

1977 REPORT

Engineering Experiment Station



Georgia Institute of Technology
Atlanta, Georgia 30332

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The Engineering Experiment Station Georgia Institute of Technology

Observations Of The Director

The end of fiscal year 1977 almost coincided with my first anniversary at Georgia Tech, serving as director of the Engineering Experiment Station (EES). As I review tangible milestones of those twelve months, I want also to share a newcomer's perspective of the more subjective elements that make EES unique.

Almost 60 years have passed since the General Assembly of Georgia created the Engineering Experiment Station with the mission of serving the community, the State of Georgia and the nation by: promoting scientific, engineering and industrial research; encouraging the development and use of Georgia's natural resources; fostering industrial and economic development; working for the general welfare of the people through research; and assisting national programs of science, technology and preparedness. Our efforts extend across those lines with myriad dimensions from developing aids for the motorist in trouble to assisting the nation in defense and energy preparedness.

Unlike many non-profit R&D organizations affiliated with major universities, EES is an integral part of Georgia Tech. Our activities are monitored and coordinated with the research conducted by the academic colleges through the Vice President for Research, who has cognizance of all research at the Institute. Most of our facilities are on campus. Students comprise 25% of our total employment, and we are the second largest employer of undergraduate co-op students in the State.

EES in 1977 successfully carried out investigations and projects in engineering, science and economic development for a diversity of

sponsors, including federal, state and local government agencies, business, industry and foreign countries. EES continues to be the State's primary technical resource for applied research committed to making important contributions to the economy and the quality of life. Economic analyses show that the impact of EES and its spin-off activities amount to over \$100 million annually, and the State tax revenues generated are over \$4 million. Of the total research at Georgia Tech in 1977, about 60% was conducted by the Engineering Experiment Station.

Technical resources of EES and the academic schools are readily accessible to each other and are exchanged formally as well as informally. Several academic faculty members have continuing assignments in the Station; others are budgeted into EES contracts as appropriate; conversely, some EES personnel teach credit courses and others contribute to academic research efforts. Many times, portions of major research contracts are sub-tasks between elements of EES and academic schools.

The Station's greatest asset is its people. Their dedication, technical capability and integrity are the cornerstones on which our successful reputation has been built. We consciously strive for direct interaction between our professional staff members and our sponsors so that the same individuals who originally discuss and plan a new program are the ones who see it through to a final demonstration or report. Many of our people have been at EES for 15, 20, 25 or more years, but with a growth curve that has exceeded 30% compounded over the past



Dr. Donald J. Grace, Director of
the Engineering Experiment Station

several years, we've added many other fine personnel at all levels. They've brought new skills, new ideas and new programs.

The year 1977 was, first of all, one of consistent and dynamic expansion in sponsored research and services. Accommodating that growth has taxed our physical space, capital equipment, organizational structure and recruiting effort. I think we are meeting these demands extremely well and look forward to the further challenges that continued growth will surely bring. At the same time, we have achieved added maturity and strength in existing areas of excellence, expanded in others and made significant starts in selected new fields.

Total EES expenditures during FY77 amounted to \$14.5 million, with \$12.2 million derived from sponsored research and the remaining \$2.3 million coming from State allocation. This represents an increase of 30% over FY76.

Sponsored personal services (salaries and wages covered by contracts and grants) is another significant measure of change. In dollars, the 1977 figure was \$5.5 million, an increase of 26% over 1976. Our full-time staff grew from 417 to 475 persons, with the ratio of professional to support staff remaining about 70%. A total of 278 supplementary (part-time) staff brought the year-end Station employment to 753.

The types of sponsored research in EES remained highly diversified, with 391 active contracts and grants during 1977, ranging in size from a \$50 service project to a \$5,000,000 defense program. The Army, Navy and Air Force accounted for 14%, 18% and 21%, respectively, of all sponsored personal services (PS) income, with 7% from NASA, 9% from ERDA (now the Department of Energy) and 18% from other federal agencies. There were 111 separate industry programs representing 7% of the sponsored PS and 60 projects from state and local government accounting for the remaining 6%.

The policy of investing significant amounts of internal funds in facilities, personnel and equipment for research growth programs and in major research improvement projects was continued so that the quality of research which keeps this organization going...and growing...would be enhanced. Some of the research improvement facilities and projects included:

- portions of a 400kW th Solar Thermal Test Facility
- a solid state power amplifier for a Ka-band

instrumentation radar

- a combined radar laser sensor facility
- high power signal sources (magnetrons)
- an on-line hodoscopic data collection and analysis system
- equipment and training to assist Georgia industry with OSHA problems
- equipment for the Materials Technology Group
- an automated EM phase and amplitude measurement system

Another unusual and noteworthy acquisition was a USAF surplus T-29 (Convair 240) aircraft for use as an airborne laboratory to give EES added capability for airborne electronics systems testing.

Also, plans were set in motion to acquire the latest state-of-the-art GC/mass spectrometer, a major step forward in the Station's capabilities to deal with problems in environmental research.

Expanding our activity in energy-related projects was a major thrust of research during the year. One segment focused on analytical and management aspects of energy conservation technology for industry, including food processing, textile and carpet industries as well as industrial co-siting concepts. Other projects were in institutional and public sector areas of energy conservation and development of alternate energy sources, which included pyrolysis, biogasification and solar energy.

Solar energy programs continued to include development of technology for a wide range of applications extending from electric power plants to agri-business and industrial processes. An important accomplishment was the completion of the ERDA/Georgia Tech 400 kWth Solar Test Facility which became operational in September, 1977, as the second largest high-temperature solar facility in the world and the largest in the U.S. Significant also was the successful completion of the Solar Electric Pilot Plant Storage Research Experiment at Georgia Power Company's Plant Yates.

In atmospheric and environmental chemistry, exciting new research activities were initiated which included recruitment of a talented research team and the awarding of the multi-year NSF project called GAMETAG. Other notable contract awards were also received for work in chemical kinetics.

After EES was named the Georgia Productivity Center in 1975, efforts to build a program base for the Center resulted in NSF-RANN funding for a regional productivity study and also for a "Tri-University Project," in which

Georgia Tech, the University of Georgia and Georgia State embarked on a cooperative venture in assisting local government improve productivity and solve problems. The Center continues to attract considerable interest from other states and from foreign countries.

Services related to activities in Georgia were provided by the EES Office of Technical Assistance in Atlanta and by the Management and Technical Assistance Program, a part of our Industrial Extension Service located in seven field offices throughout Georgia. These services encompassed assistance to minority businesses, market analyses, community development assistance and technology transfer. Efforts in energy conservation alone identified annual savings of about \$2 million for the 50 firms we aided.

In the international arena, applied research programs were carried out in 18 countries during 1977. Such programs include management and technical assistance in small industry development, rural development, water systems, appropriate technology, agricultural machinery, alternative energy sources, technology transfer and employment generation — all focused on the developing countries.

An increasing number of foreign visitors to the campus, requests for technical assistance, invitations to participate in international conferences and opportunities to develop major programs in other countries are indicative of our substantial growth in international recognition.

As in prior years, our research programs in electronics showed rapid growth. Our national reputation and leadership in the technical community have extended into many additional areas which include:

- near-field techniques for microwave antenna measurements
- antenna analysis, development and fabrication
- electromagnetic compatibility
- applications of electromagnetic radiation in biology and medicine
- new applications of minicomputers and microcomputers as parts of complex electronics systems.

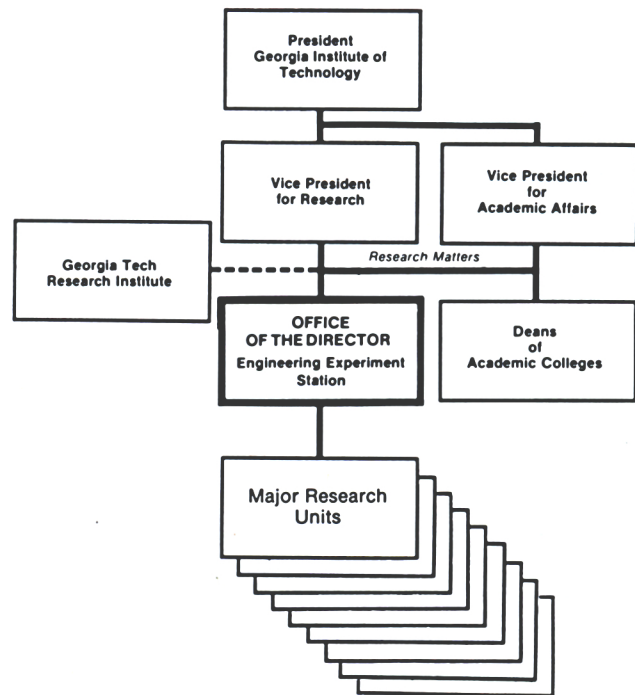
Significant progress was realized in the development of millimeter radiometers, in sub-millimeter technology and in the development of quasi-optical components. Also, strong programs were conducted in the analysis of multi-spectral remote sensing data and in application for remote sensing.

The Georgia Tech Research Nuclear Reactor continues to be operated by EES for campus-wide use. As part of the ERDA-sponsored Reactor Sharing Program, services were furnished to some 21 educational institutions, mostly in the southeast, including six units of the University System of Georgia.

As a consequence of the recent years of rapid growth, several noteworthy changes were made in the organization of the Engineering Experiment Station during 1977. Integrating groups of related activities within single units improved technical and administrative communications and helped us develop stronger and more easily identifiable areas of prime focus.

As the Engineering Experiment Station continues to cover the distance needed to serve our community, the State of Georgia and the nation, we are increasingly aware of the difference we make in contributing to a finer quality of life for people of all nations tomorrow.

Donald J. Bruce Director



Organization

EES is now organized into nine major units according to general areas of research activity. However, interaction among the units is common and joint teams can readily be formed in areas of mutual interest and expertise to provide optimum service to the client.

The major units of EES are:

- Applied Sciences Laboratory**
- Electromagnetics Laboratory**
- Electronics Technology Laboratory**
- Nuclear Research Center**
- Office of International Programs**
- Radar and Instrumentation Laboratory**
- Systems and Techniques Laboratory**
- Systems Engineering Division**
- Technology and Development Laboratory**

The new **Systems and Techniques Laboratory** has primary interest in electromagnetic systems, biomedical studies, antennas and electronic countermeasures.

The **Radar and Instrumentation Laboratory** performs research in radar technology, computers (hardware and software) and electronics support measures.

The new **Systems Engineering Division** has interests in computer simulation of large-scale systems, cost-benefit analyses operational/systems analysis.

The new **Office of International Programs** coordinates and conducts the international activities of the Engineering Experiment Station.

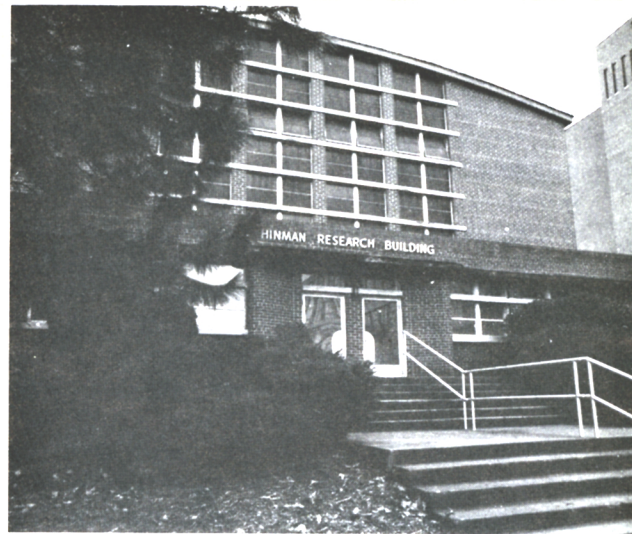
The new **Technology and Development Laboratory** comprises the majority of the technical, economic and extension capabilities of EES which are concerned with business, industrial and governmental needs, particularly those in Georgia. This laboratory also has programs in waste utilization and industrial chemistry and has responsibility for operating the Georgia Productivity Center which was established at EES in 1975 by the Georgia legislature.

The **Applied Sciences Laboratory** works in solid state sciences, solar energy and materials technology, energy and environmental analysis.

The **Electromagnetics Laboratory** does research in radiation systems and electro-optics.

The **Electronics Technology Laboratory** conducts research in electromagnetic compatibility and communications technology.

Facilities



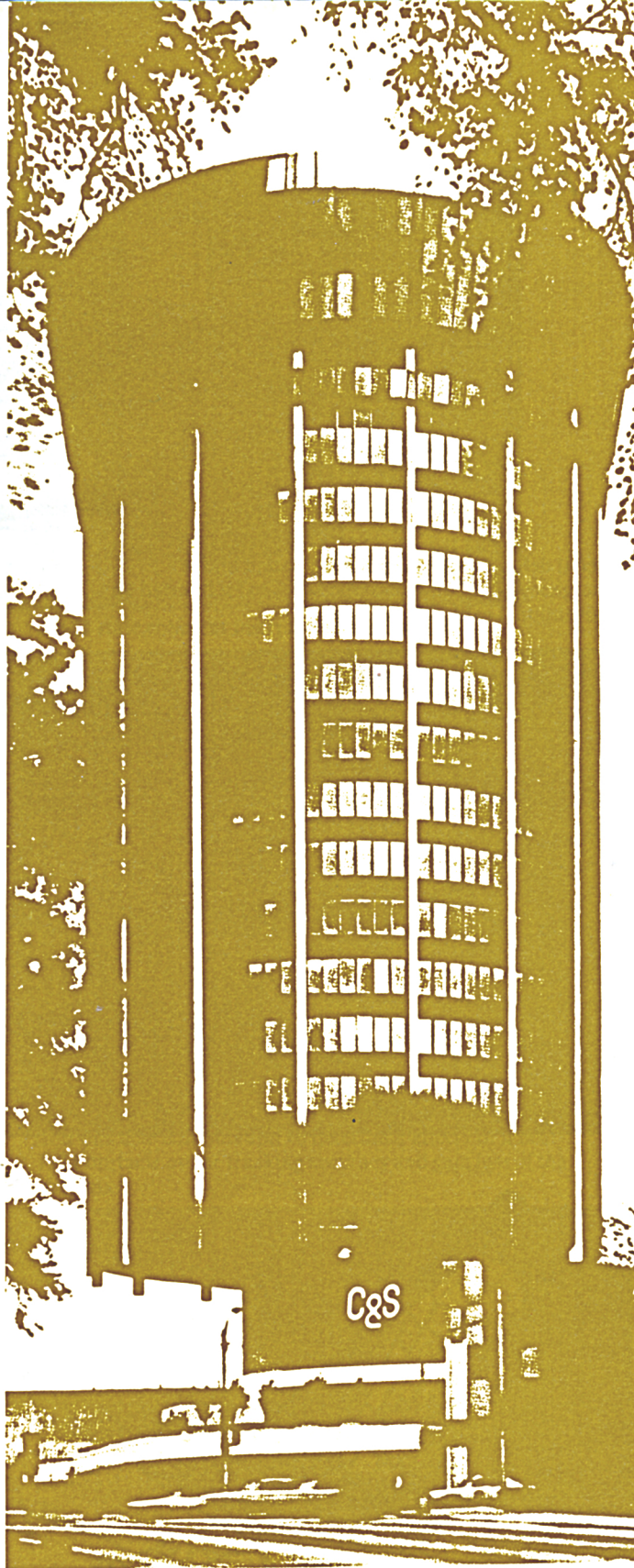
Hinman Research Building



Baker Building



Emerson Building



Citizens and Southern Bank Building



Georgia Tech Nuclear Research Center



Electronics Research Building

Reflecting the dynamic growth of the Engineering Experiment Station's activities, six buildings house the staff and facilities in on-campus locations, and a seventh is in nearby downtown Atlanta in the C&S Bank Tower. EES had a total of 245,399 square footage of research area and modern facilities, under roof, at the end of fiscal 1977.

HIGHLIGHTS OF RESEARCH OPERATIONS

Electronic Systems

- Radar
- Communications
- Radiometers
- Simulation
- Satellite RF

XM Program Office

EES has expanded its capabilities in complete radar system design and development this year with the largest sponsored research program EES has ever had. Work on this radar system began with an initial analysis project, followed by preliminary mechanical, microwave and circuitry design studies. This program calls for detailed design of a special-purpose mobile radar system actually including two complete radars with other equipment, and fabrication of two of the radar systems, including the vehicle.

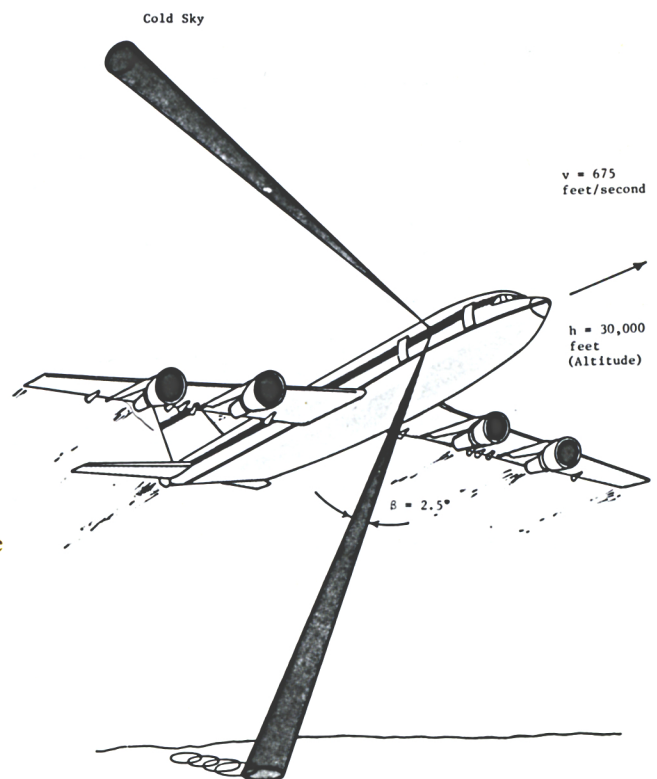
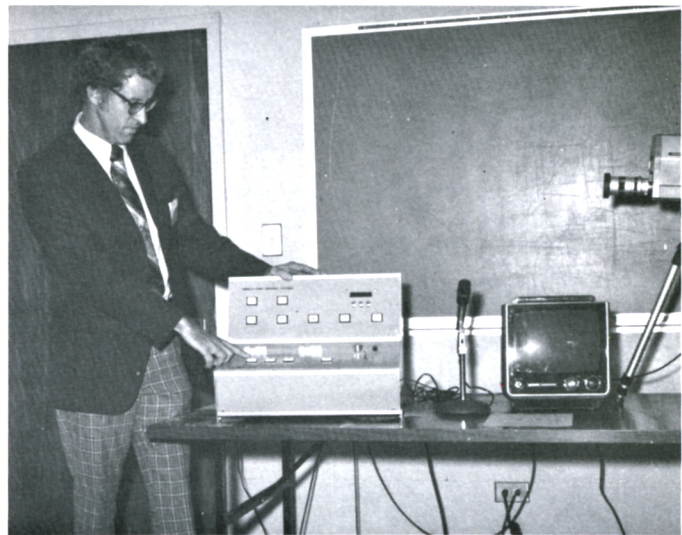
Millimeter Wave Research

Major EES research programs include: the development of millimeter wave radiometric systems, basic and applied research in submillimeter wave technology, the development of software and concepts for the processing of remotely sensed earth resources data, and the development and testing of electro-optical components and systems.

Under sponsorship from NASA, a two-channel millimeter wave radiometer was developed and installed in a Convair 990 aircraft and flown over the northwest United States, Canada, Alaska and Greenland to collect data on the vertical distribution of water vapor in the atmosphere.

A flight radiometer system and an infrared guidance simulator were highlights of EES electromagnetic research.

A civil defense cable-TV alerting system allows emergency visual and aural messages to be inserted on conventional cable TV channels.

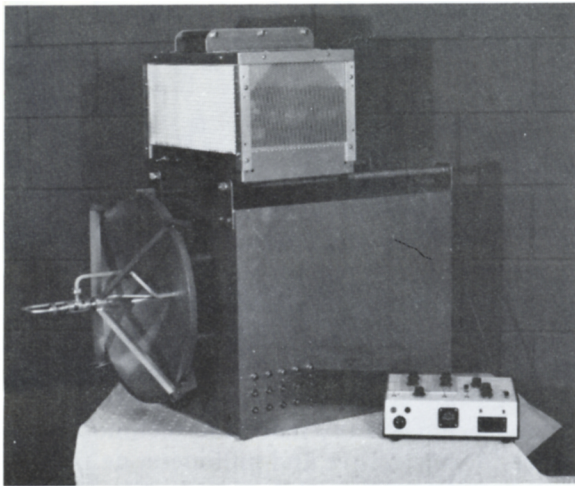


Communications

A communications project initiated for the Federal Highway Administration involved the design and pilot testing of a new concept for emergency motorist aid, based on the use of Citizens Band Radio used in conjunction with an Automatic Interconnect Digital System (CB-AIDS) to allow direct motorist access to emergency services.

Two projects on the communication needs of the Georgia Electric Membership Corporation were initiated and sponsored by the Georgia Rural Electric Service Corporation. The initial effort was a short-term survey of all EMC telecommunication requirements including telephone, land mobile radio, data services and load control. Results of this survey led to a more comprehensive effort to develop statewide plans for future EMC telecommunication needs. One important aspect of this effort is the impact of telecommunications as a necessary element in load management, load shedding and energy conservation.

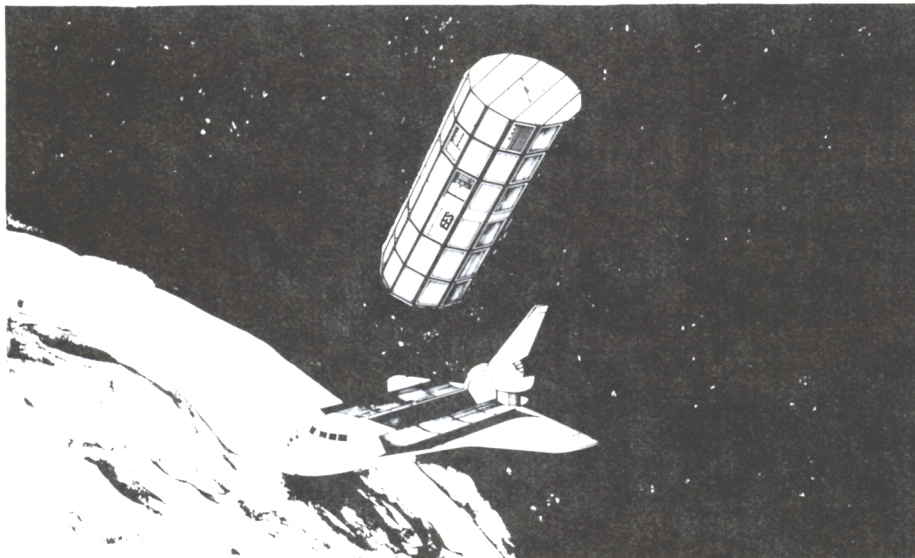
Work continued on a program for the Armament Development and Test Center to develop and fabricate three scanning/tracking antennas. A surveillance antenna and two different tracking antennas were produced for the Missile Intelligence Agency.



Solid state coherent instrumentation radar.



Measurements being performed on a monopulse antenna and obstacle combination to determine effects of a near-field obstacle on the tracking accuracy and gain loss of the antenna.



Space shuttle long duration exposure facility.

Electronic Components and Techniques

Microwave Devices and Circuitry

This area of work has been expanded to include work related to lumped-element varactor-tuned GUNN microwave oscillators, studies of instabilities in pulsed and cw IMPATT amplifiers and thermal analyses related to microwave semiconductor devices. In addition, multi-chip power combining has been continued with successful achievement of cw power goals using a gallium arsenide IMPATT device. This effort has led to additional funding for similar work using pulsed devices where a goal of 200 watts peak has been established.

Solid State Research

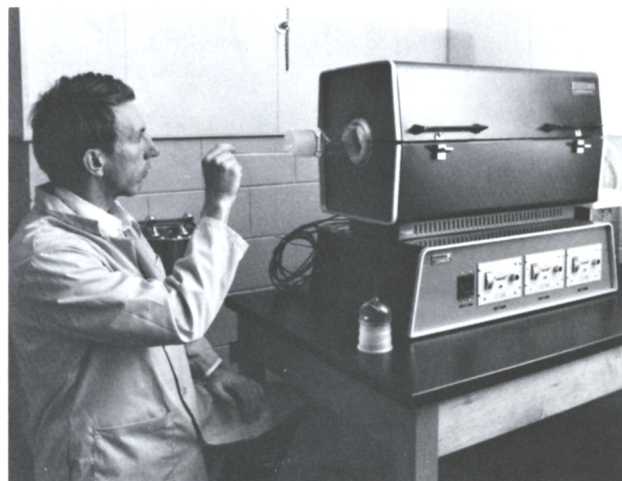
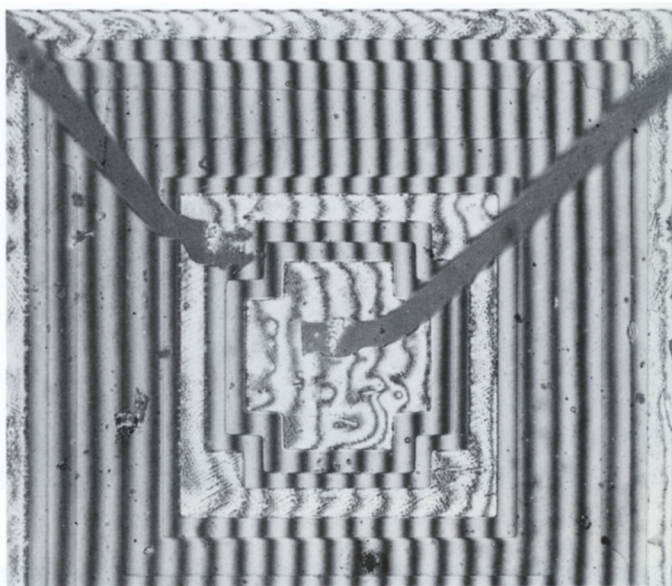
EES solid-state programs continue to grow. The Air Force Avionics Laboratory has continued support of research addressing chip-level microwave power combined for both cw and pulsed operation as oscillators and amplifiers. Reliability and failure modes are also being investigated. Cw output power of 22 watts has been demonstrated at 8.5 GHz in a six diode multi-chip configuration which exceeded the 16 watts performance goal of the program. Present goals include the fabrication of similar structures capable of delivering 200 watts of pulsed radio frequency power.

Pacemaker Studies

In the civilian sector, the effects of high-level RF signals on 50 different cardiac pacemakers were determined for five manufacturers, and a disaster warning system was developed further. In addition, extensive site inspections and evaluations were made at several of the nation's air traffic control facilities.

Semiconductor Materials

A two year research program for NESC/NRL is in progress to develop and characterize a molecular beam epitaxial reactor for growing precisely controlled GaAs epitaxial layers for microwave and millimeter wave devices. The precise control of epitaxial layer thickness, impurity concentration and uniformity possible with molecular beam epitaxy made this technique a logical choice for microwave and millimeter devices where the material quality and doping profile are particularly stringent.

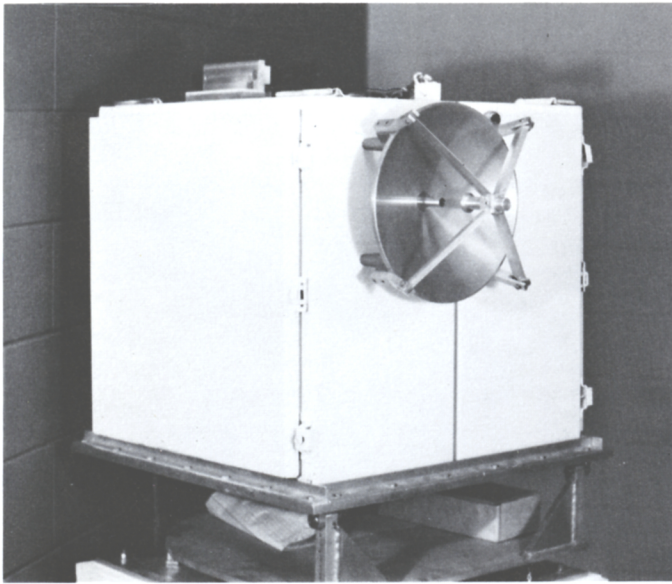




Radar Development

The radar program for manatee tracking sponsored by the National Aeronautics and Space Administration involves the design and development of a tracking system which will monitor the location of manatees located in the wildlife preserve at Cape Kennedy. This work is being coordinated with the Florida Wildlife and Game Administration and is directed at learning more about the habits of the nearly extinct manatee.

A radar backscatter characterization program with U.S. Army MIRADCOM is emphasizing the reflectivity of military targets in a variety of clutter environments. In addition, a program is underway with Eglin AFB to plan a snow reflectivity measurement project. Both of these programs are directed at determining signal processing techniques for target detection and identification.



95 GHz instrumentation radar.

Radar Analysis

The major research efforts concentrated in the areas of pattern recognition for classification of targets, target detection and discrimination, radar systems, radar backscatter and meteorology radar applications.

EES is involved in assisting the U.S. Customs Service in developing a border radar resources program. The border radar network is being developed to detect the transport of drugs, exotic birds, currency and other contraband smuggled across the Mexican border into the United States by low-flying aircraft.

Computer Applications

EES has developed an expertise in computer/sensor interface design, display and graphics systems, micro-mini computer applications and simulation technology. The Station supplies computer hardware and display system support to both the SADS VI M Simulator Program and to the XM Program Office in the development of a complex mobile radar system.

- Target discrimination
- Fire control and tracking
- Radar/laser sensors
- Guidance and seekers
- Computer/sensor interface
- Computer graphics and software
- Solid-state electronics
- Failure analysis and reliability
- Microwave devices
- Microcomputers
- Signal processing
- Training devices and battlefield sensors
- Bonding, grounding and shielding
- Biomedical instrumentation

Antennas, Electromagnetics and Optics

• Antenna analysis, design and development • Electromechanical scanners • Phased arrays • Near-field antenna and RCS measurements • Radar reflectivity measurements and analysis • Propagation phenomena • Electromagnetic measurements • Laser applications • Remote sensing • EM radiation effects • Electro-optical techniques and devices • Millimeter/submillimeter techniques and applications

Microwave Field Measurement

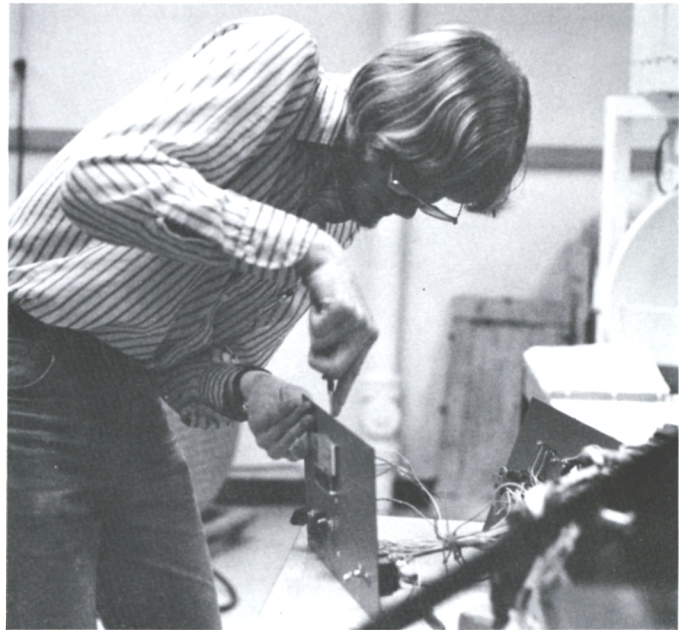
Georgia Tech is a national leader in the development of the near-field technique of microwave field measurement, a technique possessing several significant technical and economic advantages over conventional measurement techniques, including the provision of information which cannot be obtained with conventional techniques. A conceptual design was produced this year for a near-field measurement facility which will be useful in characterizing antenna performance.

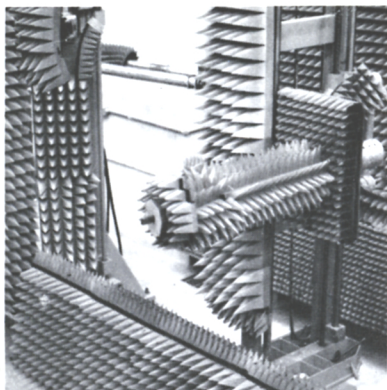
Weather Monitoring

Research for NASA Goddard in sferics monitoring as an indicator of severe weather has continued. EES engineers are expanding and improving the instrumentation required for airborne and ground-based data collection. Activities include preparation for participation in the Thunderstorm Research International Program (TRIP) to be conducted at the Kennedy Space Center in Florida.

A strong program base in remote sensing technology resulted from the funding of a program in earth resources data processing by the State of Georgia. This program was enhanced by three NASA programs relating to the development of low-cost systems for processing LANDSAT earth resources data and to the transfer of remote sensing technology to state and local governments.

Shown being briefed on the EES programs are Tech, state, and federal officials.





Radar Technology

Particular emphasis at EES is placed on radar research involving millimeter wave systems and techniques, environment simulation, intrusion detection system, reflectivity characterization, meteorology, stationary target discrimination/classification, and battlefield identification-friend-or-foe (IFF).

Several design studies of electromechanical scanning antennas have been completed. Four major complete radar systems or antenna

subsystems incorporating an innovative electromechanical scanning antenna have been developed. This type antenna permits continual scanning coverage over a large solid angular region while multiple targets within the region are tracked simultaneously in range, azimuth and elevation.

Researchers at EES and at the Naval Ship Engineering Center (NAVSEC) are working with ship architects to design topside configurations for future ships that will have improved EM scattering properties. By means of math-modeling techniques, the Station is assisting NAVSEC in determining the far-field effects of nearby obstacles on various shipboard antennas.

Advanced instrumentation for measuring, predicting and diagnosing the effects of EM system components, such as antennas, on very short radar pulses is being developed for Rome Air Development Center.

Two short courses were offered by EES during the year: "Principles of Modern Radar" and "Radar Reflectivity of Land and Sea."

Electromagnetic Compatibility

Research concerned with the effects of high-level RF signals on electronic systems continues to be a strong EES activity. Major programs were conducted for the three military services and emphasis ranged from management/procurement practices to testing and hardening technology.

Radomes

A program has continued to improve and establish the processing parameters required to produce a thermal shock resistant reaction sintered silicon nitride which will be highly resistant to laser radiation and will have dielectric characteristics suitable for radome applications. Processing parameters have been adjusted to produce suitable silicon nitride materials even though reproducibility parameters are not fully established. The objective of this program, sponsored by the Air Force Materials Laboratory through Martin Marietta, Orlando, is to develop laser hardened radome materials.

Defense Electronics

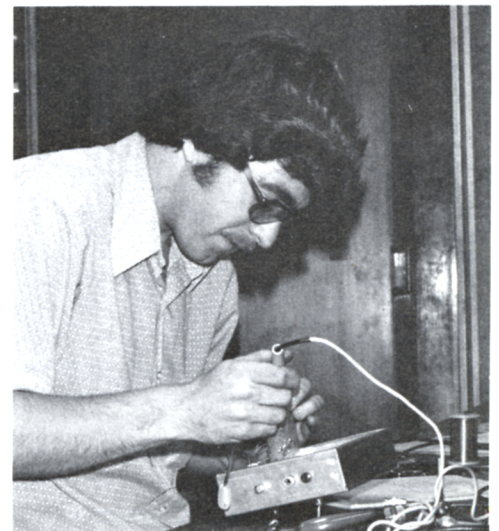
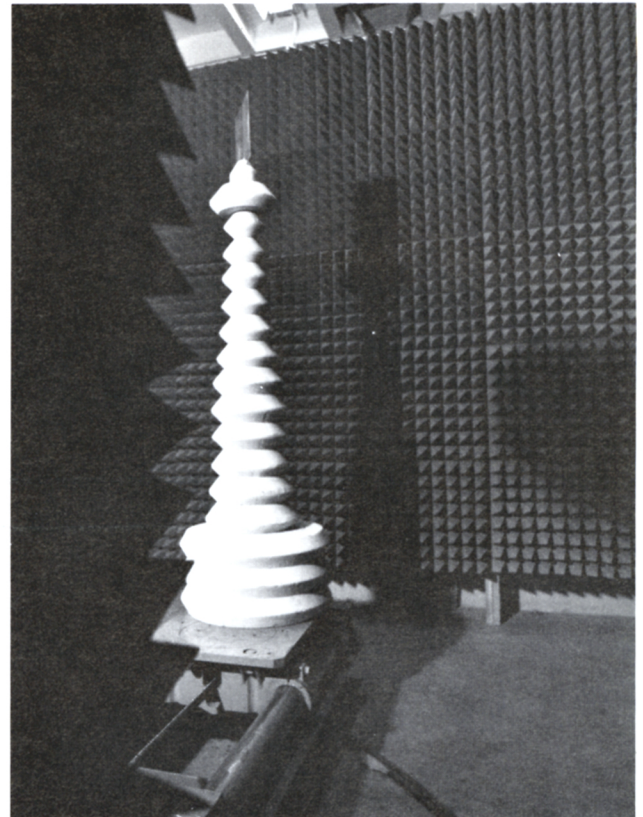
- Radar analysis and simulation
- EW range instrumentation
- Aircraft survivability
- Detection estimations
- Communications EW
- ECM effectiveness analysis
- ECM modulation techniques
- Radio location/direction finding
- Foreign technology assessment
- ECCM
- Electronic support measures (ESM)

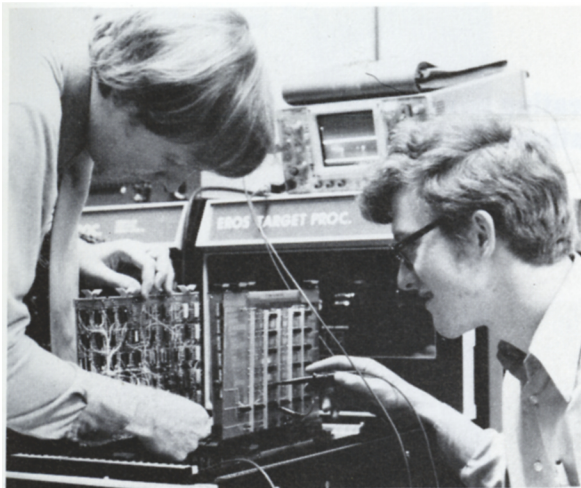
Electronic warfare has continued as an EES activity related to national defense. An Electronic Countermeasures (ECM) project for the U.S. Army Electronics Command (ECOM) deals with specific threats. Engineering activities include propagation analysis, interpretation and evaluation of technological findings, derivation of alternative solutions, and design plans to produce a feasible system. Other activities in related areas include further development and use of an interactive scenario-based analysis model for evaluation of various techniques on the modern electronic battlefield.

Electronic Countermeasures

Research activities in electronic countermeasures technology ranged from the theoretical development and experimental evaluation of new techniques for use against operational radar systems to feasibility determination of extrapolating these efforts to future ECM scenarios.

In-depth analyses of an RF seeker have been performed to identify inherent susceptibilities to countermeasures, to determine where improvements can be made to enhance system performance and to develop a realistic and effective closed-loop simulation facility.





The EES Convair 240-27 airborne electronics laboratory.



Systems Analysis

Major activities in defense systems analysis have been in: electronics countermeasures (ECM), computer simulation of threat radar environments and weapon delivery systems, computer-aided flight test planning and evaluation, specialized aircraft radar cross section measurement, and electronics warfare (EW) systems analysis.

Efforts utilizing the General Effectiveness Model have included comparisons of prototypes and conceptual power-managed ECM systems, survivability predictions for tactical aircraft missions, cost-effectiveness comparison of weapon systems and flight-test planning for mission profile optimization.

Research has been performed in the cost-benefit analysis area such as methodology development and engineering economics, including life-cycle costing concepts. Cost-benefit studies included the Georgia Natural Resources Inventory Systems, stratospheric and tropospheric monitoring and integrated electrical and thermal energy systems.

A new program to develop statewide traffic forecasting procedures for the Georgia Department of Transportation has been initiated. In addition, a data systems study for retrieving remote sensing stratospheric pollution monitoring data from satellite, airborne and surface platforms recently began. New programs in software development include real-time control applications, transportation data systems analysis and an automated accounting and management information system.

- Radar and communications systems analysis
- EMC analysis
- Large-scale computer simulations
- Cost-benefit analysis
- Reliability analysis
- Environmental systems
- Energy and resource systems
- Satellite systems
- Weapons systems
- Transportation systems
- Management systems
- Computer-aided test and evaluation planning
- Operations research
- Modeling and simulation
- Data systems analysis and design

Solar Energy

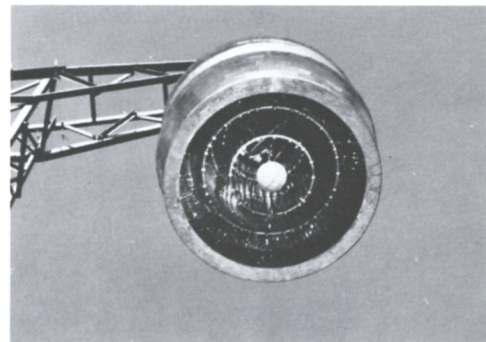
- Process heat
- Minerals processing
- Agricultural drying
- Heating and cooling
- Electric power generation
- Thermal storage systems
- High temperature applications
- Biomass conversion
- Methane production
- Wind energy

Solar Energy Research

Opportunities for solar research continue to increase. EES programs involve local citizens, industry and government at the state, national and international levels.

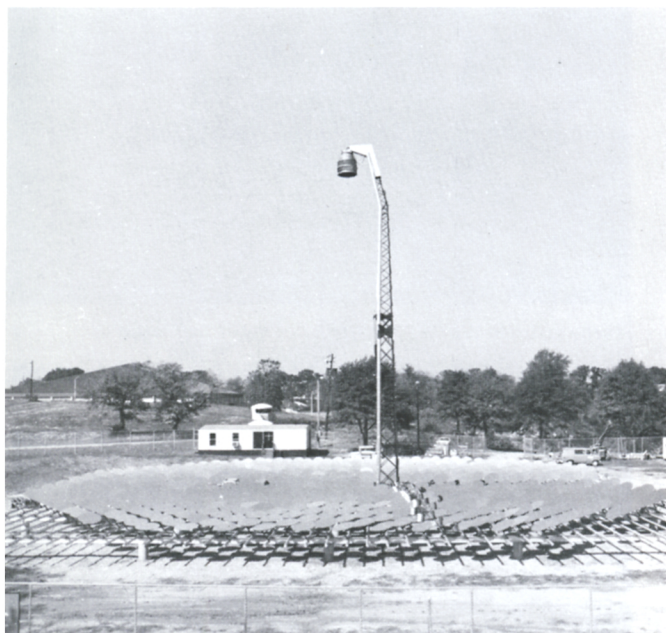
The scope of EES solar research activities expanded during the year as illustrated by the following major programs:

- Bench Model Solar Steam Generator; supported by the Energy Research and Development Administration (ERDA)
- Thermal Storage Subsystem Research
Experiment and preliminary design of 10 MWe Solar Powered Pilot Plant and conceptual design of 150 MWe commercial solar power plant; supported by Martin Marietta, Denver, under prime contract from ERDA.
- Ceramic metal-joint designs for a gas-cooled open-cycle 1 MWth bench model central solar receiver; supported by Black & Veatch, Kansas City, Mo., under prime contract from the Electric Power Research Institute (EPRI).
- Preliminary design of a 150 kWe solar powered deep well irrigation facility; supported by Black & Veatch under prime contract from ERDA.
- Design support for the 5 MW Solar Thermal Test Facility; supported by Black & Veatch under prime contract from ERDA.
- State-of-the-art survey of solar powered irrigation pumps and food cooking stoves; supported by Al Dir'Iyyah Institute, Geneva, Switzerland.





The Georgia Tech 15kW Grumman Wind Generator used in wind energy systems analysis programs.



The ERDA/Georgia Tech 400kWth Solar Research and Test Facility on the Tech campus.

- Development and evaluation of a 400kWth solar steam generating plant and test facility; supported by ERDA.
- Design of a solar collector and energy storage system for heating greenhouses and rural residences; supported by U.S. Department of Agriculture.
- Feasibility analysis — potential utilization of a solar system to provide space and process heating for the Western Electric Atlanta Works.

This large array of programs and associated technical and administrative activities resulted in many accomplishments, highlighted by three major milestones:

- The previously designed one MWth bench model receiver was successfully tested during the summer, 1976, at the CNRS 1000 kW Solar Furnace in southern France. These tests, conducted by a technical team from Georgia Tech, Martin Marietta and Sandia, with collaboration of CNRS, produced the first electric power plant quality steam from solar radiation.
- The thermal storage subsystem research experiment, providing designs for the 10 MWe Solar Thermal Electric Pilot Plant, was completed, successfully operated, tested and evaluated during the year. The complete two-stage storage subsystem using molten inorganic salt and hydrocarbon oil as the storage media was constructed adjacent to Georgia Power Company's Plant Yates near Newnan, Georgia. Heat from steam supplied by the power plant was successfully stored and steam was regenerated from the thermal energy stored.
- The ERDA/Georgia Tech 400kWth Solar Research and Test Facility constructed on campus was completed and became fully operational by the end of 1977. This facility is one of the two major high temperature solar research facilities planned and being constructed in the U.S.
- Conceptual design of a solar total energy-large scale experiment; supported by Westinghouse Advanced Energy Systems Division under prime contract from ERDA.
- Design of collectors and instrumentation for solar drying of agricultural crops; supported by U.S. Department of Agriculture.

Energy Application Programs

- Management
- Conservation
- Alternative analysis
- Optimization
- Hybrid systems

Energy Conservation

Research activities related to local, state and national energy problems assumed significant proportions during the year. Conservation was a primary focus with projects in the food processing, textile and carpet industries. EES personnel, working with approximately 50 firms throughout the state, identified resulting annual savings of about \$2 million. This work stimulated over \$900,000 in-plant capital expenditures for conservation.

Energy conservation in schools, hospitals and other institutions also became an important project activity with typical savings of 20 percent in energy costs realized from these studies.

Short courses, conferences, seminars and presentations to various public and business groups on energy, conservation and productivity were an important activity in EES during FY 1977 and helped strengthen awareness of EES functions throughout Georgia.

Five energy conservation workshops were held throughout the state for plant managers and engineers under U.S. Department of Commerce sponsorship. The annual Industrial Development Short Course co-sponsored by the American Industrial Development Council, Southern Industrial Development Council and Georgia Industry Developers Association was held in April with 54 persons from 17 states in attendance. In June, a seminar on wood for energy was conducted in Atlanta in cooperation with the Georgia Forestry Commission.

Productivity engineers have visited numerous industrial plants to monitor processes for energy consumption.

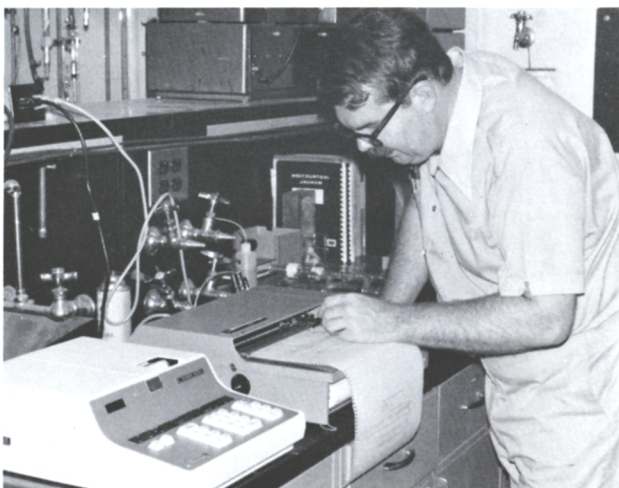


Demonstration of a solar rock collector heating a poultry grow out house





The EES 10,000-gallon anaerobic digestion system converts manure into energy.



Resources and Waste

- Resource utilization
- Waste management and treatment
- Industrial waste conversion
- Anaerobic digestion
- Industrial process improvement
- Synergistic co-siting of industrial activities

Resource Conservation and Utilization

Strong emphasis continues to be given to resource conservation and utilization. Development continued on the 10,000-gallon anaerobic digestion pilot plant near Cumming, Georgia, with support of the Georgia Department of Agriculture and the Georgia Poultry Federation. Emphasis was given to new applications for the EES pyrolysis system and to location of new sources of support for research in this area. The licensee of this system, Tech-Air Corporation, reported that successful 24-hour/day, 7-day/week operation was achieved at its commercial prototype installation at Cordele.

Synergistic Co-Siting Programs and Studies

A study of the environmental, economic and conservation aspects of integrated energy-use applications has been underway. This program is investigating the environmental, economic and resources-conservation merits of supplying total energy requirements to an industrial and commercial-operations complex, as compared to conventional multiple single-purpose sources of energy supply. Several alternative concepts for centralized total-energy supply and use are being assessed for feasibility and overall economy in terms of fuel costs, pollution-control costs, energy production and distribution costs.

This program is an interdisciplinary study to extend and broaden research concepts of synergistic co-siting of industrial activities as an important and promising approach for the solution of major national problems such as energy and resources conservation, environmental quality, land use and effective industrial development.

Mechanical, Chemical and Materials Science

• Complex mechanical structures and equipment • Machine, equipment and tool design • Pyrolysis • Water and air quality • Kinetics and atmospheric chemistry • Coal desulfurization • Wood gasification • Wood chemistry • Carbon technology • Polymer science • Paints and coating • High-temperature materials

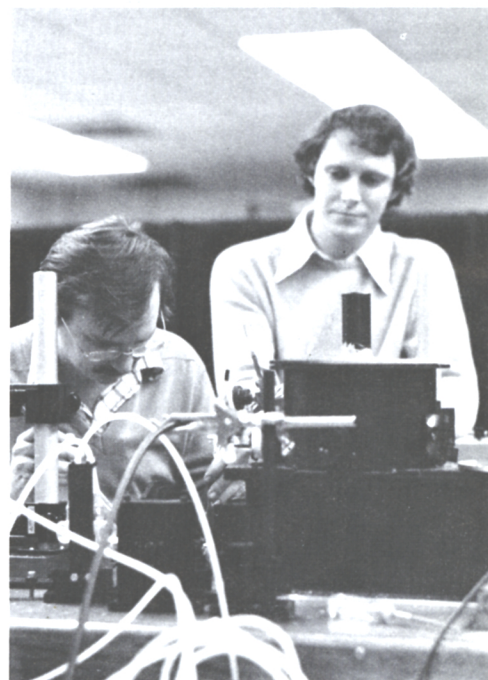
EES received two major projects, sponsored by the Environmental Protection Agency, involving water research (trace element identification).

There has been an active demonstration project with the objective of obtaining field data on the general applicability of sand or mixed media filters for upgrading the effluent from ponds or other wastewater treatment facilities to meet federal regulations for suspended solids. A large portable trailer with a mounted filter and support components has been designed and built. The filter will be tested at various stabilization ponds throughout the state and is expected to provide an acceptable and economical solution to large and widespread problems of upgrading the effluent from waste treatment facilities.

Three major EES research programs have continued in applied physics. Two are supported by the National Institute of Dental Research and are addressing the structure and analysis of tooth enamel using x-ray diffraction techniques. The third program is a major neutrino research program supported by National Science Foundation.

Kinetics and Atmospheric Chemistry Programs

Using the NCAR (National Center for Atmospheric Research) Electra as a sampling platform, a global sampling effort has been initiated which involves the measurement of over 50 atmospheric species and meteorological parameters on a simultaneous basis. Recognizing both the importance of chemically coupled atmospheric species and the strong interaction between chemistry and meteorology, the GAMETAG (Global Atmospheric Measurements Experiment on Tropospheric Aerosols and Gases) program is to be a joint effort among meteorologists, cloud physicists and atmospheric chemists. Project GAMETAG calls for a seven-year study.



The Tech pyrolysis system produces clean burning fuels.

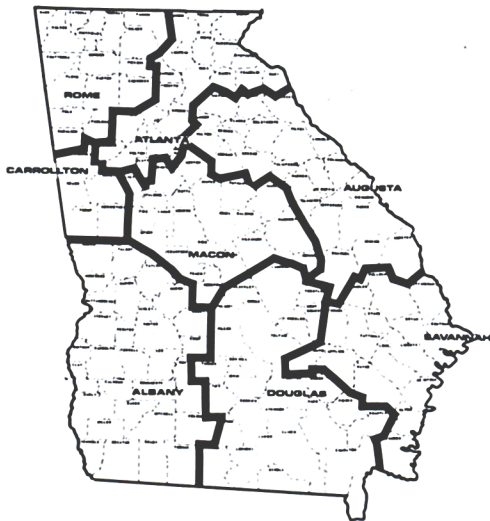


Economic Development/Technical Assistance

Productivity



Efforts are being made to improve worker image in the gum naval stores industry by improving conditions and productivity through the development of power tools and gum hauling equipment.



EES aids Georgia community and business development through seven field offices located in Albany, Augusta, Carrollton, Douglas, Macon, Rome and Savannah.

EES was named the Georgia Productivity Center in 1975, and awarded two projects by NSF-RANN; one a regional productivity study and the other a survey of existing productivity organizations. The Tri-Universities project, (Georgia Tech, University of Georgia and Georgia State), funded by NSF-RANN via the Georgia Bureau of Community Development for local government productivity improvement, was announced late in the year.

Services to the State of Georgia were a substantial part of EES activity during the year. In the private sector, the Office of Industrial Assistance continued to provide responses to inquiries on technical problems as well as assistance to inventors. The Management and Technical Assistance Program handled 41 separate projects including: management and technical assistance to Georgia businesses, community development assistance to local and state-wide development groups and development of housing resources in the state.

Assistance to Business

A special research activity under the EDA University Center program involved assistance to business depressed by the shift of tourism away from the U.S. Highway 301 corridor to new Interstate 85. Feasibility studies for loan guarantee applications to the Farmers Home Administration were proposed for two loans of \$4,000,000 and \$1,300,000.

In public sector services, 11 cities were certified under the Certified Cities Program and 22 participated in the follow-up program to overcome deficiencies preventing certified status.

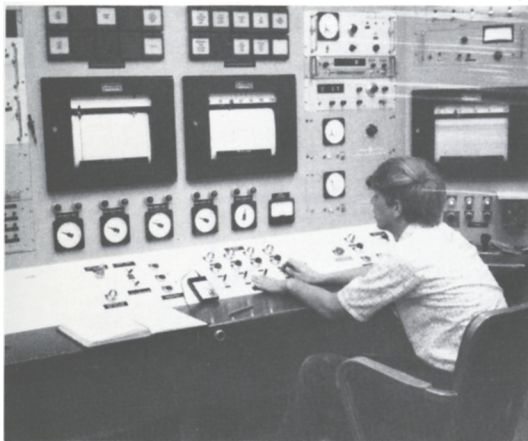
• Productivity • Economic analysis • Manpower/training • Management and technical assistance for small business • Minority business development • Technology transfer • Industrial assistance • Community development • Human factors/labor productivity • Industrial process improvement



Nuclear Sciences

The key component of the Frank H. Neely Nuclear Research Center is the Georgia Tech Research Reactor, a heterogeneous heavy-water moderated and cooled type, fueled with enriched uranium and designed to develop a sustained power output of five megawatts. Capabilities include:

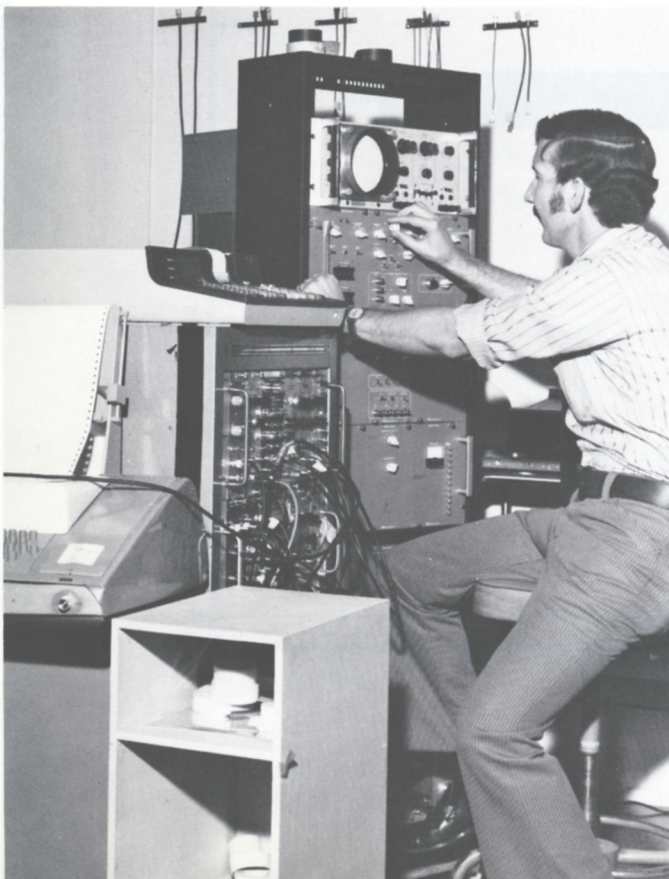
- Isotope production
- Neutron diffraction studies
- Neutron radiography
- Neutron activation analysis
- Radiation damage effects
- Radiochemical formation and packaging
- Radioactive material studies

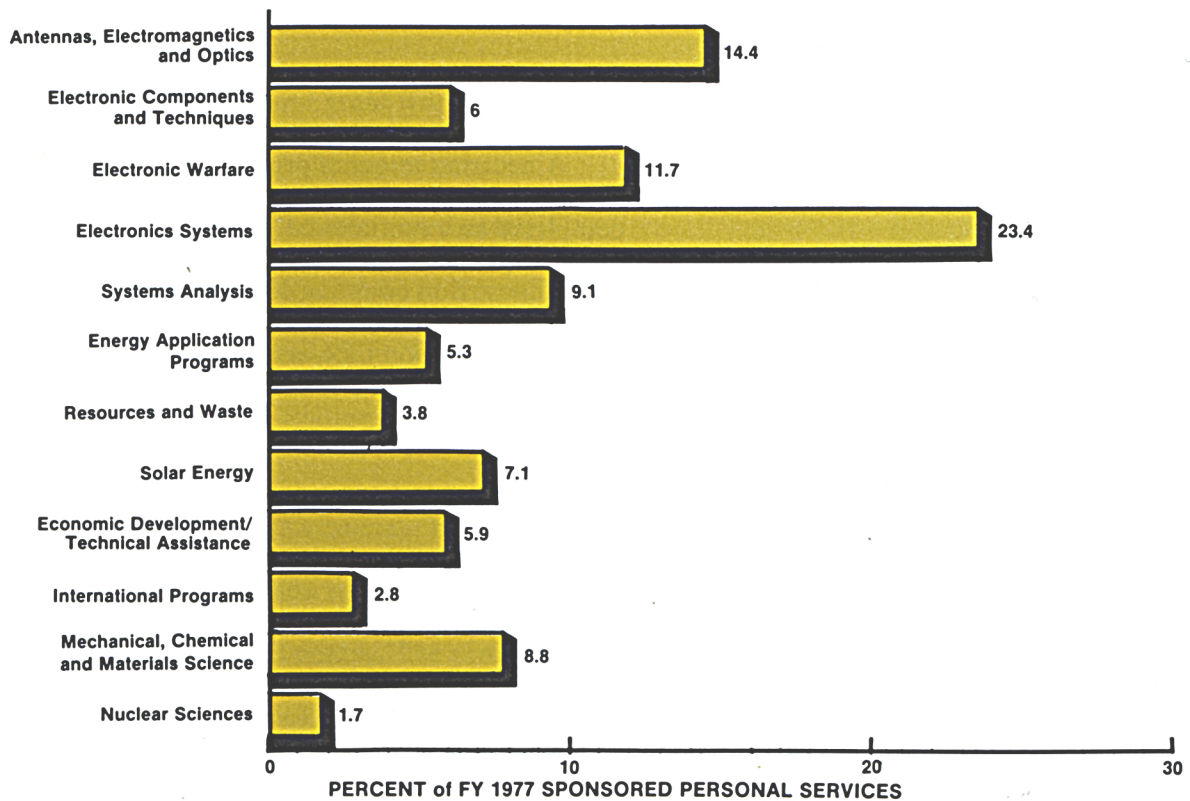
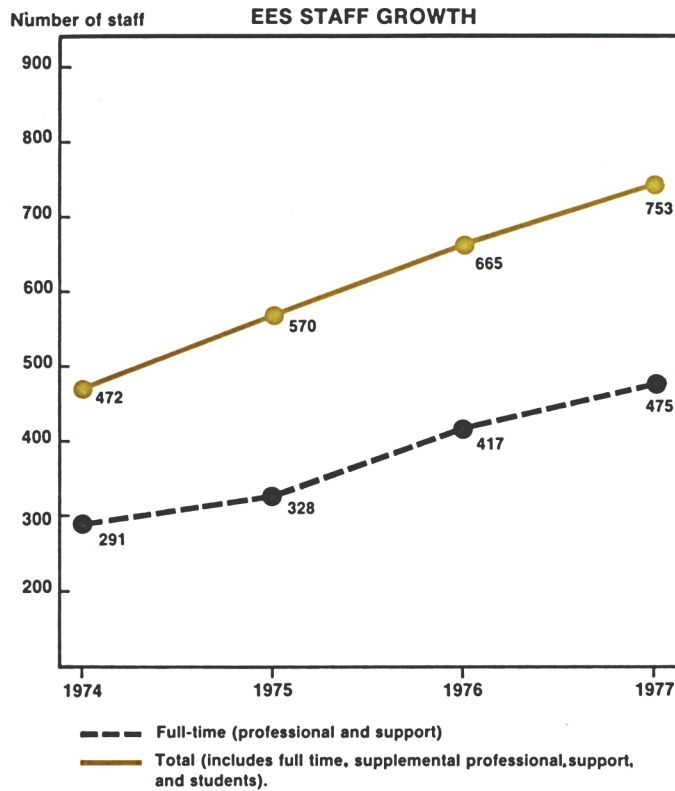


Research activity at the NRC continues to emphasize neutron activation analysis applications. Trace elements in such materials as blood, other biological materials, copper artifacts, rocks and meteorites have been studied. Other research is concerned with nuclear physics studies of the decay of radionuclides, the production of radioactive tracers, neutron radiography and neutron diffraction studies.

Neutrino Research

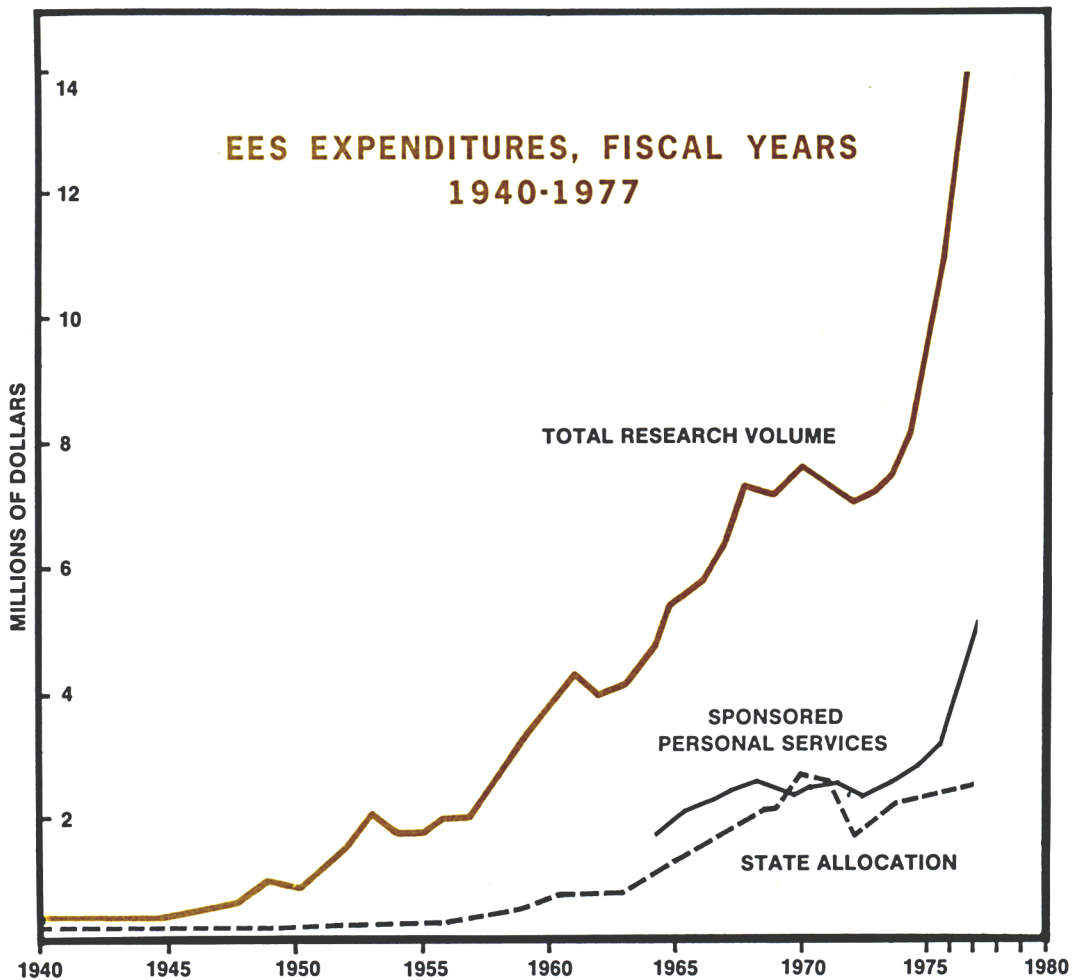
A neutrino research project sponsored by NSF has continued. This year's research has successfully completed an experimental feasibility study for a much larger experiment which will measure a basic weak interaction coupling constant (neutrino interaction with a deuteron) as well as provide a test of weak interaction theories at low energy. Such a test is of great interest to the physics community.





**Personal Services—Percentage Support
From FY 76-FY 77 Sponsors**

	FY 76	FY 77
Federal Government	79	87
Army	12	14
Navy	16	18
Air Force	22	21
NASA	5	7
DoE	8	9
Other	16	18
Industry	10	7
State/Local Government	<u>11</u>	<u>6</u>
	100	100



The Georgia Tech Research Institute

Most of the research at the Engineering Experiment Station is supported by contracts with governmental organizations and with private industry. Contracts are handled through the Georgia Tech Research Institute (GTRI) and are usually of the cost-reimbursable (no fee) type. GTRI is a non-profit Georgia corporation organized and operated to support the research programs of Georgia Tech. This support includes contractual relations and copyright and patent procedures associated with the performance of research projects for outside sponsors. The Vice President for Research of Georgia Tech also serves as Director of Research and Secretary of GTRI.

The Georgia Tech Research Institute continued its role of providing support to the Georgia Tech research program. The year brought several changes to the officers and trustees of the

Corporation. Most notable was the retirement from active board membership and election as a Trustee Emeritus of Mr. Fuller E. Callaway, Jr., one of the three founders in 1937 of the Research Institute. Mr. Glen P. Robinson, Jr., succeeded Mr. Richard K. Whitehead, Sr., as Chairman of the Board. New trustees elected were: Mr. Haran W. Bullard, Sr., and Mr. Robert B. Ormsby, Jr.; they succeeded Mr. Callaway and Mr. Clyde M. Kennedy, III, who resigned.

GTRI financial support included expenditures of \$231,000 from the grant to the Engineering Experiment Station, primarily for major equipment, and an additional grant of \$225,000 to provide basic laboratory equipment required by the increase in Engineering Experiment Station research personnel.

Additional information about the capabilities of EES can be obtained from the Office of the Director. We shall be glad to discuss your interests as well as identify staff members who can discuss your technical problems in detail. The address and telephone number are:

**Director
Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332
Telephone: (404) 894-3400
Cable address: Eng. Exp. Sta.
Telex: 542507 GTRI OCA ATL**

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Research at the Engineering Experiment Station
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