1978 REPORT

Engineering Experiment Station
Georgia Institute of Technology

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Dr. Donald J. Grace, Director
Engineering Experiment Station

Observations of the Director

About EES

The Engineering Experiment Station (EES) is a modern, nonprofit research and development organization, staffed with hundreds of full-time, dedicated professionals. It is also an integral part of Georgia Tech, reporting directly to the Institute's Vice President for Research and employing more Tech students than any other industry in the state.

EES programs range from the most basic neutrino physics experiments to the development of economically viable solar-heated chicken houses; from analyses of systems for monitoring stratospheric pollution to design and implementation of totally new radars; from evolving software processing techniques for earth resources satellites to management of the nation's second largest solar energy test facility. There's a $4.2 million contract with a federal government agency and a $500 contract with a rural industry. The Station also has programs with local, regional, and state governments, with major companies, with other R&D organizations, and with developing nations. The key to EES is its people — and this report is a chronicle of their accomplishments.

In Brief

The 1978 fiscal year for EES was characterized by a major increase in research volume, continuing diversification of technical thrusts, addition of new sponsors, and expansion of the professional staff. It was also a year of growing interaction among the major operating units within the Station — and with external research entities as well.

Research and Development

The total number of active projects during the year, including both externally and internally sponsored activities, was more than 500, up 25% from the previous year. A total of 786 proposals with a value of $67 million were written in FY 1978. At year's end, 230 of these were still outstanding for a potential value of $27 million.

Electronics remained the largest research and development area, constituting about half of the EES activity. Electronics includes radar systems, antennas, electromagnetics, optics, defense electronics, components, and techniques. Energy was the second largest segment, with about equal emphasis on solar, resources and waste, and various applications — accounting for a total of 15% of the effort. Defense and civilian systems analyses comprised 10% of EES R&D in FY 1978, as did the combined fields of physical, chemical, and material sciences. Domestic and international economic development accounted for about 9%, and the balance was in computer applications. Specific examples of the year's activities are highlighted in the succeeding pages of this report.

Financial Growth

The most significant highlight of the current fiscal year (ending June 30, 1978) for the Engineering Experiment Station has been the continuation of its growth momentum from the previous years. Total sponsored research for FY 1978 approached $16 million, a 37% increase over the previous year. Total expenditures were approximately $19 million, of which $2.6 million came from the State allocation. Outside sponsors paid EES researchers more than $7 million for their personal services. This represented an increase of about 32%.

Sponsors

The mix of sponsorship changed somewhat from FY 1977, with nonfederal government sponsors providing a relatively larger share of the total sponsored personal services in FY 1978. All federal agencies

except the Army supplied a reduced percentage of the total dollars in FY 1978, while the categories of industry and state/local government increased by 3 percentage points each to a total of 19%. Despite the overall decline in the proportion of federal support, however (81%, compared with 87% the previous year), actual dollars from all federal agencies except the Navy increased during the fiscal year.

New Technical Thrusts

During the year, the 400-kW Solar Thermal Test Facility was completed on the campus and designated as the U.S. Department of Energy Advanced Components Test Facility. Significant new research thrusts included paints and coatings, wood energy, and rehabilitation engineering.

In continuation of a policy to stimulate the growth of research activity, approximately $900,000 of internal funds were allocated by the EES Director's Office for procurement of research equipment, support of programs to hire research leaders, and as seed money for new activities. These funds were in addition to those allocated to the Laboratory units for meeting their ongoing administrative and research support needs.

Service to Georgia

EES continued to operate its seven field offices in Albany, Augusta, Carrollton, Douglas, Macon, Rome, and Savannah, with significantly expanded assistance to local governments and Georgia industries of all sizes. Assistance included management and technical advice, energy conservation and innovation, programs to help meet OSHA and EPA requirements, and the establishment of new industries. The Carrollton field office received special recognition by that community for its contributions toward locating the CBS records and tapes plant which will employ 3,000 persons. New assistance programs included a project to help Georgia industry improve productivity through less turnover, two projects to assist minority businesses, and some initial efforts in developing work for the handicapped. The Station continued to develop and present selected short courses. These courses have gained national recognition and attendance from key government and industry leaders.

Personnel

Overall staff size at EES rose by about 14% during FY 1978, with the heaviest growth in the professional areas. At year's end, the full-time staff of 560 people included about 70% professionals having one or more college degrees.

Within the total of over 900 employees at the end of the year, about 25% continue to be part-time undergraduate and graduate students; EES remains the largest employer of Georgia Tech co-op students in the state. In addition, about 60 of the professional staff are pursuing graduate degree programs on a part-time basis.

Organization

There was one major change in the organizational structure of EES: the Nuclear Research Center was transferred to the School of Nuclear Engineering within the College of Engineering effective at the beginning of the new fiscal year (FY 1979). This leaves eight major research units reporting to the Office of the EES Director.

Space

While space remained a critical problem during the year, the promise of significant short-range relief was achieved at year's end with a lease agreement for approximately 125,000 sq. ft. of prime quality R&D space from the Lockheed Corporation in Marietta.

Projections for FY 1979 indicate a further compounded growth rate on the order of 30%. This will add further demands for physical space, especially with the planned return to the campus early in the year of staff members who have been occupying five floors of the C&S Bank Building on North Avenue.

Interaction

The EES External Advisory Committee, composed of eight nationally recognized leaders from industry, universities, and government, met for the second time on the campus. Their deliberations were extended beyond the Station to broader matters of research impact and interaction on a national level.

Emphasis continued to be given by the Director's Office to interactions between EES and the academic units, highlighted by an EES Open House for new faculty and detailed briefings for faculty of several of the academic schools at Georgia Tech.

A joint committee was formed with representatives of the University of Georgia's Agricultural Experiment Stations to explore mechanisms for developing joint programs.

Presentations were made to a variety of alumni groups, including the National Alumni Advisory Board, Tech Today, and the Committee of Twenty. These exchanges have led to a greater mutual understanding in addition to significant expansion of industry participation in EES research.

A host of distinguished individuals visited the campus during the year, including Dr. James Schlesinger, Secretary of the Department of Energy; Dr. Frank Press, the President's Science Advisor; and Dr. Richard Atkinson, Director of the National Science Foundation.

Publications

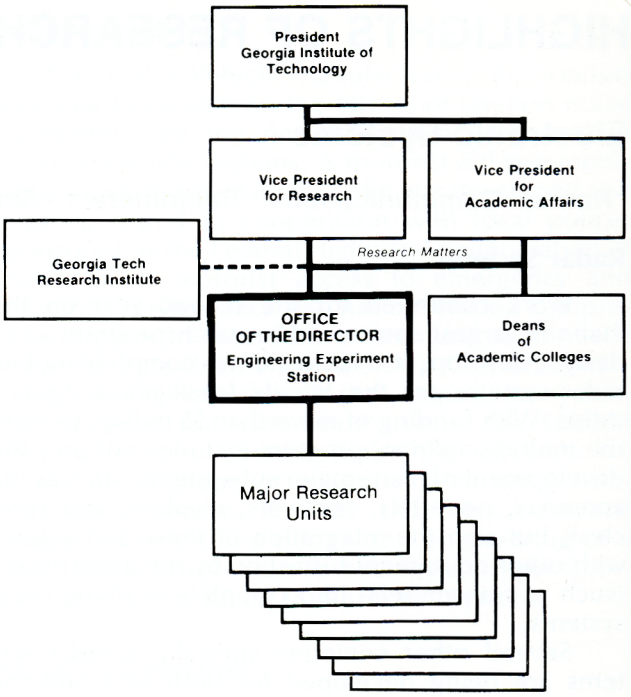
A series of monographs on significant campus-wide research activities and capabilities was initiated. Titles currently available include *Solar Energy, Profiles in Energy, Remote Sensing,* and *Waste Not, Want Not.* The EES story also is told through the bimonthly newsletter *EES Report,* dozens of press releases on individual projects, extensive radio and television coverage, and this general-interest version of the Annual Report.

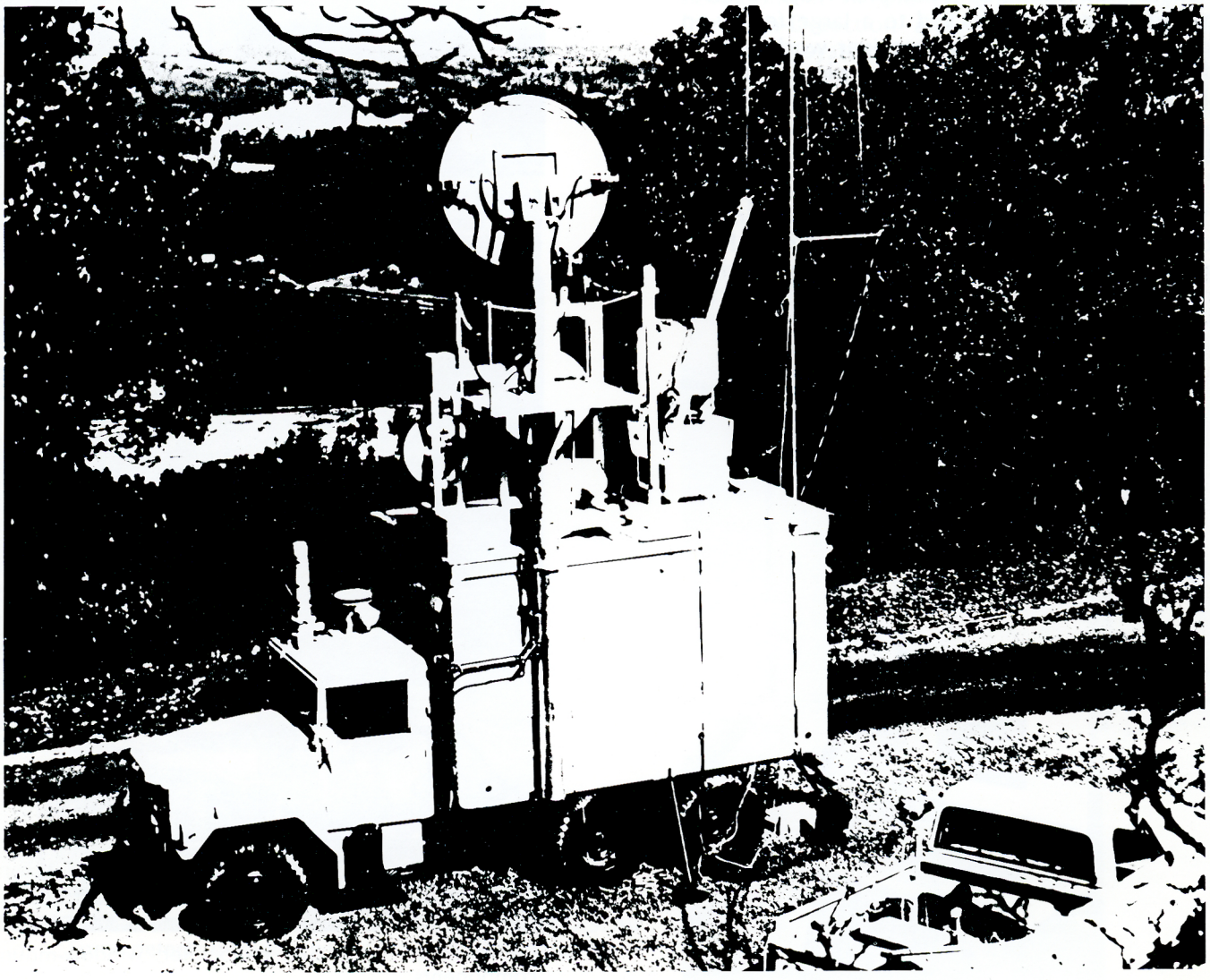
Problem Areas

Although salaries have certainly improved over the last two years, EES is under continuing pressure to remain competitive with industry for professional personnel in some of its research fields. The increase in sponsored programs has put added burdens not only on the recruiting of top-quality staff, but on their orientation, management training, and the internal organizational structures. The pressures of rapid growth have emphasized the need for sophisticated computer-based management information systems of all kinds. There is an ever-increasing need for more sophisticated research facilities and for the latest in capital equipment to avoid obsolescence. Although the State allocation for FY 1979 was increased over FY 1978, it continues to become a smaller percentage of the EES budget every year, making it impossible to keep pace in service projects for the state.

Whatever the problems, they stem from success. While continuing our dedication to quality, we move forward enthusiastically toward the challenges of tomorrow.

Donald J. Grace, Director





HIGHLIGHTS OF RESEARCH OPERATIONS

Electronic Systems

• Radar • Communications • Radiometers • Simulation • Instrumentation • Millimeter wave

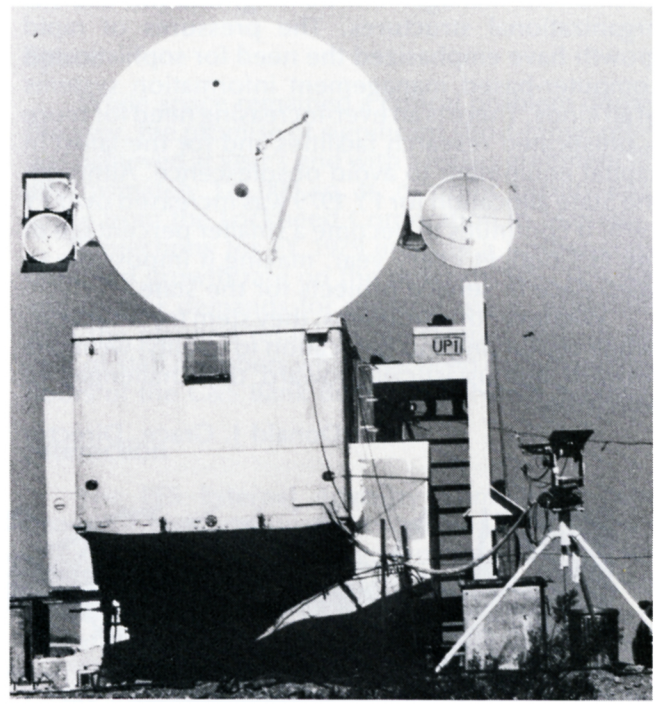
Radar Systems

Work continued for the second year on the Station's largest sponsored research program — to design, develop, and fabricate two complete mobile radar systems for the Missile Intelligence Agency (MIA). With funding of more than $5 million to date, the multidisciplinary program includes not only the development of many major subsystems (such as the antennas, pedestals, receivers, displays, and vehicles), but also the integration of these subsystems with other equipment furnished by the government (such as transmitters) into complete working radar systems.

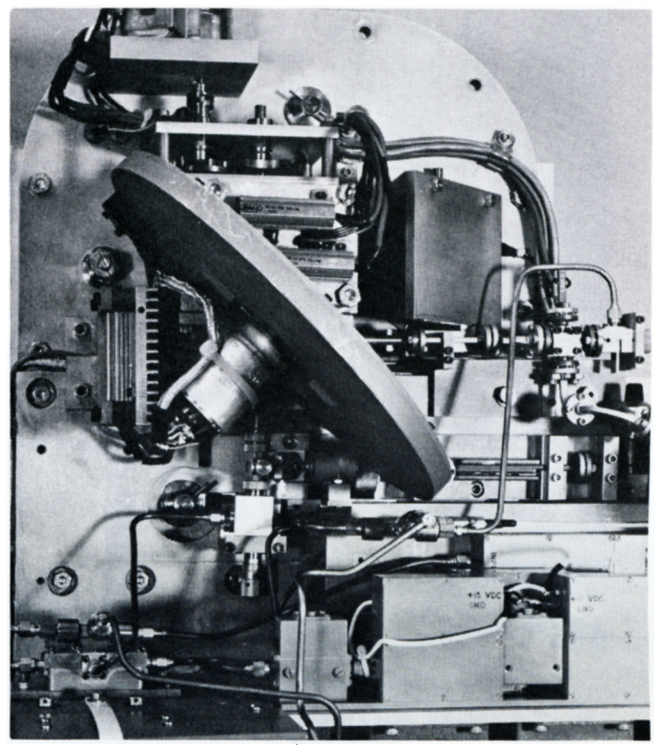
Several other complete specialized radar systems are being developed for both MIA and the Armament Development and Test Center (ADTC). The successful testing of a complex radar receiver being built for ADTC has led to a large follow-on program that continues the receiver work and includes additional systems for a complete scanning/tracking radar complex.

Radiometers

A major accomplishment was the development and delivery of a multichannel flight radiometer which will be used by NASA to measure atmospheric temperature profile data over severe weather regions from a B-57 aircraft. This will contribute to the understanding of tropical storm characteristics.



Four EES radars with frequencies of 10, 35, 70 and 95 GHz were used to record the radar history of the dust cloud from a simulated nuclear blast.



Georgia Tech 94/183 GHz radiometer: window-mounted components.

Scientists and engineers can continue their education on the job by viewing Georgia Tech classroom sessions that are videotaped in this on-campus facility.

Communications

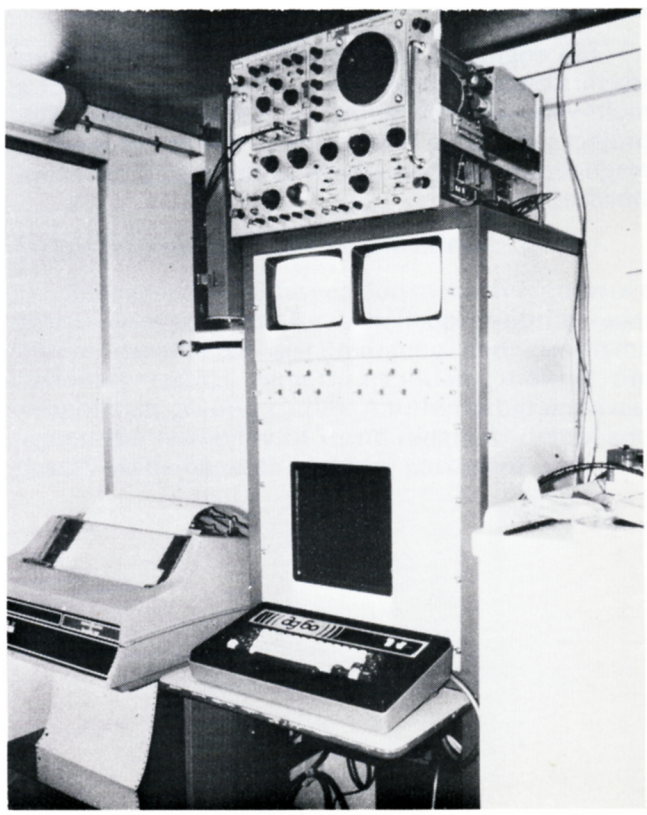
The Motor Vehicle Manufacturers' Association sponsored research on the effects of ignition noise interference on the performance of land mobile communications systems. A motorist aid communications system based on CB radio was developed and is being tested in cooperation with local police. Sponsored by the Federal Highway Administration, it allows direct motorist access to emergency and assistance services. EES also has developed comprehensive plans to meet future communication needs of the Georgia Electric Membership Corporations.

A mobile enforcement data acquisition system was designed for nationwide use by the Federal Communications Commission. Other projects included investigation of minimum time delay communication systems for the U.S. Naval Surface Weapons Center, and design and engineering of a two-classroom television recording facility for Georgia Tech's Video-Based Instructional System.

EES-developed radar system at Panama City, Fla., warns against unauthorized waterborne traffic.

Intrusion Detection

A major milestone this year was achieved when development of the Long-Range Area Radar for Intrusion-Detection and Tracking (LARIAT) signal processing system was completed, the signal processors were integrated with two radars, and the equipment was shipped to the test site. In another program for the Tri-Service Base Installation and Security System, a prototype target detection unit was developed for the Waterborne Intruder Detection Segment and successfully passed feasibility evaluation tests.



The LARIAT signal processing system built for the U.S. Air Force detects intruders who are trying to enter a secure area.

Electronic Techniques and Components

• Target discrimination/classification • Fire control and tracking • Radar/laser sensors • Guidance and seekers • Computer/sensor interface • Continuous wave/coherent techniques • Solid-state electronics • Failure analysis and reliability • Microwave and millimeter-wave devices • Signal processing • Training devices and battlefield sensors • Bonding, grounding, and shielding • Biomedical instrumentation • Radar meteorology • IR/EO sensors

Biomedical Studies

An extensive area of electromagnetic (EM) research at EES concerns beneficial applications of EM radiation in biology and medicine. Some examples are new techniques for determining the electrical properties of living tissues; EM techniques for thawing frozen white blood cells for transfusion in cancer therapy, for thawing frozen kidneys for transplantation, and for hyperthermia applications in the treatment of cancer; and math modeling in biological studies for enzyme inactivation through use of EM energy. EES also tested the effects of EM pulses on 94 cardiac pacemakers, and began research to determine if any biological consequences of pulsed versus CW nonionizing radiation occur on the granulopoietic blood-forming system.

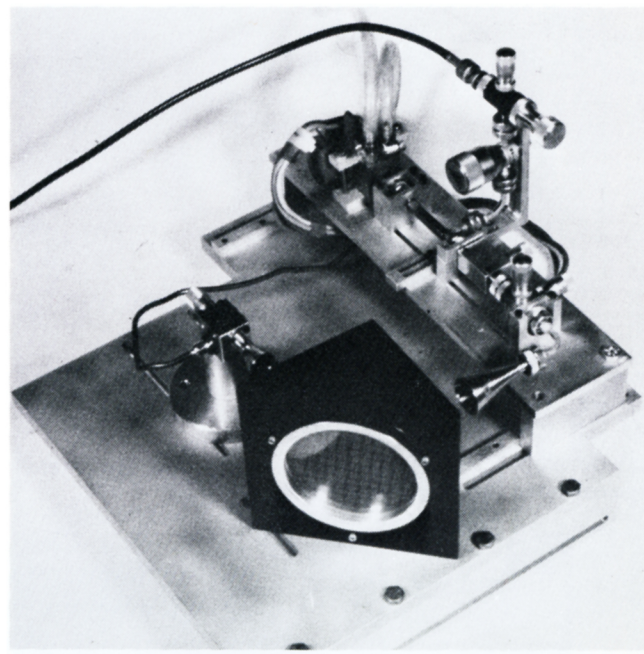
High-power source for electromagnetic measurements used in testing cardiac pacemakers.

Air Defense and Fire Control

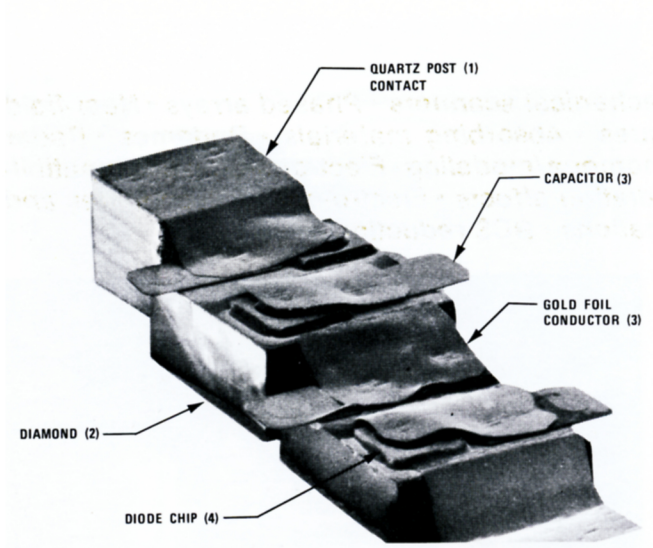
Work for the U.S. Customs Service to design a radar network to detect smugglers led to a current project to assess air defense requirements for nuclear materials storage areas. Several fire control radar studies were conducted, and a 70 GHz radar was modified to demonstrate the feasibility of a combined millimeter-wave/lidar fire control system.

Weather Studies

EES engineers participated in the 1977 Thunderstorm Research International Program as part of a multi-year research effort for NASA Goddard. The project's objective is to examine the use of electromagnetically emitted sferics as indicators of severe weather.



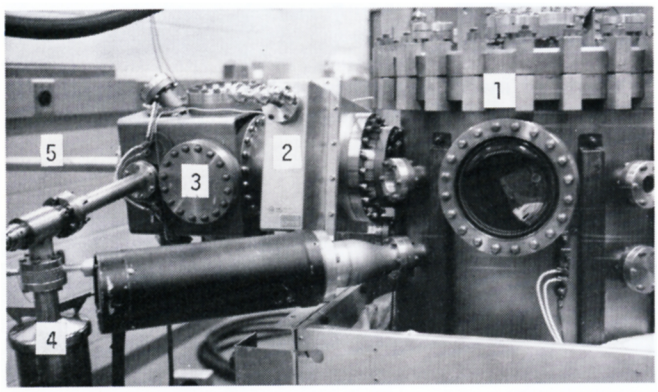
Heterodyne submillimeter receiver employing quasi-optical Fabry Perot diplexer.



High-power series-connected IMPATT diode assembly with diamond heat sinks.

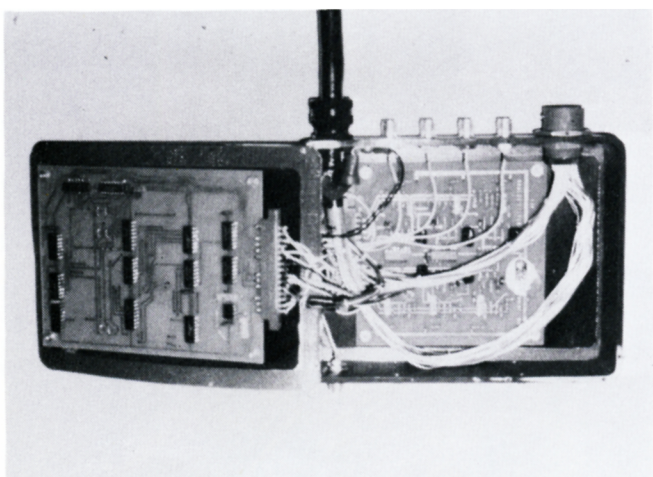
Microwave and Solid-State Research

EES continues to make state-of-the-art gains in this work area. Research, supported by the Avionics Laboratory, on multiple integration of microwave devices at the chip level has produced single structures delivering 60 watts of pulsed rf power at X-band with greater than 20% dc to rf conversion efficiency. In solid-state research sponsored by the Naval Research Laboratory, high-quality thin-film GaAs semiconducting materials have been grown using molecular beam epitaxy techniques. These results have received international recognition.



Molecular beam epitaxy system constructed at Georgia Tech for growing high-quality GaAs films.

1. MBE growth chamber
2. Interlock valve
3. Interlock chamber
4. Roughing pump
5. Insertion rod housing



This posture sensor unit built for the U.S. Army provides data to a central computer on the posture of a player in a weapons evaluation exercise.

Target Discrimination/Classification

Research during the year led to the definition of a design configuration for a helicopter-borne radar system capable of discriminating and classifying stationary tactical targets, especially indirect fire weapons, in ground clutter. Another program investigated the feasibility of using radars to detect and classify voids beneath highway pavement.

Antennas, Electromagnetics, and Optics

• Antenna analysis, design, and development • Electromechanical scanners • Phased arrays • Near-field antenna and RCS measurements • Polarization techniques • Absorbing materials • Radomes • Radar reflectivity measurements and analysis • Propagation phenomena/modeling • Electromagnetic compatibility (EMC) • Laser applications • Remote sensing • EM radiation effects • Electro-optical techniques and devices • Millimeter/submillimeter techniques and applications • RCS reduction

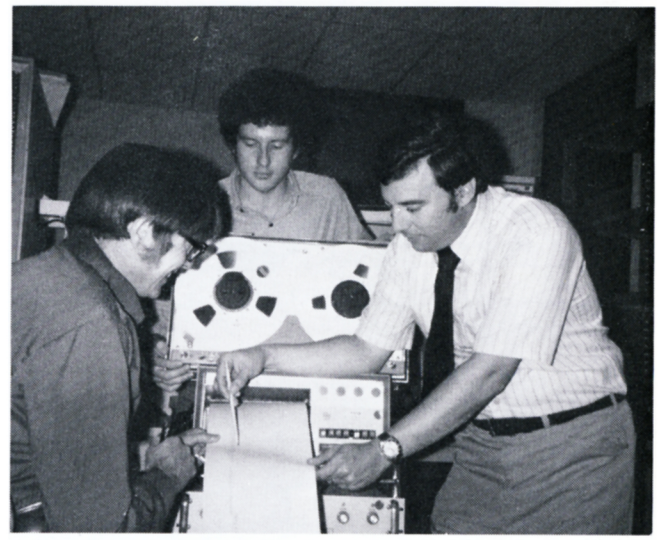
Millimeter Wave Technology

EES also is nationally recognized as expert in millimeter wave technology, including data collection and analysis as well as systems research and development. Substantial millimeter wave reflectivity measurement programs are conducted for all three military services.

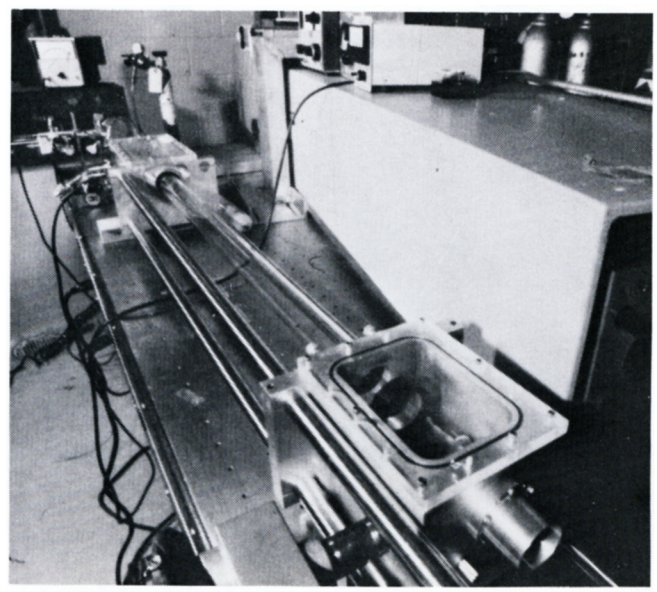
Typical activities during the year were: reflectivity measurement and analysis to determine the characteristics of man-made targets and clutter to establish a comprehensive data base for design and development of missile, fire control, and surveillance systems at millimeter wavelengths; modeling for millimeter guidance applications; millimeter wave radar sea return studies; and a design study for a facility to evaluate the effects of adverse weather on the performance of millimeter wave seekers.

Propagation Phenomena

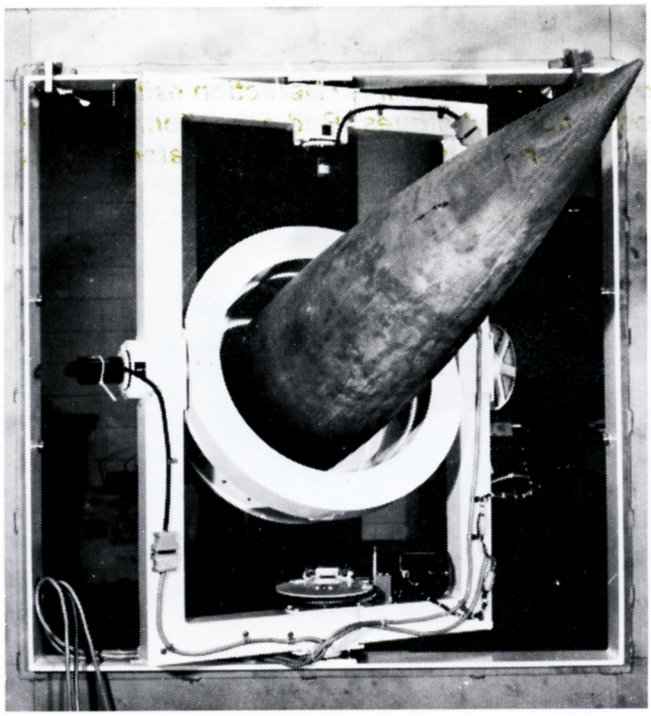
A near millimeter transmitter/receiver system employing a state-of-the-art optically pumped molecular laser transmitter was developed for the Army Missile Research and Development Command to investigate propagation through screening smokes and other battlefield-generated aerosols. Work also began on a new three-year program for the development of a mobile multi-wavelength propagation facility. A continuing program to develop a hybrid laser/radar engagement system emphasized development of a coherent CO_2 laser transmitter/receiver system in FY 1978.



Tracking of insect swarms by millimeter-wave radar in a U.S. Department of Agriculture project could lead to more efficient use of pesticides.



High-power, optically pumped laser developed for atmospheric research.



Two-axis radome positioner gimbal for an EES-designed radome positioner system used in an Army Radio Frequency Simulation System Laboratory.

Antennas

The analysis and design of radar antennas and systems is a strong program at EES. One program for the Air Force Avionics Laboratory involved computer analysis of pod-mounted antenna configurations for a side-looking radar antenna on an aircraft.

Electromagnetic Studies

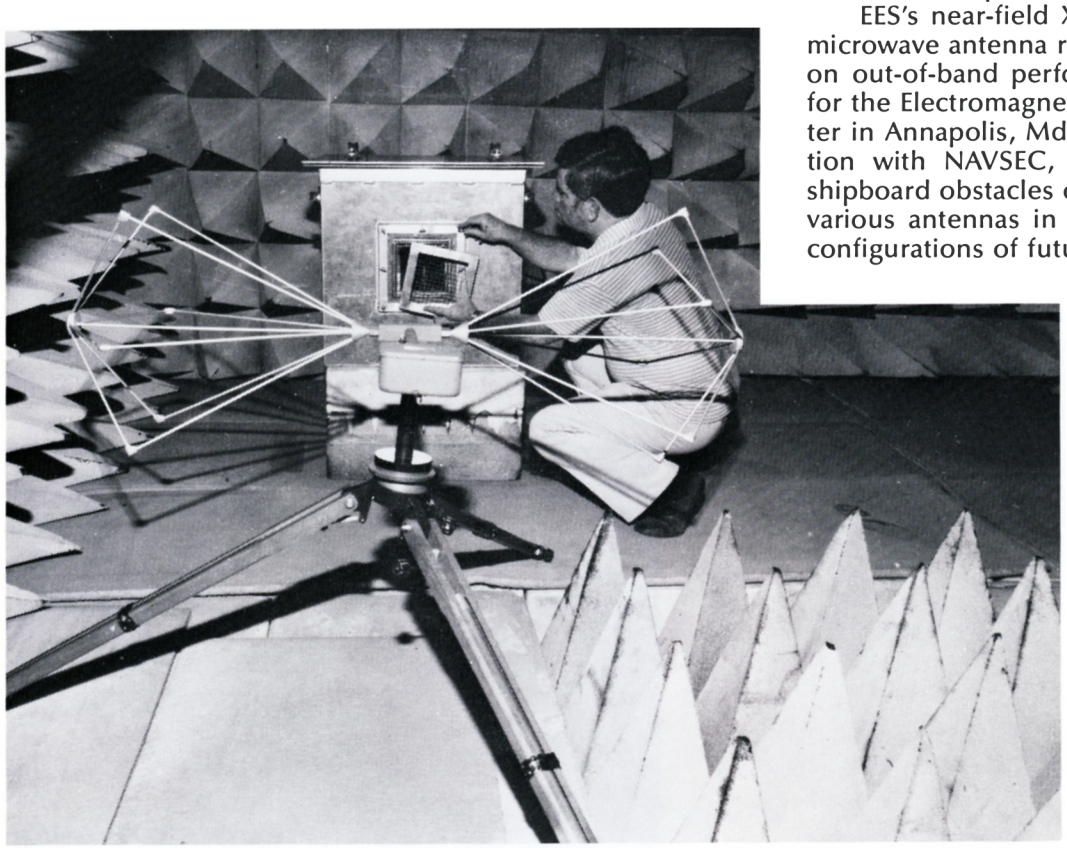
A major multi-year Air Force program is aimed at developing an electromagnetic radiation hardness program for weapon-designator systems. Rockwell International Corp. and the Naval Ship Engineering Center (NAVSEC) sponsored development of analytical methods for predicting the EM scattering and absorption properties of broadband chaff.

Near-Field Measurement Techniques

Continuing the research that has made Georgia Tech a national leader in the development of the near-field technique of microwave field measurement, EES engineers demonstrated the capability of processing near-field data directly on a minicomputer co-located with the measurement facility.

Studies begun for the Ballistic Missile Defense Advanced Technology Center include determining (1) various possibilities for low-cost, hardened phased arrays, and (2) near-field array measurement techniques for predicting the far-field performance of antennas transmitting through missile plume at millimeter frequencies.

EES's near-field X-Y probe and the on-campus microwave antenna range were used to gather data on out-of-band performance of reflector antennas for the Electromagnetic Compatibility Analysis Center in Annapolis, Md. Work continued, in cooperation with NAVSEC, on predicting the effects of shipboard obstacles on the far-field performance of various antennas in order to improve the topside configurations of future ships.



Anechoic chamber used in electromagnetic compatibility studies.

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) • Integrated test and evaluation

Electronic Countermeasures

EES engineers continued work on an important electronic countermeasures (ECM) program. They conducted experimental tests to evaluate the use of new ECM techniques against equipment that had been analyzed to identify possible areas of susceptibility. Another continuing effort involves increasing the capabilities and effectiveness of existing electronic defense systems by incorporating new and unique modes of operation. Major research efforts also were expended to design, fabricate, and evaluate breadboard and brassboard countermeasures equipment.

A new project begun in FY 1978 includes propagation modeling, definition of tactical communication scenarios, analysis of degradation due to specific jamming threats, and evaluation of ECCM techniques. Work also progressed on another project to design and evaluate a helicopter-mounted jamming antenna.

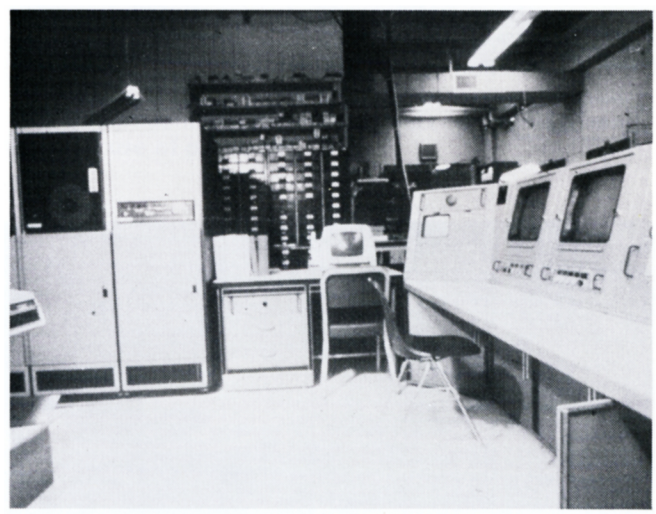
Surveillance

Surveillance research includes evaluation of automatic direction-finding equipment and electronic support measures (ESM) studies. Among the myriad of activities are at-sea testing and data analysis for over-the-horizon targeting exercises, evaluation of a real time detectability analyzer, assistance to Project STONEGATE, and investigation of surveillance sensor system techniques and the mechanics of physical phenomena.

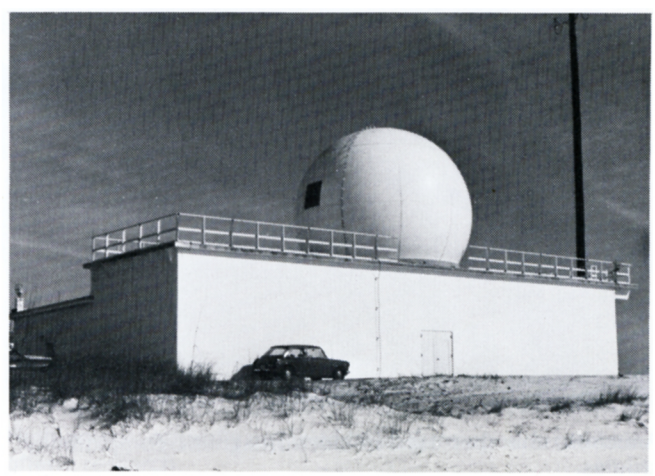
Simulation

Development of the SADS-VI M Closed Loop Flight Test Simulator was completed during the year. It will significantly enhance defense capability for evaluation of ECM system effectiveness. An Electronic Warfare Open Loop Simulator (EWOLS) also is being developed for application in an ECM signal analysis system designed at EES.

The EES airborne electronics laboratory, used for flight tests of experimental ECM equipment, also is available for atmospheric sampling.

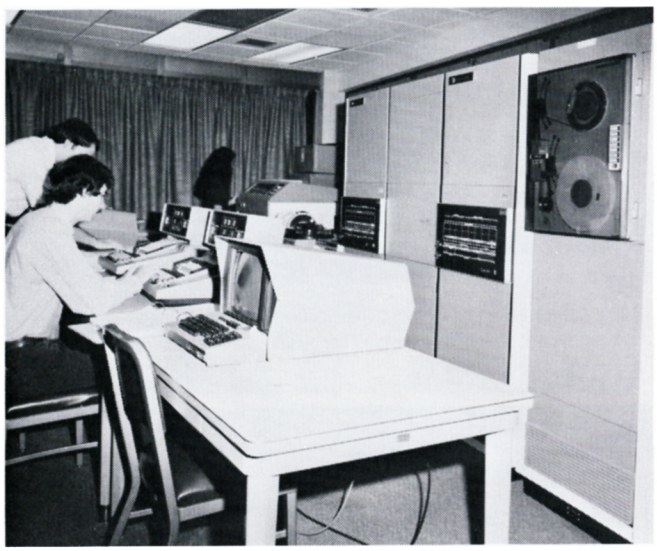


SADS-VI M equipment in development stage at EES (above) prior to installation in Flight Test Facility at Eglin Air Force Base (below).



Systems Analysis

• Radar and communications system analysis • EMC/EMV analysis • Large-scale computer simulations • Cost-benefit/effectiveness analysis • Reliability analysis • Economic systems • Environmental systems • Energy and resource systems • Satellite systems • Weapons systems • Transportation systems • Control systems • Management systems • Computer-aided test and evaluation planning • Operations research • Technology assessment, forecasting, and steering • Modeling and simulation • Data systems analysis and design • Psychological systems modeling and simulation • Human factors



Multidisciplinary capabilities are used to design and integrate this complex computer-controlled ECM performance verification system.

EES is assessing and developing models to predict traffic volumes on Georgia's freeways and major highways. Local, regional, and intercity bus services also are under study.

Electronic Defense Systems Analysis

Major activities in defense systems have been in computer-based rf environment instrumentation, computer-aided flight test planning, computer simulation of weapon delivery systems, validation and verification of software-controlled electronic countermeasures (ECM) systems, human operator modeling, and unintentional radiation analysis.

Culminating seven years of development, the General Effectiveness Model (a large-scale computer simulation) was delivered to the Air Force. A modified version was used to demonstrate the utility of computer-aided test and evaluation for the Air Force Armament Development and Test Center.

System integration of the EES-designed Electronic Countermeasures Signal Analysis System (ECSAS) was begun for the Warner Robins Air Logistics Center. Computer software was developed and systems engineering performed on the EWOLS. Other research included Stand-Off Target Acquisition System cost analysis.

Systems Technology

Work in systems analysis included satellite communication systems, stratospheric pollution monitoring data systems, wind energy applications, and transportation systems. Cost-benefit studies included an environmental and economic assessment of large power plant cogeneration systems for the Environmental Protection Agency and a benefit assessment of pollution monitoring satellites for NASA. Planning and analysis assistance to the Georgia Department of Transportation was continued, and a study of transportation needs of the handicapped and elderly was initiated.

A particularly challenging project was a study for the Federal Communications Commission (FCC) of tradeoffs between the quality of AM, FM, and TV broadcast transmissions and the regulatory programs of the FCC.

Computer Applications

• Software engineering • Mini/micro computers • Graphics • System evaluating • Netting

Computer Science

Computer science research included operating systems, software support systems, software portability, computer architecture, and distributed computer systems. EES is nationally recognized in certain aspects of computer software, with personnel serving on several national review and assessment committees as well as providing technical expertise in support of a number of Department of Defense and industry activities.

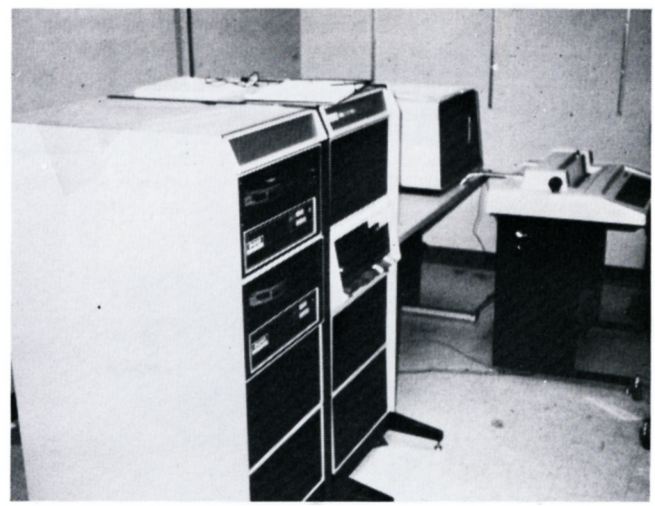
Computer Technology

Computer technology research included special-purpose bit-slice processors for high-speed, dedicated applications and modified systems to facilitate system simulation and hardware emulation; high-speed logic design techniques; multiprocessing using shared memory processors; computer system diagnostic theory; and video-signal processing and simulation techniques.

Computer Applications

EES produced a set of statewide land cover maps and statistical data for the State of Georgia, utilizing software developed at Georgia Tech to process LANDSAT satellite imagery.

Microprocessor techniques were used in the design and fabrication of an Arabic/English word processing CRT terminal.



The Environment and Radar Operation Simulator (EROS), built for the U.S. Army Electronics Command, simulates the video signal from a radar for signal processing evaluation and operator training.

The EES Earth Resources Data Analysis System (ERDAS) was displayed at an international technology exposition in Atlanta and received a large number of inquiries from foreign guests.

International Programs

• Industrial development • Integrated rural and urban development • Appropriate technology • Alternative sources of energy • Information collection and dissemination • Education and training

One of the metal fabricating shops in Korea assisted under an AID small industry development program supervised by EES.

This water pump was manufactured and installed in Costa Rica as part of an AID-funded field testing program.

EES offers tailor-made training programs to technicians from numerous developing countries.

During the year, EES conducted 27 sponsored projects in 19 countries, assisted by other Georgia Tech faculty and staff members. Twenty of these projects were funded by the U.S. Agency for International Development (AID). Other sponsors were the National Academy of Sciences, the U.S. Department of Commerce, the International Science and Technology Institute, the United Nations Industrial Development Organization, the Bio-Energy Council, the Asian Development Bank, and the Korea Credit Guarantee Fund.

Major research activity focused on small industry development in developing countries; field testing and evaluation of manually operated water pumps in Nicaragua, Costa Rica, Guatemala, the Dominican Republic, and Indonesia; and the construction of pyrolytic converters to utilize wood and agricultural wastes in Ghana and the Philippines.

Training of personnel of developing-country economic development organizations continues to be a significant part of EES's international work. During FY 1978, 18 Indonesian librarians participated in a three-month training program on technical information management; four Koreans from the Korea Credit Guarantee Fund received one month of training in industrial extension work; and the National Technical Information Service sent several representatives of its developing-country counterparts to Georgia Tech as part of their training. Preparations also began for an appropriate technology/small industry seminar for the Asian Development Bank.

A major five-year project aimed at strengthening Georgia Tech's capabilities in employment generation through the stimulation of small-scale industries was completed during the year. This AID-funded project resulted in formal cooperative agreements with 12 developing-country institutions and led directly to many other development projects.

Solar Energy

• Process heat • Minerals processing • Agricultural drying • Heating and cooling • Electric power generation • Thermal and chemical storage systems • High temperature applications • Wind energy • Hydrogen production • Cookers and irrigation systems

Solar Test Facility

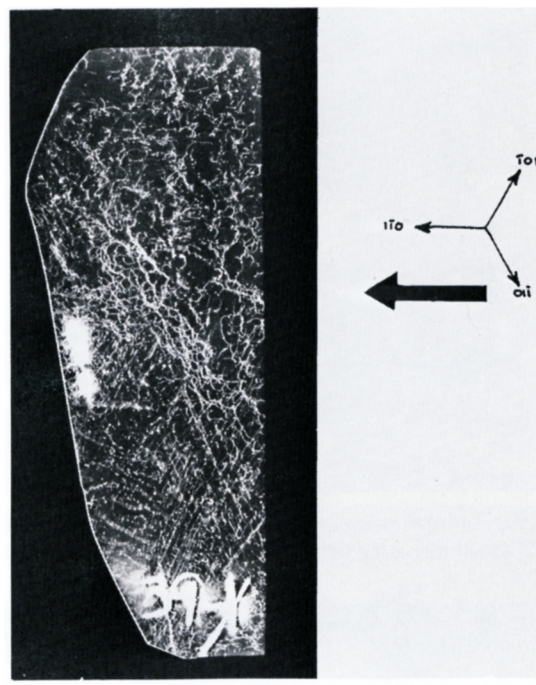
The 400-kW Advanced Components Test Facility (solar thermal test facility) underwent major modifications during the year and is ready to support testing of newly developed and heavier solar components during FY 1979. Developed and operated by EES for the Department of Energy (DOE), it is one of DOE's two major test facilities in the U.S.

Consisting of a 550-mirror field, a tower that can support a 20,000-pound test load, a control building, and complete computer system, the installation can achieve temperatures up to 3500°F. It is available to industry, university, and government laboratories or qualified individuals to evaluate experimental components such as steam generators and other heat exchanger devices and to perform research in such areas as metals, ceramics, coatings, and chemical syntheses.

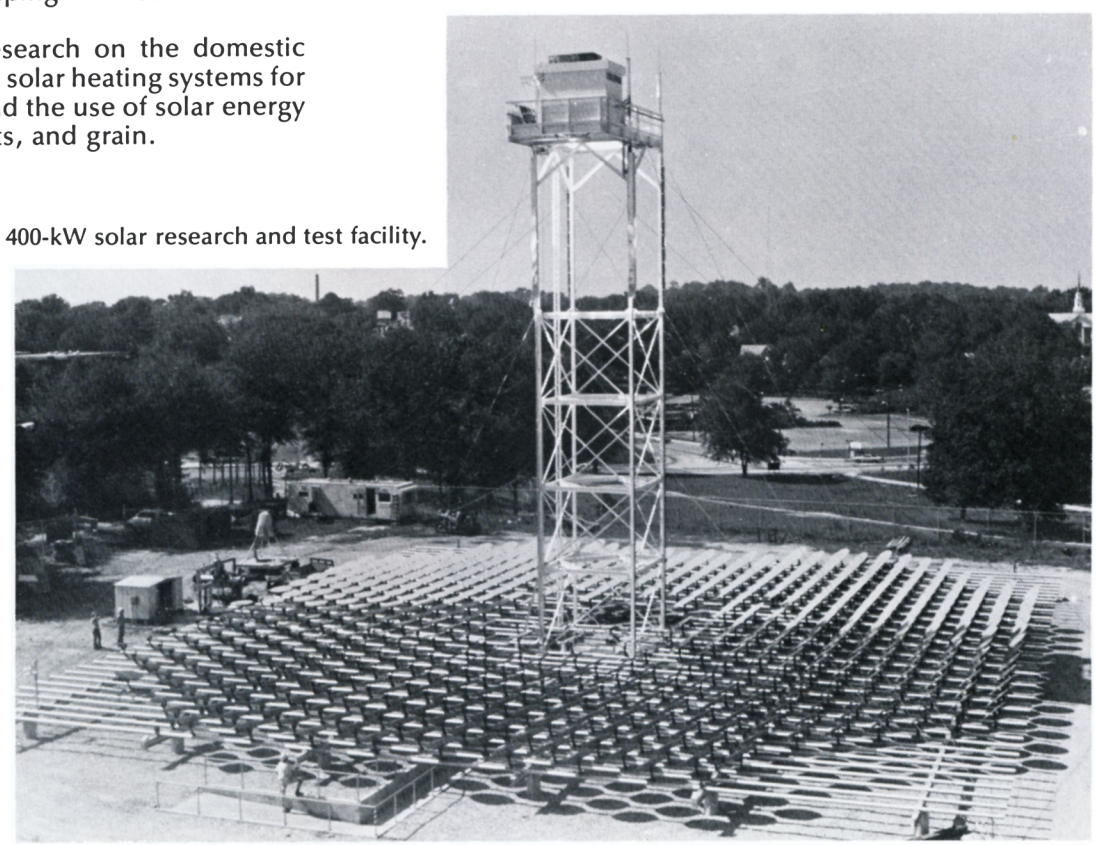
Solar Technology

Research in FY 1978 emphasized application of solar technology to both national and international needs, particularly the needs of underdeveloped countries for solar cooking and irrigation pumping. A major design, development, and demonstration project on irrigation pumping will be continued during FY 1979.

Agricultural energy research on the domestic side involved the design of solar heating systems for poultry growout houses and the use of solar energy for drying tobacco, peanuts, and grain.

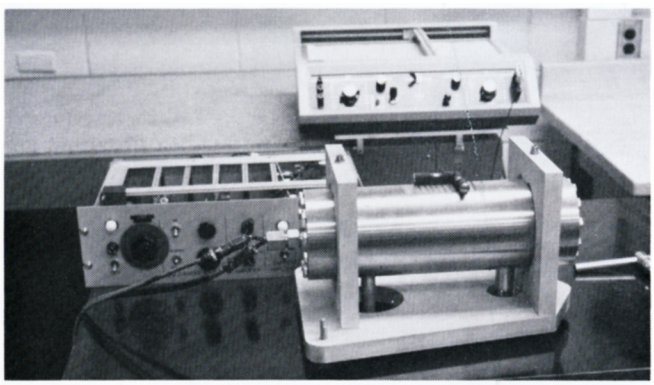


X-ray diffraction topograph of a 1 x 2 cm silicon wafer used for solar energy conversion. White markings indicate strain fields due to defects and precipitates.

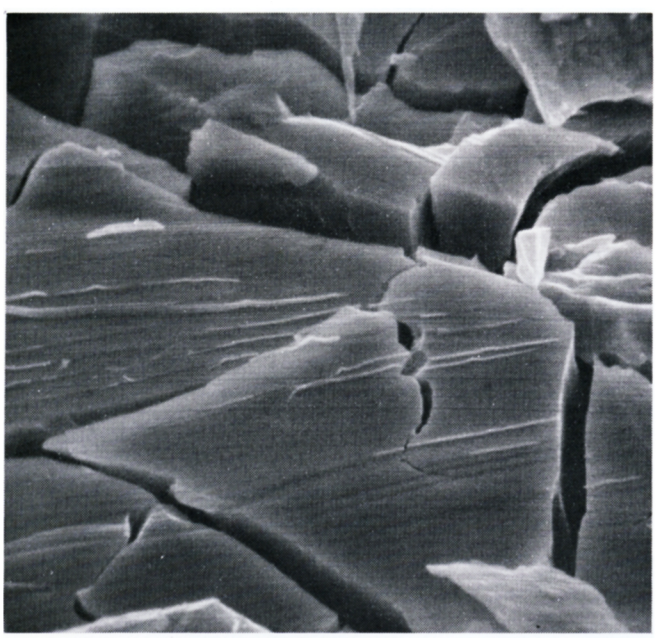


Georgia Tech/DOE 400-kW solar research and test facility.

Solar instrumentation pad on roof of Civil Engineering Building at Georgia Tech.



This high-pressure hydrogen microbalance designed and built at EES measures the weight change as hydrogen is absorbed into metal alloys, forming hydrides for energy storage.



Metal alloy magnified 5000 times by Georgia Tech's scanning electron microscope. As hydrogen is forced into the spaces in the alloy crystal structure under moderate pressure, the metal cracks and eventually crumbles to powder.

Solar Radiation Monitoring

Work started in FY 1978 on a five-year meteorological monitoring and student training program involving both EES and the academic side of Georgia Tech. The DOE-sponsored project features the installation of solar radiation monitoring facilities on campus and at Shenandoah, a new town south of Atlanta utilizing the solar total energy concept. Although the primary function is the collection and analysis of solar radiation data, the facilities also measure wind speed and direction, temperature, and humidity.

Hydrogen Storage

Fundamental research on the storage of hydrogen in metal alloys for later release to fuel homes, transportation, and industry is another ongoing DOE-funded program. EES scientists are studying the effects of alloy composition, geometry, surface conditions, and other factors on the hydriding process to determine the best practical alloys for hydrogen storage. This relatively new area of scientific investigation focuses on one avenue toward solving the basic problem of practical storage of the energy derived from such intermittent energy sources as the sun. Hydrogen is a clean, completely recyclable energy medium because it can be obtained by decomposing water and, when burned as fuel, it recombines with oxygen to again form water.

Wood As an Energy Source

In a study conducted in cooperation with the Georgia Forestry Commission and the U.S. Forest Service, EES researchers estimated the potential of wood for fuel (including supply and demand) and surveyed the current state of available technology. This project has led to funding by the Forestry Commission of three demonstration projects to educate the Georgia public and to encourage the residential, industrial, and commercial use of wood-fueled energy systems.

Energy Application Programs

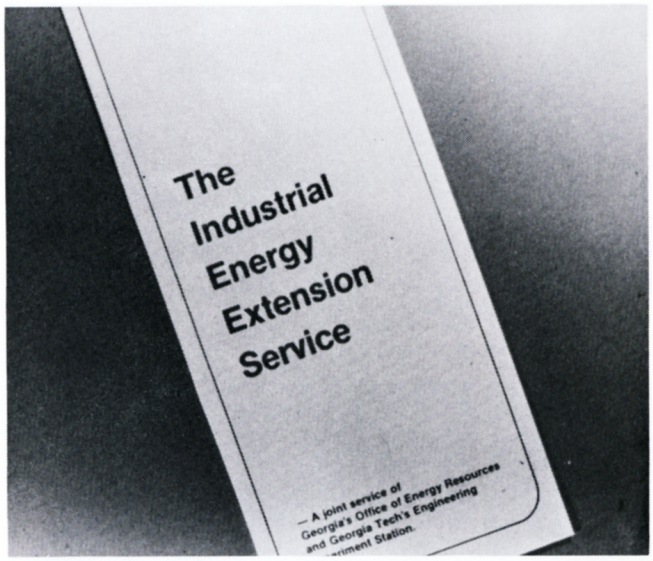
• Total energy systems • Management • Conservation • Alternative analysis • Optimization • Hybrid systems • Self-sufficient energy systems • Conventional power systems • Cogeneration

Energy Conservation

EES stepped up its energy conservation efforts in FY 1978 with the establishment of an Industrial Energy Extension Service (IEES), sponsored by the Georgia Office of Energy Resources and aimed at helping Georgia manufacturers to use their energy supplies more efficiently. Initial activity concentrated on the food, chemical, textile, and the stone, clay, and glass industries because of their large energy usage and great potential for improvement. Using in-plant surveys and assistance, seminars and workshops, handbooks, and a newsletter, this project seeks a 10%-20% overall reduction in projected 1980 energy usage by Georgia industries.

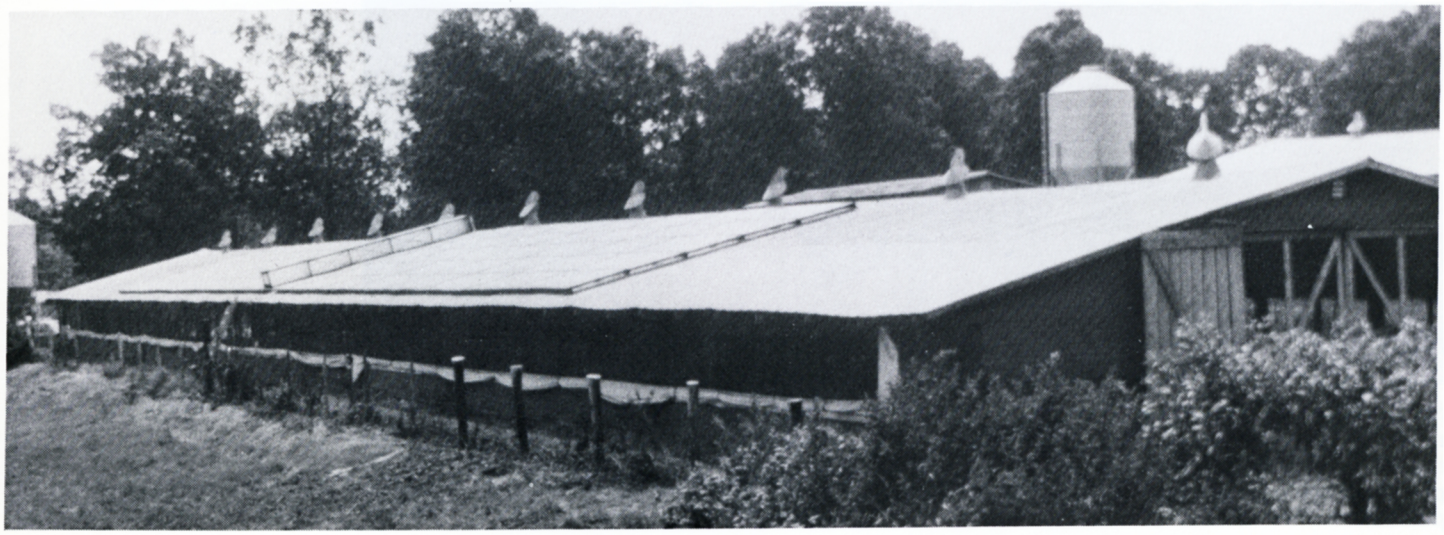
Major conservation projects, including process modification studies, were carried out for the southeastern textile industry, the national electroplating industry, the Georgia poultry industry, and a major national steel producer. For the latter, EES researchers identified ways to save $5.5 million annually in natural gas costs for a single mill.

Home builders learned how to construct more energy-efficient houses in three workshops conducted by EES for the Georgia Office of Energy Resources.



EES personnel work with representatives of Shenandoah, a new town, on cogeneration and total energy system designs for maximum energy efficiency.

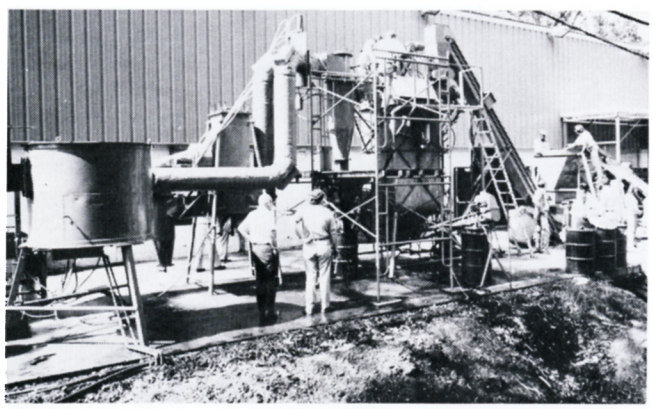
This poultry growout house cuts heating bills with a new roof-top solar facility designed by EES engineers.



Resources and Waste

• Resource utilization • Waste management and treatment • Industrial waste conversion • Anaerobic digestion • Industrial process improvement • Synergistic industrial co-siting • Pyrolysis • Biomass conversion • Methane production

This machine is harvesting trees that can be converted to energy sources through pyrolysis.



Blue IV, the Georgia Tech prototype pyrolytic converter.

EES anaerobic digester converts chicken manure to methane.

Waste Conversion and Biomass

EES engineers continued development and improvement of the Georgia Tech pyrolysis system, which converts wood and other fibrous wastes to char, oil, and gas. This work was supported by the licensee, Tech-Air Corporation. Emphasis was on improving the operating parameters of the Blue IV prototype system. Evidencing the extremely widespread interest in pyrolysis as an alternate energy tool and waste conversion technique, several hundred persons visited the campus to view the system.

Operation of a 10,000-gallon pilot plant to produce biogas from manure was continued on a poultry farm in Forsyth County with support from the Georgia Department of Agriculture. A related study on the feasibility of producing methane at a major sewage treatment plant was conducted for Fulton County.

Natural Resource Utilization

An important area of study is the economics of natural resource utilization. Active projects included studies of the feasibility of producing alumina from kaolin, of optimum water management for kaolin mining for alumina production, and of a timber processing complex and wood energy center in north Georgia.

Mechanical, Chemical, and Materials Science

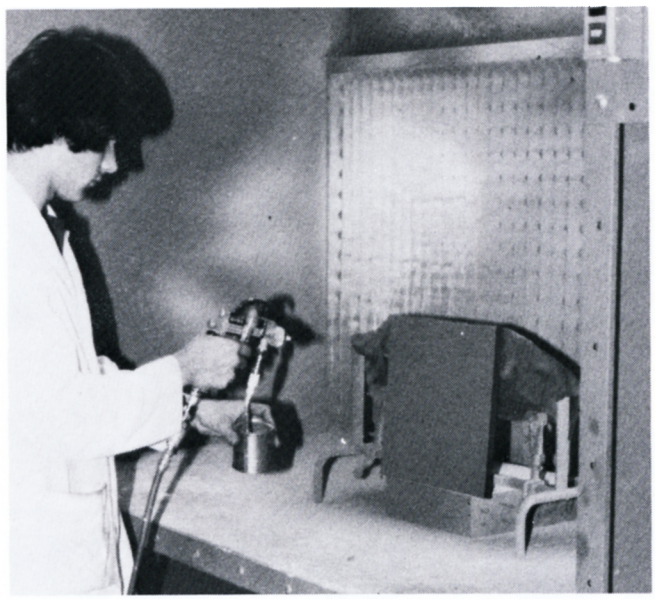
• Molecular, combustion, and environmental chemistry • Chemical processing • Magnetic, composite, and radome materials • Complex mechanical structures and equipment • Machine, equipment, and tool design • Water and air quality • Kinetics and atmospheric chemistry • Coal desulphurization • Wood gasification and chemistry • Carbon technology • Polymer science • Paints and coatings • High-temperature materials • Characterization of materials • Micro-mechanics

Approximately $500,000 in new contract support was developed for the EES program in paints and coatings technology. Researchers are working on new temporary highway pavement marking paint systems that are less expensive and easier to remove. Another highway-related project, sponsored by the Transportation Research Board of the National Research Council, involves a nationwide study of coating systems for corrosion protection of structural steel. Some work also was performed in the area of polymeric sciences.

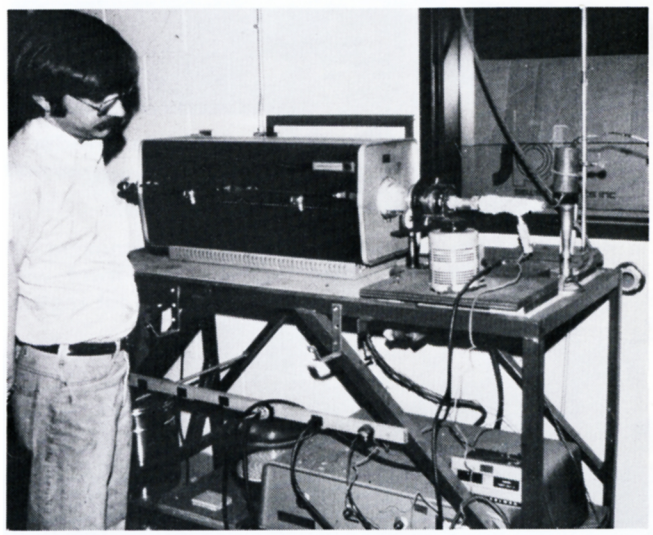
Carbon technology research centered mainly around char (carbon) activation, which has applications to water and air purification and sampling. A major project was initiated for the Department of Energy to study the potential for extracting chemical intermediates from paraquat-treated pine trees.

In contributions to the fields of environmental and atmospheric chemistry and combustion, laser excitation, coupled into advanced chemical kinetic photolysis research, kept Georgia Tech at the forefront. Ongoing programs include a study of the chemistry of the stratosphere for NASA and a study related to fundamental combustion reactions for the Air Force.

A major analytical equipment addition during the year was a computer-interfaced gas chromatograph/mass spectrometer, which is being utilized primarily for trace element analysis in water research.



EES researcher applies experimental coating system to section of an old bridge girder prior to marine exposure on Atlantic coast.

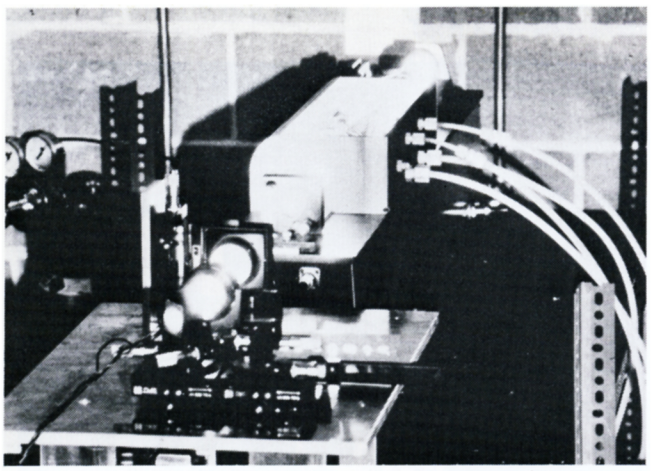


Controlled activation of carbon to achieve specific pollutant control for wastewater.

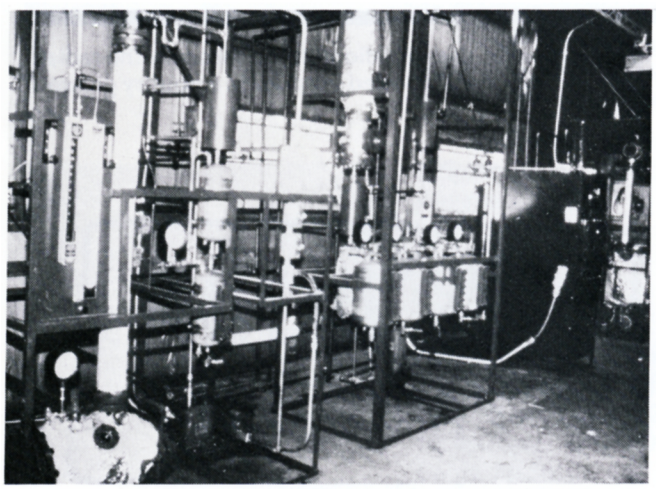
Researchers analyze a gas chromatogram which displays the chemical components of turpentine.

Nuclear Sciences

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



Photolysis laser used in chemical kinetic systems.



This new chemical pilot plant isolates and produces wood chemical intermediates for EES study of their use as substitutes for petrochemicals.

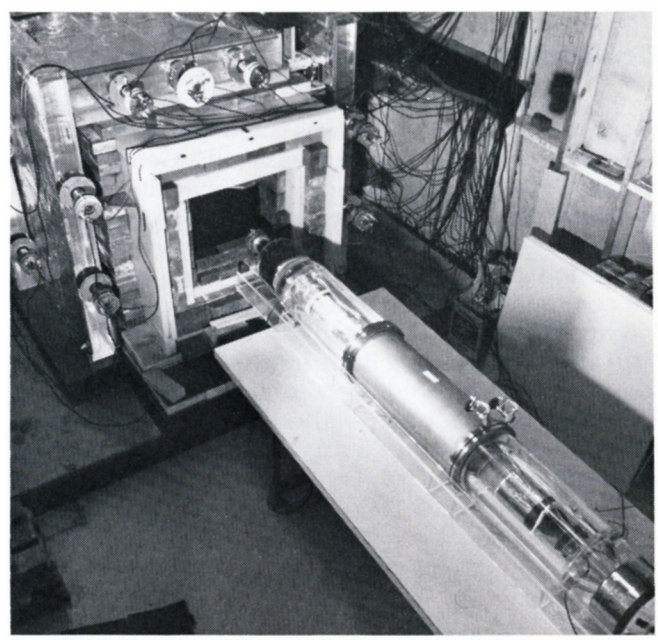
The Georgia Tech Research Reactor was used by 20 different departments of 16 universities and colleges in FY 1978, as well as by five academic units and EES at Georgia Tech. Governmental clients included two departments of the State of Georgia and five federal agencies.Other users were seven industrial organizations and two hospitals.

Participants continued to emphasize neutron activation analysis of such items as hair, fingernails, blood, malignant tissue, water, and pottery shards. Dating and analysis of rock and meteorite samples also was predominant. Other interests centered on nuclear physics studies of the decay of radionuclides, production of radioactive tracers, neutron radiography, neutron diffraction studies, and neutron pumped lasers.

The gamma irradiation facilities were used by several industrial organizations to determine the effects of ionizing radiation on the operation of nuclear power plant components. Ten industrial users irradiated elastomers, manufactured items such as motors and valve operators, and sterilized pigskin to be used in burn treatments.

Radioactive resin microspheres containing yttrium 90 were delivered to a medical group for use in the treatment of metastases in the liver. Solutions containing radioactive krypton and tritium were manufactured for the North Carolina Department of Natural Resources and Mississippi State University.

At the end of FY 1978, the Frank H. Neely Nuclear Research Center was administratively transferred from EES to Georgia Tech's School of Nuclear Engineering.



Equipment used in neutrino physics research. The dual-concentric prototype detector module is ready for insertion into the shield.

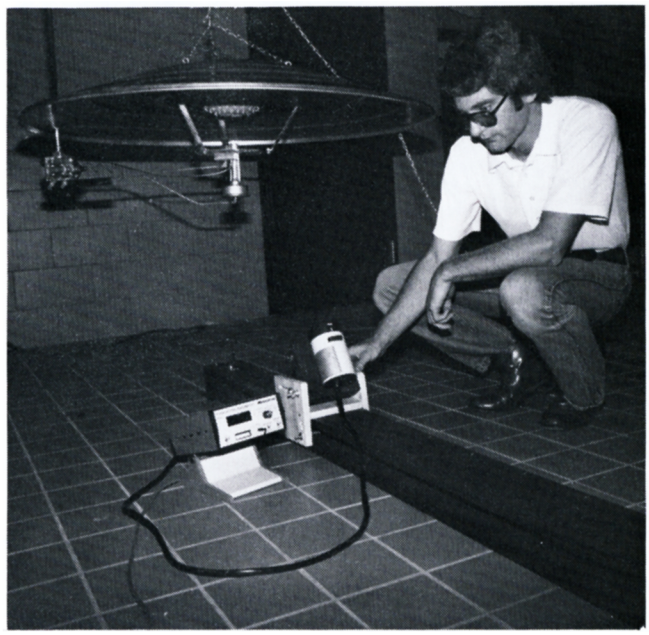
Economic Development /Technical Assistance

• Productivity • Economic analysis • Impact studies • Manpower/training • Management and technical assistance for small business • Minority business development • Technology transfer • Industrial assistance • Community development • Human factors/labor productivity • Local government technology

Industrial and Community Services

The seven EES area offices throughout Georgia continued their long-established program of management and technical assistance to businesses and communities. They provided contract services to some 20 local and area development organizations, trade associations, and industries, and handled approximately 1,000 requests for information and assistance from inventors and businesses. The Carrollton office received special recognition for its role in locating a 3,000-employee CBS tapes and records plant in that city.

Research on problems of the Georgia poultry industry continued with contract support from the Georgia Department of Agriculture.On the community side, the tri-university (Georgia Tech-University of Georgia-Georgia State) project to provide technical assistance to Georgia communities got under way; this program is funded by the National Science Foundation through the Georgia Department of Community Affairs.



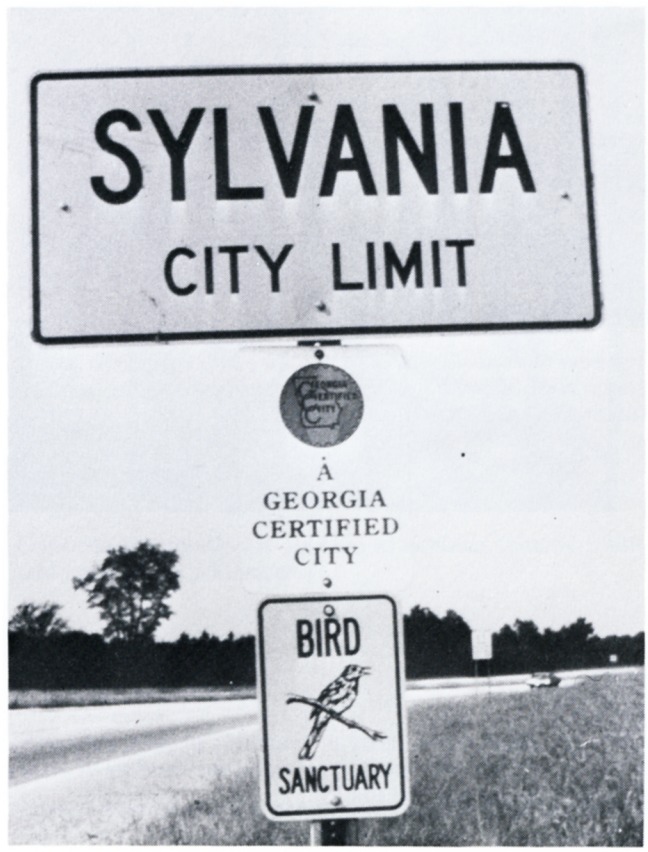
An EES engineer uses a radiometer to measure the radiant heat from this propane-fired brooder in a poultry growout house.

Human Factors/Manpower

Typical projects focused on improved productivity of retail clerks for the J. C. Penney Co. and reduction of employee turnover in poultry processing plants. The U.S. Office of Minority Business Enterprise sponsored a program to identify viable products or processes which are not profitable for major manufacturers but which could be made available to minority businesses.

Conferences and Workshops

A conference on Georgia's economic development outlook for 1978 was held on campus in February under joint auspices of the Georgia Economic Development Council, the University of Georgia Institute for Community and Area Development, and Georgia Tech. Workshops in manpower management and economic development were conducted for community leaders with support from Title I of the Higher Education Act. Georgia Tech also put on its 11th annual week-long Basic Industrial Development Course, cosponsored by the American Industrial Development Council, Southern Industrial Development Council, and the Georgia Industrial Developers Association.



EES helps communities attract new industry and promotes economic growth through the Certified City Program.

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. These contracts are handled through the Georgia Tech Research Institute (GTRI) and are usually of the cost-reimbursable (no fee) type. GTRI is a nonprofit 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 past year was GTRI's thirty-first year of participation in and support to the Georgia Tech research program. Glen P. Robinson, Jr., continued to serve as Chairman of the Board of Trustees, and Robert H. Ferst as Vice Chairman; John B. Hayes replaced Haran W. Bullard as a Trustee representing Industry-at-Large; and W. Denney Freeston succeeded Gloria P. Shatto as a Trustee appointed from the Georgia Tech faculty. The GTRI Board visited and was briefed on the anaerobic digester and solar broiler house, both in the Cumming area; the combustion laboratory and the solar power tower on campus; and Davco Company and Hercules Bumper Company in Thomasville and Pelham, respectively.

GTRI financial support to Georgia Tech research programs included over $710,000 in grants — primarily for new equipment.

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: ENGEXPSTAT
Telex: 542507 GTRI OCA ATL

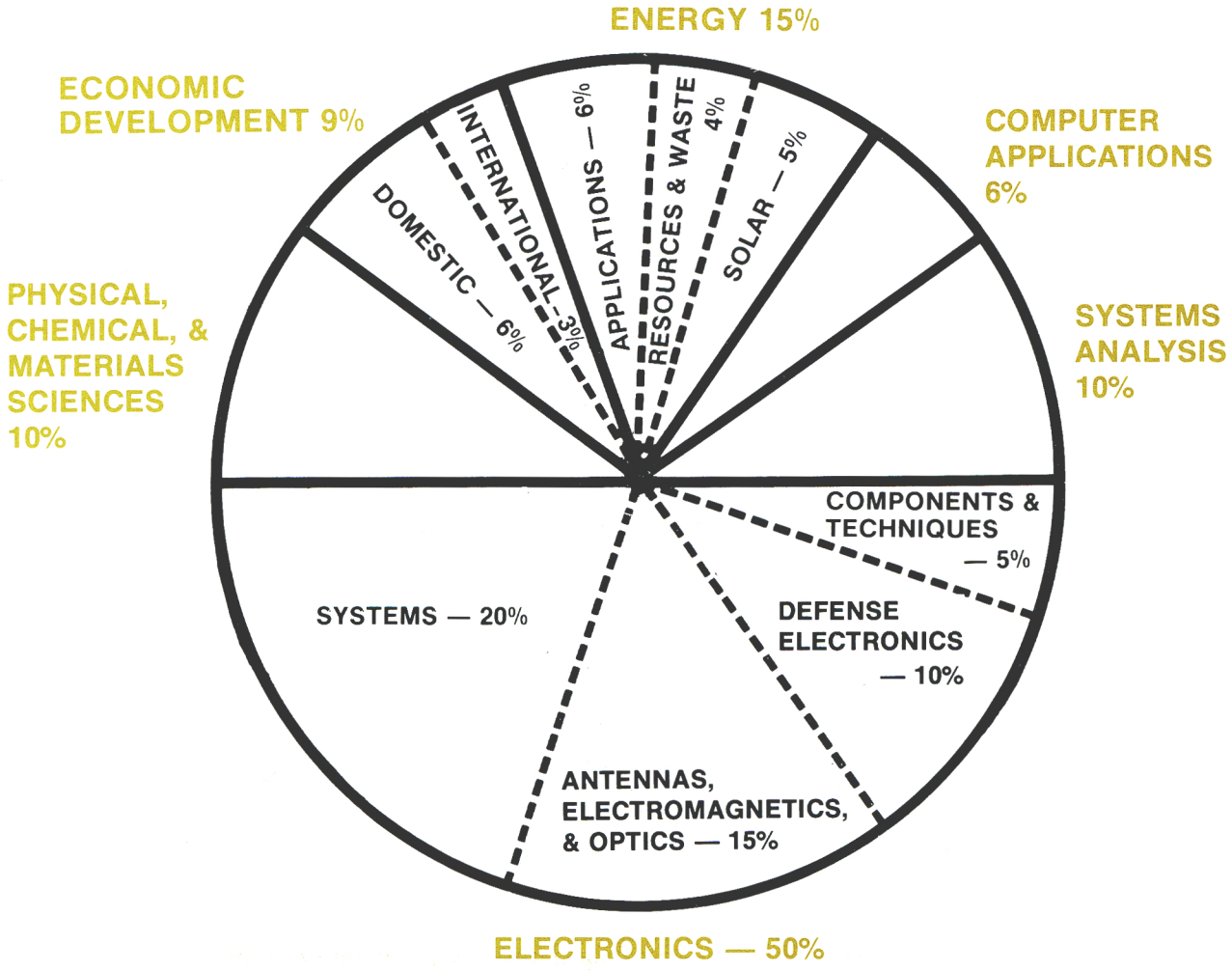
Other Available Brochures and Monographs

Solar Energy Research at Georgia Tech
Waste Not, Want Not
Research at the Engineering Experiment Station
Profiles in Energy
Georgia Tech's Service to Georgia
Remote Sensing at Georgia Tech
Energy Research at Georgia Tech
Research at Georgia Tech
EES Report (bimonthly)

EES STAFF STATISTICS

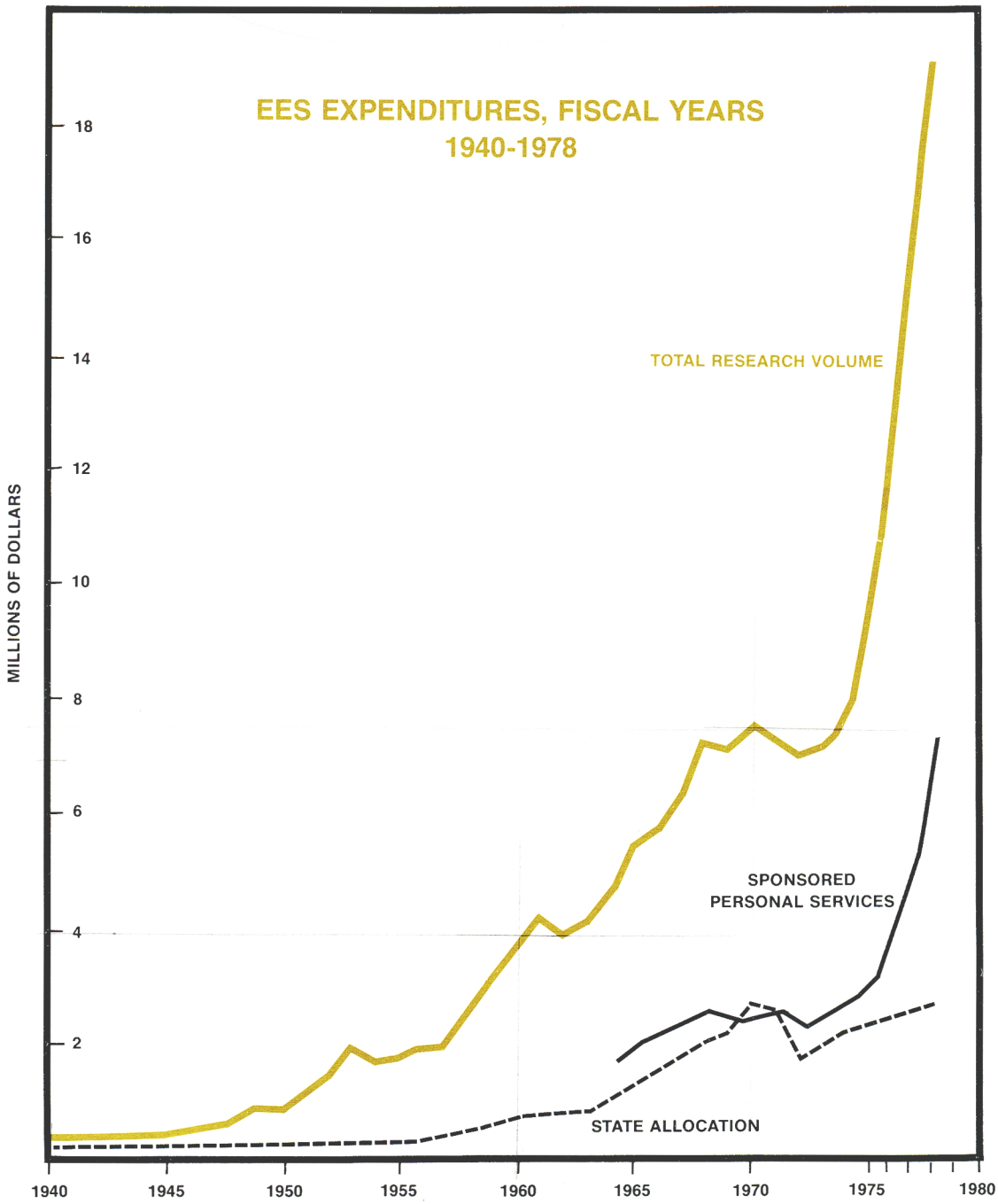
TOTAL NUMBER OF EMPLOYEES ON MAY 31, 1978			912
Total Full-time Employees		551	
Full-time Professionals	375		
Full-time Support Staff	176		
Total Part-time Employees		361	
Professionals	48		
Graduate Research Assistants	34		
Undergraduates	230		
Support Staff	49		
Highest Academic Degrees of Budgeted Personnel			
Doctor	78		
Master	136		
Bachelor	161		

EES FY 1978 SPONSORED SALARIES AND WAGES
Distribution by Research Areas



EES SPONSORED SALARIES AND WAGES
Distribution by Type of Sponsor

	FY 77	FY 78
Federal Government	87%	81%
Army	14	27
Navy	18	12
Air Force	22	17
NASA	7	5
DOE	9	7
Other	17	13
Industry	7	10
State/Local Government	6	9
Totals	100%	100%



Engineering Experiment Station

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PRINCIPAL RESEARCH ENGINEER
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ELECTROMAGNETICS LABORATORY
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ELECTRONICS TECHNOLOGY LABORATORY
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Telephone: 894-3542

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RADAR AND INSTRUMENTATION LABORATORY
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SYSTEMS AND TECHNIQUES LABORATORY
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Telephone: 424-9611

SYSTEMS ENGINEERING DIVISION
Mr. Robert P. Zimmer, Chief
Telephone: 894-3519

TECHNOLOGY AND DEVELOPMENT LABORATORY
Mr. R. L. Yobs, Director
Telephone: 894-3404

Cost: $2800

Quantity: 3000