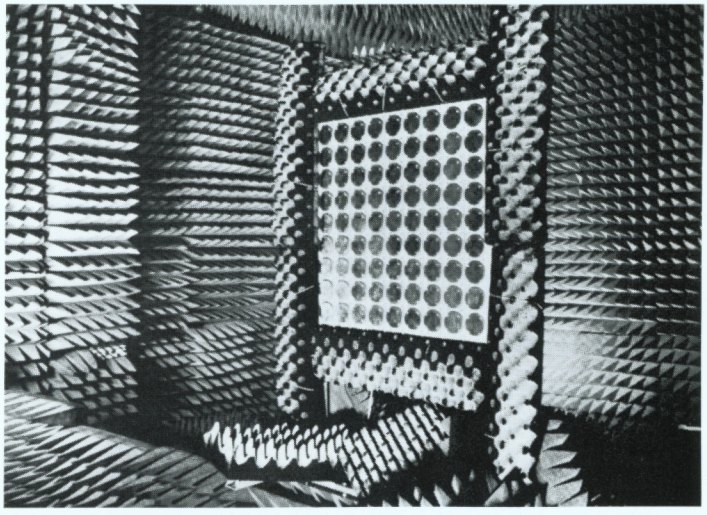


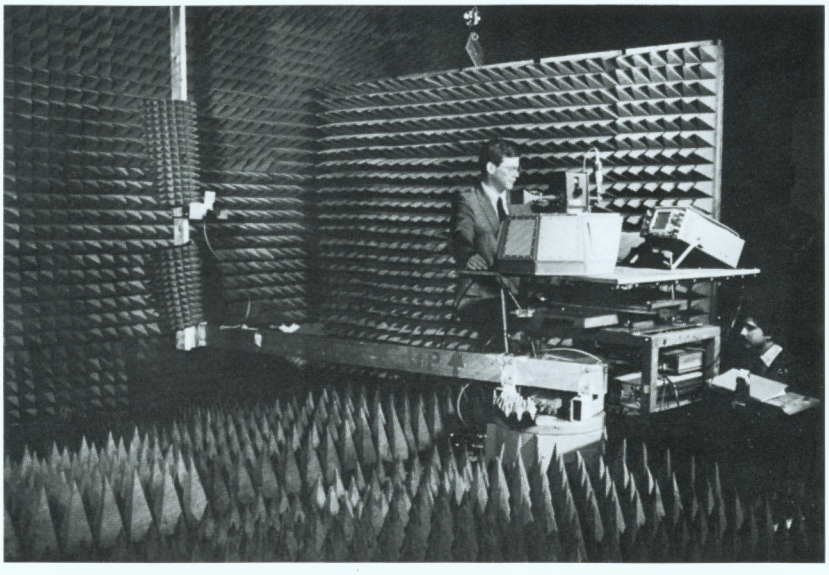
ARC Antenna Range Automation Program

Development of Instrumentation and Measurement Techniques

Georgia Tech has a long standing history in the development of antenna testing. The compact range was invented at Georgia Tech in 1964. This design was subsequently produced and is currently marketed by the defense industry as a standard antenna measurement product.

Georgia Tech researchers devised a method for implementing a planar near-field range, and the first of these ranges was located at Georgia Tech and the National Bureau of Standards. The first cylindrical near-field range technique was also located at Georgia Tech. Today, Georgia Tech continues to conduct pre-eminent research in antenna measurement technologies and techniques. For example, STL personnel have conducted research on a large (70 foot) outdoor compact range which will operate into the high millimeter wave spectra. The final design of this range will be installed at Ft. Huachuca, Arizona, for use at the US Army Electronic Proving Ground. This design will incorporate various innovative technologies, such as the use of corrugated feedhorns, close tolerance machining, and computer automated acquisition test data.





Near Field Antenna Range

Hybrid Systems Integration

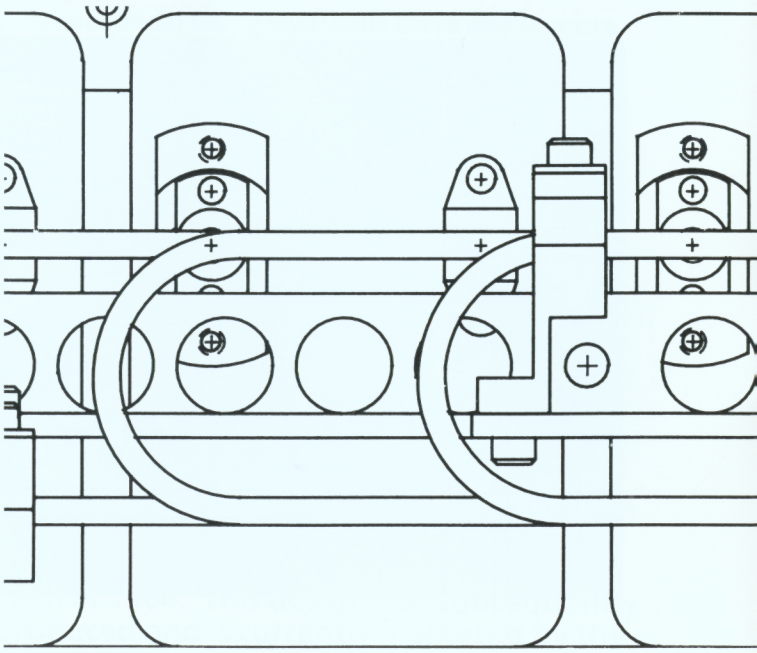
One of the fortes of STL is the research and development of large electronic/mechanical systems. Executing a large system, such as a radar, requires the participation of many subdisciplines of mechanical and electrical engineering. STL provides a complete system design and development laboratory for unique, difficult one-of-a-kind systems.

For example, design and development of a large radar simulator included:

- A microwave antenna design (electronic-microwave engineering)
- A pedestal procurement (mechanical engineering-structural and electronic engineering and servomechanisms)
- A multi-ton vehicle redesign (mechanical engineering - large vehicles)
- Custom electronics installation in the vehicle (mechanical engineering - electronics packaging)
- Two transmitter procurements (electronic engineering - microwave devices)
- Superheterodyne receiver design (electronics engineering - radio frequency and intermediate frequency)
- An MTI system (electronics engineering - coherent signal processing)
- A signal detection system (electronics engineering - video signal processing)
- A display system (electronic engineering - electro-optics)
- A control system (electronic and mechanical engineering - servomechanisms)
- A digital data recording system (electronic engineering - digital electronics and electronic engineering - built-in test equipment (BIT and BITE))
- Vehicle heating, air conditioning, and equipment cooling (mechanical engineering- HVAC)
- On-board and remote power generation and distribution (mechanical and electrical engineering power systems)

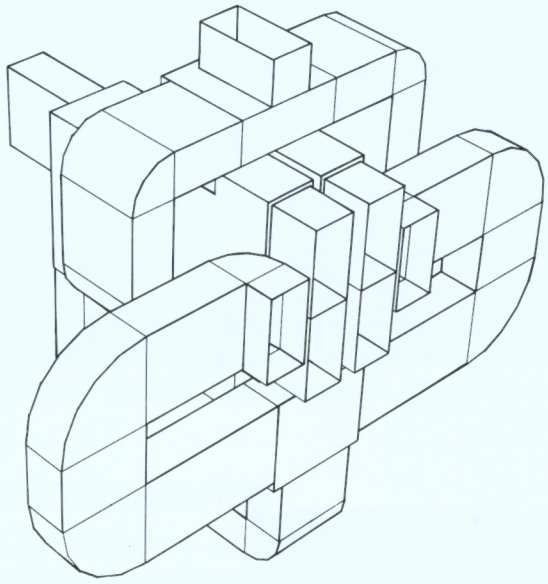
Manufacturing Technology

Georgia Tech has long been a major contributor to advancements in manufacturing technology (MT). STL's mechanical expertise is in the forefront of this technology and notable areas of contribution include: sensors, materials, automated guided vehicles, artificial

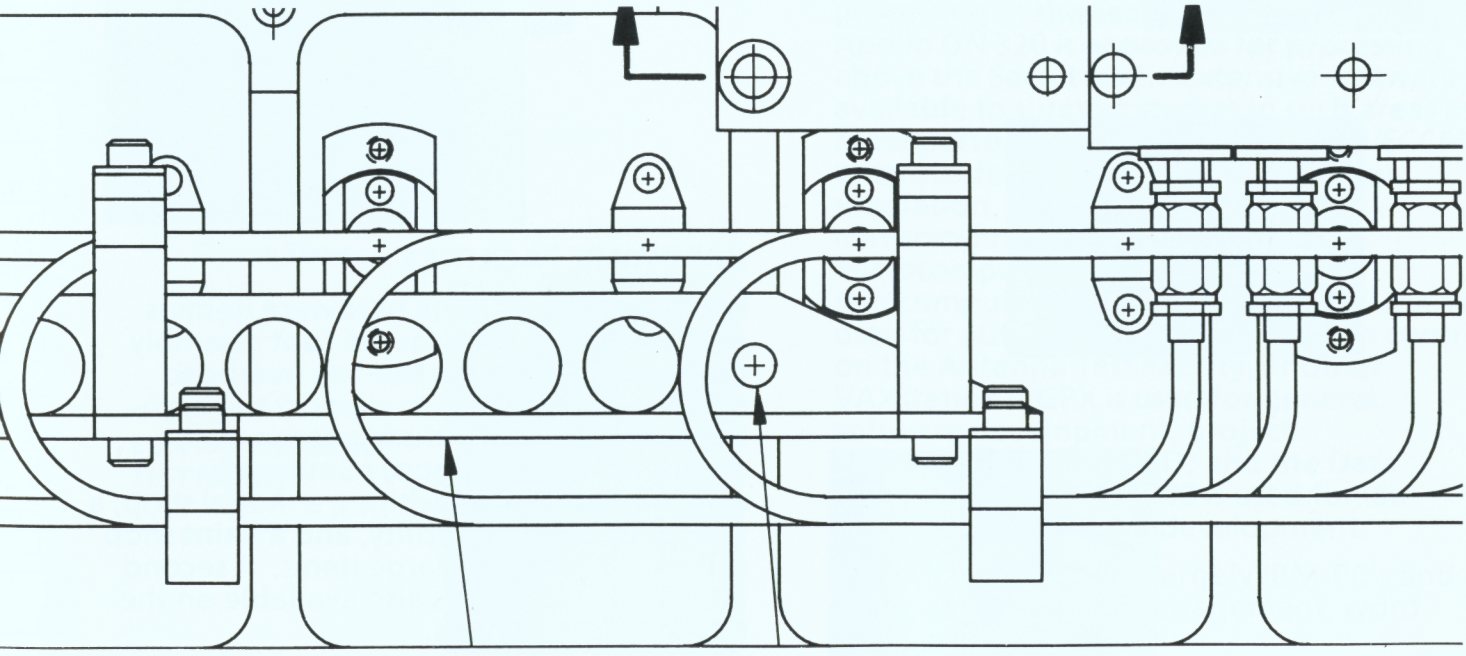


intelligence, robotics, CAD/CAM, plant design, material handling, signal processing, and energy sources. Currently STL, along with other Georgia Tech contributors, is undertaking a major manufacturing technology initiative with the following objectives:

- Focus MT efforts at Georgia Tech
- Foster cooperative interdisciplinary MT projects between and among research laboratories and academic departments
- Initiate cooperative MT ventures with industry and government
- Enhance Georgia Tech's scientific contributions through MT developments.



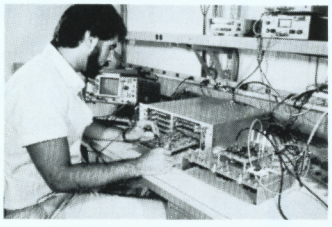
Waveguide Assembly Design

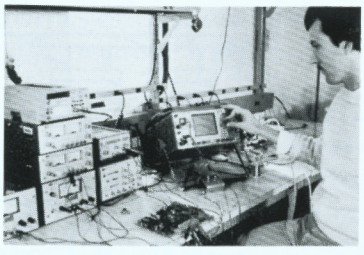


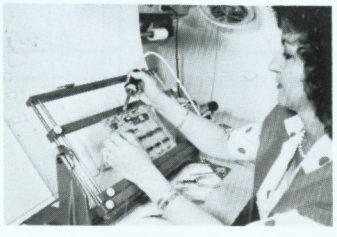
Airborne Phased Array Feed Design

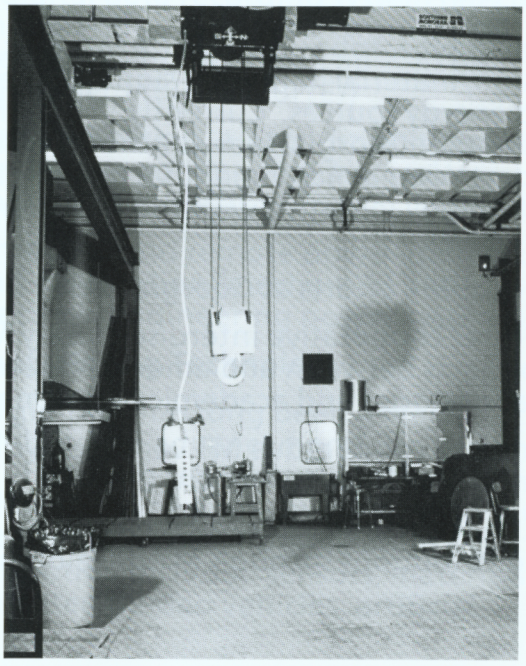
ELECTRONICS LABORATORIES

STL's radar development and fabrication activities are carried out in a number of laboratories and work areas, including a high-power test laboratory, a microwave laboratory, and a printed circuit board facility including a large circuit board assembly area. To perform development and fabrication, STL maintains an inventory of laboratory instrumentation valued in excess of $1.2 million. In addition to standard instruments and equipment, the inventory also includes numerous specialized research tools required to meet the exacting standards of these research efforts.









High-Bay Assembly Area

HARDWARE FACILITIES

Final assembly of large hardware items is performed in a 3600 square foot assembly area equipped with a ten-ton overhead crane. Satellite areas to support the high-bay assembly area include a large, well-equipped machine shop, numerically controlled milling machines, a model shop, a fiberglass molding facility, and a paint shop capable of handling large items. A second large machine shop is also available on the Georgia Tech campus.

ANTENNA RANGES

GTRI has a number of ranges for taking antenna patterns and making other antenna measurements. A paramount range on campus can provide separations of over two miles, and loads up to 2500 pounds can be accommodated at the receiver site. The new Cobb County facility can handle larger reflector or array antennas up to 40,000 pounds, and provide more stringent accuracy of measurement for millimeter wave and ultra-low sidelobe antennas. Several compact and near-field ranges are also available for indoor measurements.

Source Tower

ELECTROMAGNETIC TEST FACILITY

Receive Tower

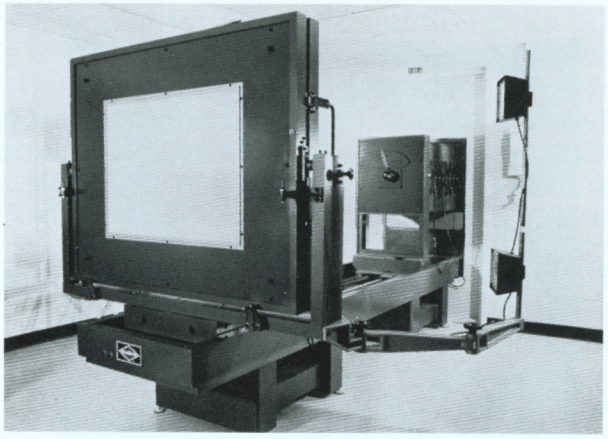
COMPUTER FACILITIES

STL's activities are supported by a variety of computers, ranging from the Institute's CDC 74-28 Cyber to numerous smaller computers and personal computers. The GTRI Gould SEL 32/55 computer is approved for processing at the Secret level, and the Apollo DN 320 is approved for processing above the Secret level. Extensive software is available to support studies in such areas as radar performance predictions, ECM/ECCM, antenna design, and missile and radar simulation, etc. STL has three minicomputers and numerous microcomputers. One of the minicomputers, a DEC VAXstation II/GPX, is used for automated instrumentation control on the Antenna Test Facility, another VAXstation II/GPX is used for general software development, project computations, and CAD; and the Data General Eclipse MV/4000 is used for lab support and software development.

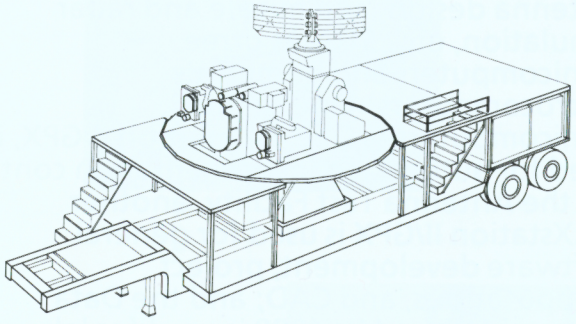
The microcomputers, largely IBM-PC's and family, are used for management, word processing, and CAD.

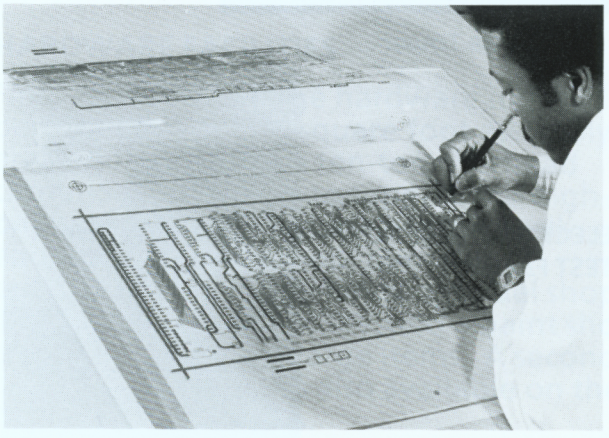
DESIGN SERVICES

The Design Services Group supports STL through the documentation of projects. Its capabilities encompass every aspect of design, drafting, illustration, photography, and reprographics. All personnel and areas are secured for processing classified work.



This group can generate drawings, printed circuit design, and documentation up through Military Specifications Level 3. Support tools of the group include CAD/CAE workstations, a VSMF microfilm data library of vendor catalogs and military specifications, a fully equipped photographic studio and darkroom, a large-format process camera, and a reprographics area with central drawing files.





LIBRARY FACILITIES

Georgia Tech's Price Gilbert Memorial Library's scientific, engineering, architectural, and management collection includes 1,924,226 volumes and 1,919,196 microtext. It is an official depository of the US Patent and Trademark Office, the US Government Printing Office, and a depository for maps issued by the US Defense Mapping Agency, Topographic and Aerospace Centers, Geological Survey, and the National Ocean Survey. It acquires and maintains collections of research reports from the National Technical Information Service, the US Department of Energy, the National Aeronautics and Space Administration and various other agencies which issue report literature.

The library currently receives over 28,000 serials, including 6,000 periodicals, approximately 75 percent of them in scientific and technical fields. It has 621,728 US Government documents and 137,415 maps.

The catalog record of the library's collection is online and is available to faculty and research personnel in their offices through the campus computer network. This online access is complemented by a campus-wide delivery service for library materials.

The library is a member of the Association of Research Libraries, the Center for Research Libraries, the Association of Southeastern Research Libraries, the Southeastern Library Network (SOLINET), the Georgia Library Information Network, and the University Center in Georgia, Inc.

Though the Georgia Tech Library is located on Tech's main campus, STL considers the library a major asset to its research and development activities.

SECURITY

Georgia Tech has a Final Top Secret facility clearance and routinely conducts research investigations at the Secret level or above. A 40 by 80 foot secure building is available for large equipment work at the Secret level or above. Analysis and computer studies can be conducted above Secret level. ARFCOS courier service is via Dobbins AFB, adjacent to the Cobb County facility.

INTELLIGENCE DATA BASE

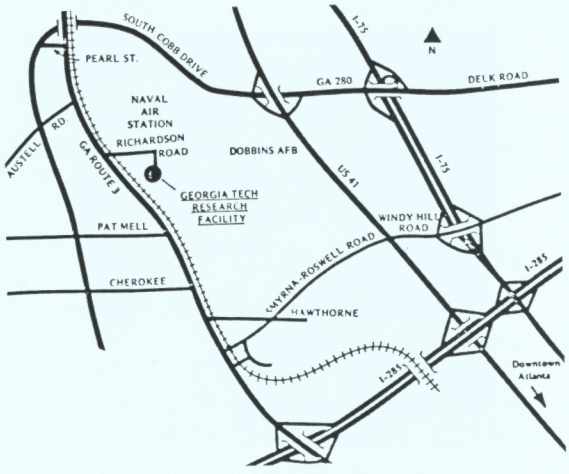
STL maintains an ongoing intelligence data base library of open and classified foreign literature relating to radar, communications, and infrared technology. This information provides data covering theoretical analysis to comprehensive design guides.

CONTRACTUAL MATTERS

Most of STL's research is done under contract with government organizations and private industry. Contracting is done via Georgia Tech Research Corporation.

PHYSICAL LOCATION

STL is located on a 50-acre research park in Cobb County, some 15 miles northwest of the Georgia Tech campus in metropolitan Atlanta and convenient to one of the world's largest airports.

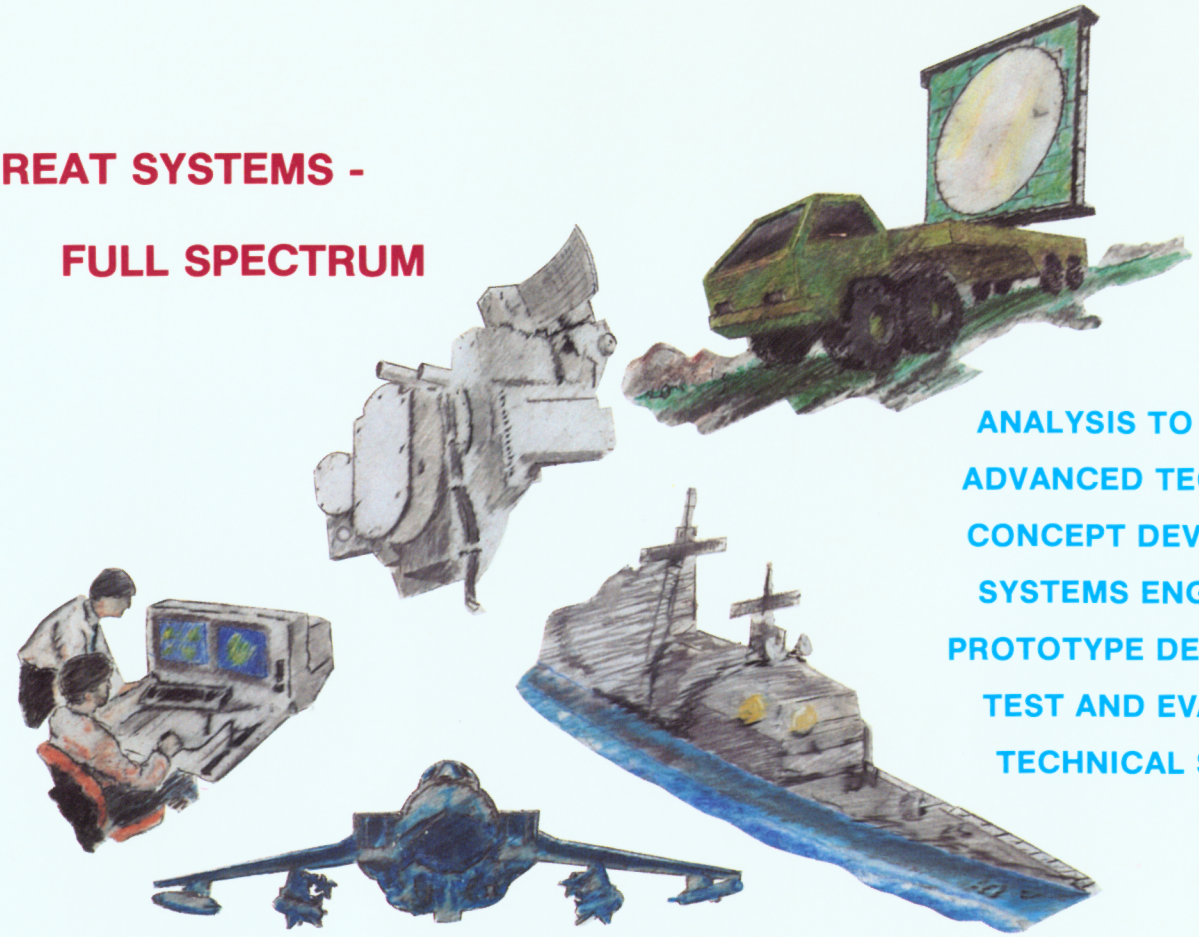


Georgia Tech Research Facility - Cobb County

Georgia Tech Campus

THREAT SYSTEMS -

FULL SPECTRUM



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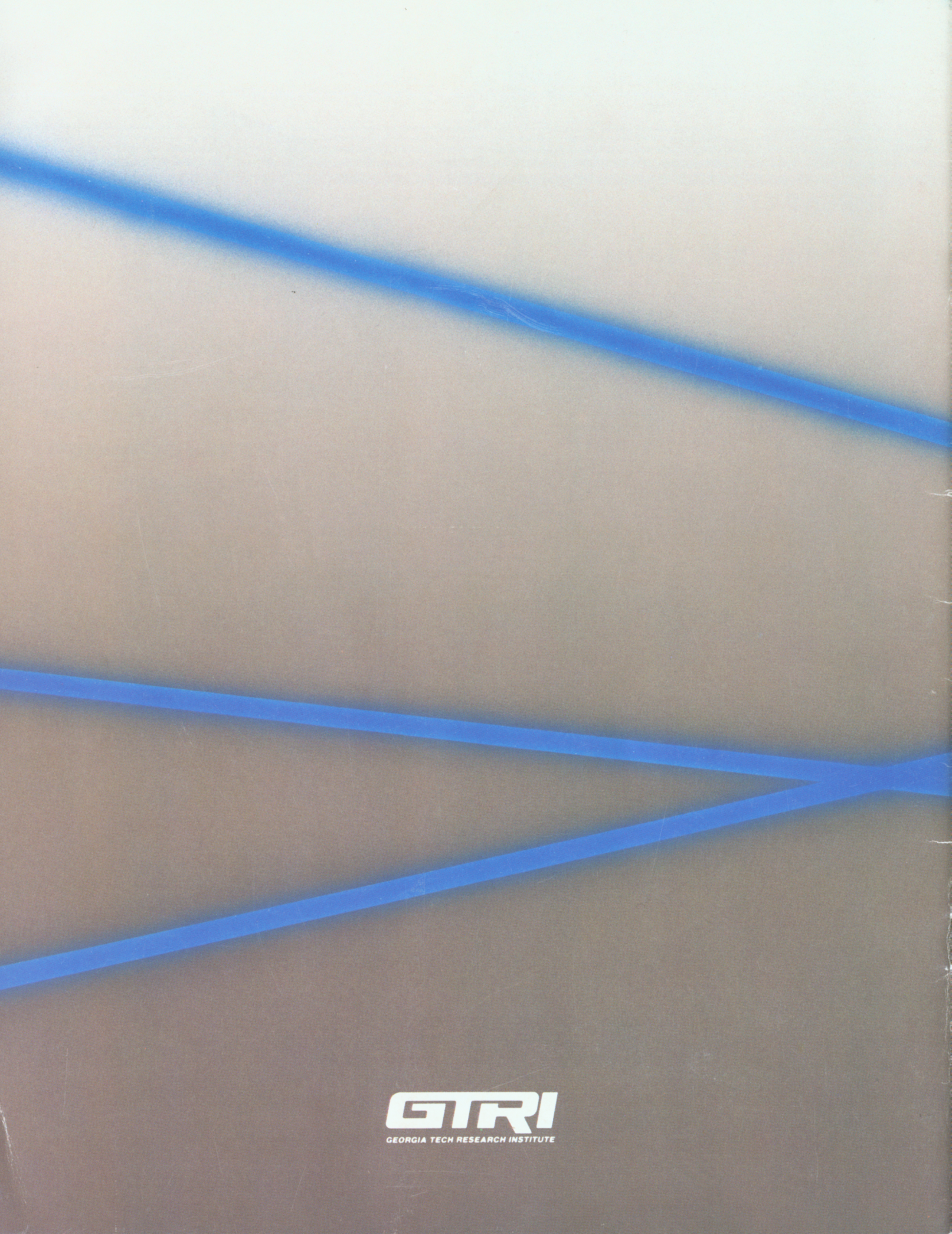
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