

1974
Annual
Report

Engineering Experiment Station

Georgia Institute of Technology

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Atlanta, Georgia

1974 Annual Report The Engineering Experiment Station

Observations Of The Director

A Year Of Improved Outlook

The Engineering Experiment Station (EES) is a client-oriented research center supported primarily by Federal and industrial contracts. The balance of funding comes from a State appropriation to encourage the development of Georgia. EES operates under a legislative charter that includes research and service for the benefit of Georgia's people, its industry and its economic development, and assistance to national programs of science, technology and preparedness.

The Station serves the Nation, the State and the Georgia Institute of Technology through advanced technological research and development programs. It serves the State by bringing in dollars to Georgia directly through contracts, through attracting industry, through developing new industries and through creating new jobs in existing industries.

For some years there has existed an awareness at the Federal level of the need to develop new energy sources. This year we observed an increase in the availability of Federal contract support coupled with the public outcry caused by the October through March Arab oil embargo. The needs for energy conservation and for new resources have been felt by all research units of EES. We have obtained new energy-related R&D contracts in such areas as utilization of agricultural, animal and industrial wastes to produce fuels; analysis of concepts for wind-powered generators of energy; steam generation systems using energy radiated by the sun; environmental studies associated with nuclear power plants; and assistance to business and industry for coping with the energy crisis. Funding sources for the new contracts have included the National Science Foundation, Department of Defense, Environmental Protection Agency, Economic Development Administration, National Aeronautics and Space Administration, Georgia Department of Agriculture and industrial firms.

At the request of Governor Carter, a conference on "The Energy Crisis and its Effect on Small Businesses in Georgia" was held at Georgia Tech on December 17. Representatives from State government, business, industry and the scientific and edu-

cational communities discussed the current status of energy resources, regulatory controls, conservation measures, potential effects on industrial production, transportation, employment and labor. Personnel of EES and other units of Georgia Tech participated in this conference through planning and presentation of papers.

The energy crisis generated new demands for EES to provide assistance to Georgia industry. This effort included on-site visits to guide and assist small industries in assessing the impact that energy shortages are having on their productivity, and to help the managers formulate alternative plans for action. In support of this effort, a grant was funded in June, 1974 by the Economic Development Administration to aid Georgia business and industry with their problems.

There were five national or international conferences on electronics at Georgia Tech during June. With the theme "Together in '74," these conferences helped to underscore the strength and broad involvement of EES, Georgia Tech and the Atlanta community in electronics. Personnel of EES were directly involved with planning and conducting each of these meetings.

On February 13, 1974, Dr. Thomas E. Stelson was named Vice President for Research. This new administrative position at Georgia Tech marks a step toward increased contribution through research for the Engineering Experiment Station and the academic units. As a result of this administrative change, certain streamlining in operations has already been accomplished.

There are many factors, both external and internal, that cause this office to be optimistic about the future. Among these is the recognition at the Federal level that the United States must invest tax dollars for research on energy resources and other matters related to strengthening the productivity of the nation.





M. W. Long
Director
Engineering Experiment Station

Research Volume and Station Staff

Total expenditures included in the EES budget amounted to \$7,436,419. The funds were obtained from contracts handled through the Georgia Tech Research Institute, from the State appropriation received through the Board of Regents and from several smaller sources. The income exclusive of that from the Board of Regents equaled \$5,403,960. Funding through the Board of Regents was \$2,063,000 which included \$20,000 from the Governor's Office during the year. The additional State funding included \$8,000 for a study of electronic tornado-detection techniques and \$12,000 to assist with cost sharing on an Economic-Development-Administration-sponsored study of energy needs in small industries. Sponsored personal services amounted to \$2,824,598, up from \$2,665,428 for the previous year.

There were 291 full-time EES employees (of which 175 were professional staff members) as well as 181 part-time employees. A significant contribution that EES makes is the provision of job opportunities which provide research experience for both undergraduate and graduate students.

Contributions To Georgia And The Nation

The Engineering Experiment Station is the principal technological resource which is readily accessible to Georgia's business, industry, government, and public and private organizations. It has a significant record of accomplishments. Each year thousands of jobs are created or preserved in Georgia by the research and service activities of EES. By using standard economic measures, analyses indicate that the total impact of EES and its spin-offs amounts to approximately \$100 million each year. The economic activity clearly is not a complete measure of the benefits to Georgia. As an example, the benefits of providing jobs to persons who would otherwise be unemployed—and large numbers of jobs are being filled by persons previously considered as unemployables—are immeasurable in terms of savings to the State.

The Station has been concerned with conversion of agricultural and industrial wastes to fuels for many years. The recent fuel crisis has re-emphasized the importance of making more productive uses of the vast quantities of waste produced in the U.S. each year. It is recognized that the chemical energy content of the nation's wastes is nearly that of imported oil. Therefore, converting our wastes into energy and thereby alleviating the problems of waste disposal is a significant national problem.

In the course of its years of experiment in waste conversion, the EES has developed a unique, partial-oxidation, steady-flow, low-temperature pyrolysis process capable of converting raw wastes into high energy fuels. A large-scale demonstration unit capable of feed rates of up to 50 tons per day is now in operation at a South Georgia lumberyard.

Our high temperature materials staff continues its work in the increasingly important field of solar energy. We work closely with the Solar Energy Laboratory at Odeillo-Font Romeu in the French Pyrenees Mountains. We are currently conducting a program with Martin Marietta to design a solar-heated boiler to drive a steam turbine for the production of electricity. The objective of the program, financed by the National Science Foundation, is to provide the thermal data necessary to design large-scale solar-powered boilers for central power stations.

Members of the EES staff have been working with the Kaolin and Processing Committee created by the Georgia House of Representatives in 1973 for the purpose of attracting industry that will commercially produce alumina from kaolin. It is recognized that Georgia is extremely rich in kaolin deposits and it is now economically practicable and increasingly advisable that the U.S. commence to produce alumina from kaolin. Imported bauxite promises to become not only more expensive but perhaps even less available, and the national interest indicates the growing importance of local sources of critical natural resources such as kaolin. The EES expects to continue its research directed at the development and use of Georgia's kaolin.

Our electronics engineers are investigating the effects of electric and magnetic fields on the performance of implantable cardiac pacemakers. Their findings are of direct concern to the medical community, to pacemaker patients, and to organizations whose activities involve the generation of strong magnetic and electric fields. The research is aimed at defining and controlling the types of fields that degrade pacemaker performance.

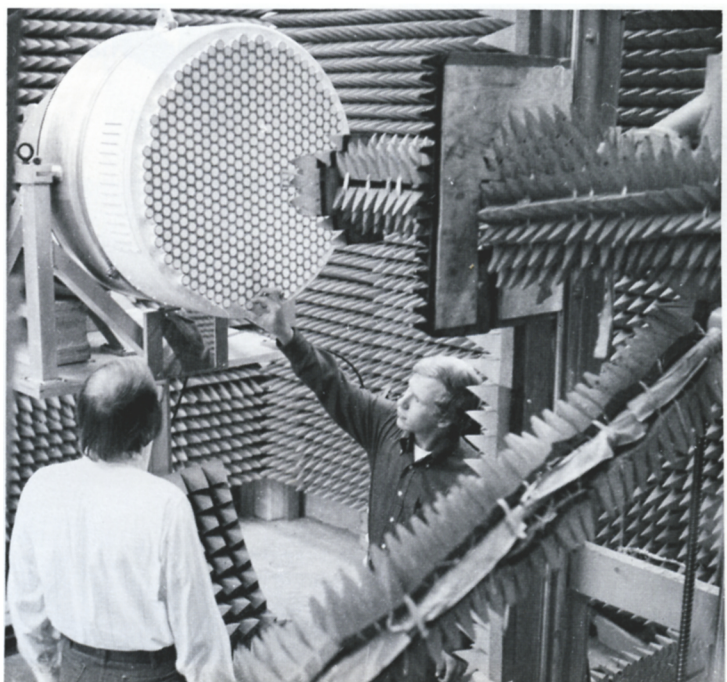
We are developing a concept for tornado and storm detection, tracking and warning system that hopefully can be implemented in the State of Georgia. It consists of combining advanced radar techniques with new sferics direction-finding techniques.

Photographs taken by the astronauts during the Skylab III mission in the fall of 1973 and other data from NASA's Earth Resources Technology Satellite (ERTS) and high altitude aircraft are being analyzed. Studies are being conducted on a variety of

subjects such as the production of land-use maps useful for geology, hydrology, agriculture, forestry, and resource management.

A team of EES researchers has been working on ways to put the Georgia poultry broiler production industry back in its leading national position. Work is progressing on improvements in automated handling of broiler chickens that will increase speed and efficiency of processing. A research effort was initiated to find efficient methods for using chicken waste to make fuel.

Our industrial development staff is assisting the Farmers Home Administration of the U.S. Department of Agriculture with evaluation and preparation of applications for business loans under terms of the U.S. Rural Development Act of 1972. The first industrial loan in the nation made under the Act's provision went to a Calhoun, Georgia, firm with the help of EES industrial services.





Rudolph L. Yobs
Assistant Director for
Technical Support

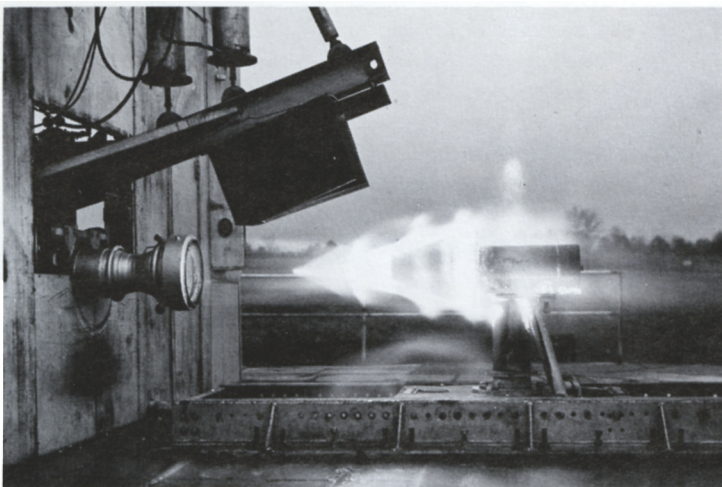
Our international development staff has been extending its activities world wide under grants from the Agency for International Development. EES representatives have been working with counterpart organizations in the development of small scale industries in such varied locations as Colombia, Ecuador, Venezuela, Nigeria, Kenya, and the Philippines.

One of our studies entitled *The Economic Impact of Georgia's Deepwater Ports* prepared for the Georgia Ports Authority received a good deal of attention and interest. The study forecasts that shipments through the Savannah and Brunswick ports will increase between 1970 and 1990 at an average annual growth rate of 3.6 percent to 4.7 percent.

The Analytical Instrumentation Laboratory (AIL) continued its work on behalf of business and industry in Georgia. Examples of the activities include studies of defects in telephone cable wire; evaluation of pigment fillers in textile fibers; analysis of air pollution, fiber glass, and carbon deposits; studies of defects encountered in the continuous casting of metals; examination of paper fillers and experimental fireproofing materials for fabrics. The

AIL was actively involved with the analysis of samples from the NASA Skylab program. One experiment was concerned with casting of metal in the form of small spheres which were smelted and allowed to float and solidify under zero gravity conditions. Another experiment involved the melting of metal rods consisting of an aluminum-copper eutectic in a graphite-lined furnace. The studies indicated that samples prepared in Skylab exhibited a higher degree of perfection in the formation of lamellar structure.

During the year it became apparent that there is an increasing need to help Georgia business and industry find ways to increase productivity. The energy crisis underscored the fact that our economy is now in a state of basic energy and material resource shortage. In order to increase our contributions to Georgia industry, exploratory work is underway in areas of poultry processing, tufted carpets, saw mills, apparel, and food canning. The subjects of investigation include process automation, alternative materials, reduction of energy use, solid waste reduction and re-use, and reduction of excessive in-plant noise levels.



Industrial Research and Extension

EES provides assistance in short-term problem solving to Georgia industry through our seven State-wide offices of the Industrial Extension Service and through the Office of Industrial Assistance at EES in Atlanta. It is estimated that 1,000 industrial contacts of all types occurred during the year. The types of assistance provided include product and process development, production layout and controls, equipment location and technical information and assistance on matters relating to environmental quality, health and safety. Where appropriate, industrial requests were referred to consulting engineers or testing laboratories.

During the year of greater activity in the Office of Industrial Assistance, technical personnel from the principal EES organizational units were drawn upon to respond to industrial requests for assistance.

During the past fiscal year emphasis has been placed on:

- Development of contacts with industry trade associations and business groups;

- Identification and definition of technological requirements and problems facing Georgia industry;

- Development of specific research proposals to solve problems of Georgia companies;

- Providing technical assistance to firms requesting technical support;

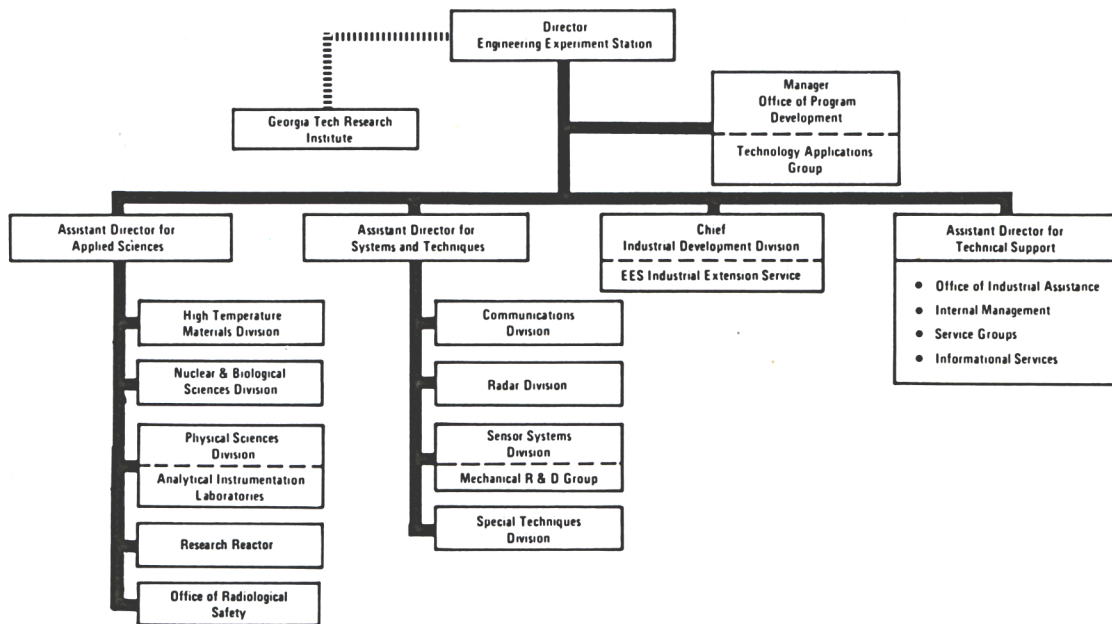
- Communicating EES capabilities and interests to the Georgia industrial community.

The expanded work of OIA during the year brought increasing realization that, in a period of resource shortages, EES needs to find ways to help Georgia business and industry increase productivity. The work described above has been a part of bringing EES capabilities into focus on this problem. In the future, increasing emphasis will be placed on developing a productivity program for industry and for State and local government.



EES Area Offices





Organization of the Engineering Experiment Station



Research Operations



Applied Sciences Department

Overview

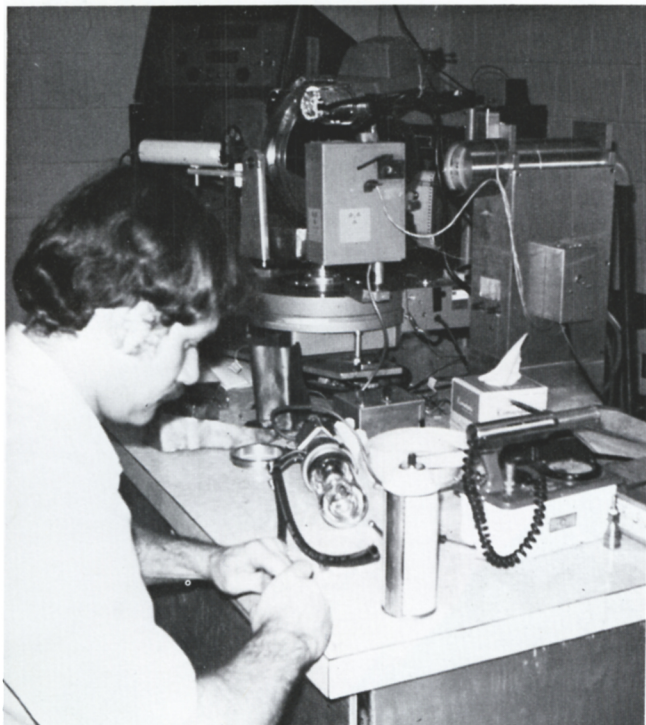
The Applied Sciences Department has conducted sponsored research during the year in many varied areas: solid state electronics, microwave devices, failure analysis of solid state devices, stability of crystal oscillators, high intensity electron guns, audio transducers, analytical and physical characterizations of materials, surface characterization of materials, micromechanical properties of materials, ferrimagnetic materials, radomes, characterization of tooth enamel, sensors for agricultural applications, weather forecasting, water and air quality, waste handling and treatment, chlorination of water, neutron activation analysis, solar energy, technology assessment and transfer, and environmental and energy management for conservation.

The Department has prepared specific plans to strengthen and enlarge its activities in solid state

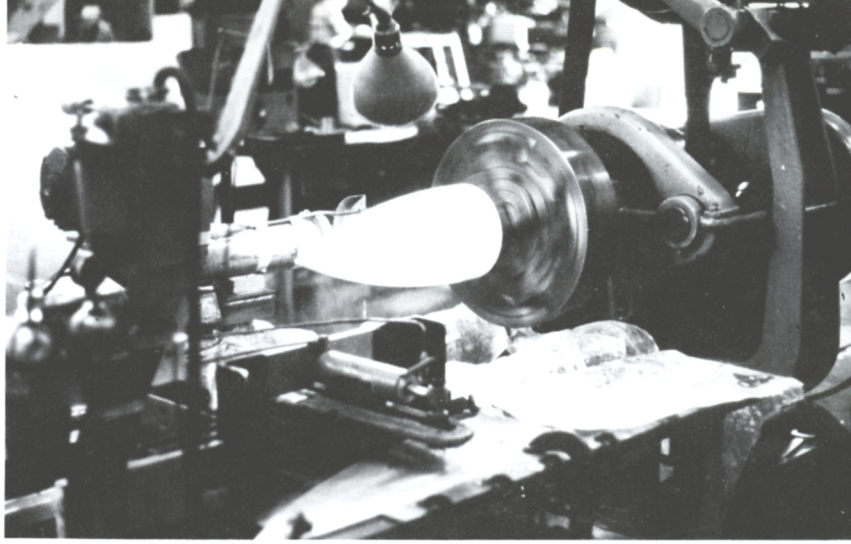
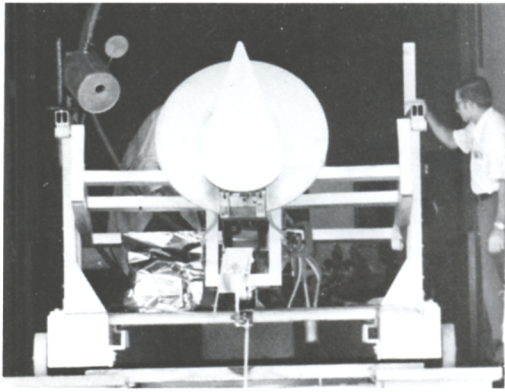
electronics and failure analysis, in materials research and application of solar energy, and in environmental and energy management and conservation.

The staff has continued to service and support a large number of industrial clients principally through the Analytical Instrumentation Laboratories and the Nuclear Applications Group. ASD conducted research projects for 21 different federal government agencies and five state agencies. The DoD, NASA, EPA, AEC, HEW, and NSF continue to be the prime federal government agencies supporting research in the Department.

The Federal acknowledgement of the energy crisis during the year created new opportunities for applied research, and our response to many of these problems will lead to a more promising sponsored research environment for FY '75.



Gordon R. Harrison
Assistant Director for
Applied Sciences



Research Activities High Temperature Materials Division

The Division has made substantial progress in solar energy research during the year, and has established a close working relationship with the 1000 kW CNRS solar furnace in France. There are various joint research activities between CNRS and Georgia Tech on solar energy. Mr. J. D. Walton, Chief of the Division, has been appointed to the Board of Directors for the Solar Energy Laboratory of the Centre National de la Recherche Scientifique, Odeillo, Font-Romeu, France as the first and only U.S. representative. Four solar energy research projects are presently being conducted with an expansion of this activity anticipated during FY75. In addition to the French solar furnace activities, HTMD is serving as a support team to plan research activities and analyze the performance capabilities of and assist in calibrating the 35 kW solar furnace operated by the U.S. Army at White Sands, New Mexico. This is the largest solar furnace in the U.S. Under a NSF-Martin Marietta contract, HTMD has begun studies and research activities on the design of a solar energy steam boiler and super heater for the generation of electrical power. This provides the opportunity for Georgia Tech to become the scientific leader in the field of solar power generation.

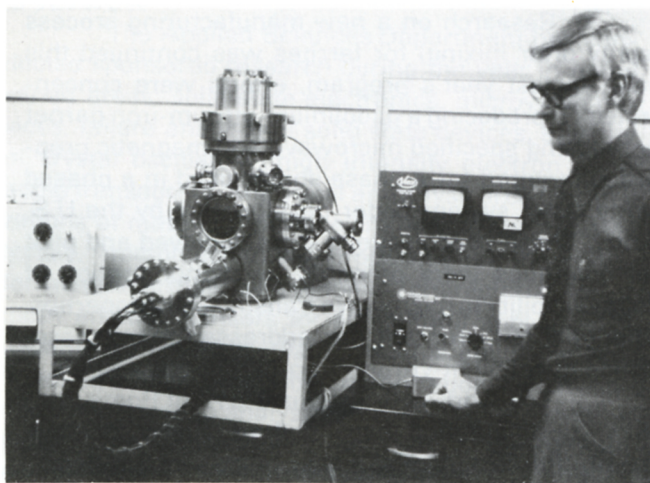
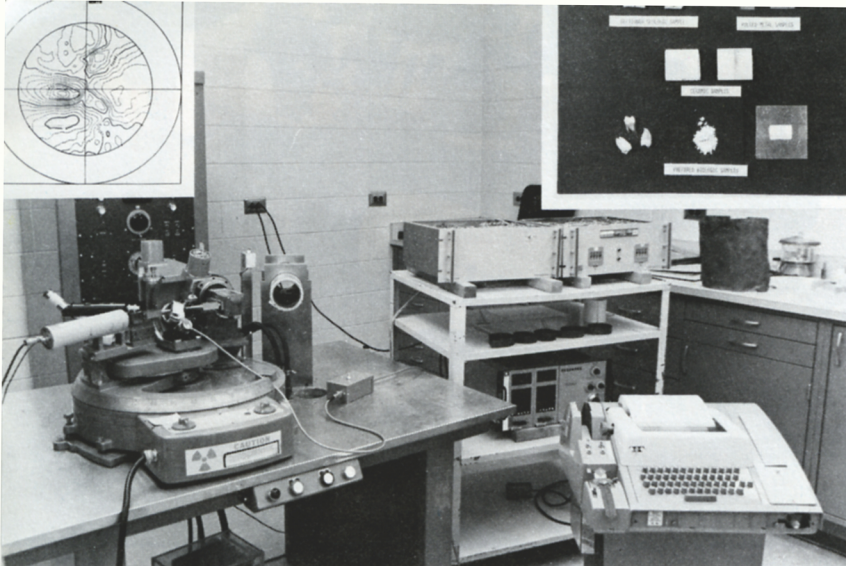
Research activities in the area of biomedical materials supported by EES and a NIH Institutional Grant have been continued. "Methods of Production and Evaluation of Porous Alumina for Dental Implants" is a program with the general objective to accumulate data on the biocompatibility of prospective ceramic dental implant materials and to generate a proposal for a major project in the area of dental implants. Animal testing to evaluate the acceptability of alumina and silicon nitride implants is being conducted in cooperation with the Animal Research Center of the Grady Memorial Hospital.

Research on a new manufacturing process (spray drier mixing) for ferrites was continued this year. In last year's program, efforts were concentrated on producing a gadolinium-yttrium-iron garnet possessing specified microwave and magnetic properties required for a phase shifter used in a phased array radar system under development by the U.S. Army. These specifications were achieved and pilot lot quantities were prepared for demonstration of reproducibility in microwave transmission properties. This year the program has addressed manganese-doped gadolinium-yttrium-iron garnet compounds.

The work with Selenia S.p.A. of Rome, Italy was continued and expanded to study, in more detail, the design of slip-cast fused silica radomes and attachment systems, prior to actual establishment of the capability of manufacturing slip-cast fused silica radomes in Italy.

A program with the Naval Air Systems Command to investigate reaction sintered silicon nitride as a hypersonic radome material was continued. Techniques for slip casting silicon metal have been developed along with techniques for nitridation. Included in this study are the effects of raw material impurities on the dielectric properties of the reaction sintered nitride, and the economics of machining partially nitrided versus fully nitrided material.

HTMD hosted the Twelfth Electromagnetic Window Symposium June 12-14, 1974. Participation by foreign countries has been encouraged and the symposia are now of international interest. Representatives from France, Great Britain, Germany, Israel, Italy, Sweden, Japan and Norway have participated.



Nuclear and Biological Sciences Division

The Division continued to perform research in environmental and nuclear related areas with some activity associated with life sciences. Some of the typical research and development activities were:

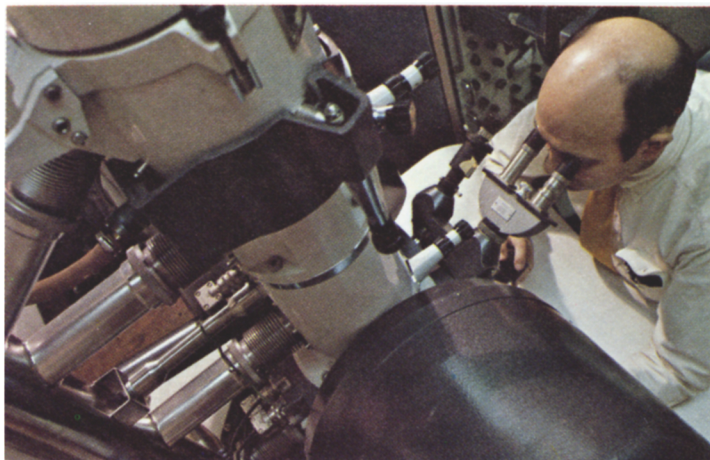
Preliminary studies conducted to understand the relationship of trace elements in normal and cancer cells have shown that the levels of potassium, copper, magnesium, phosphorous and zinc were substantially higher in cancer cells.

A feasibility study of germicidal UV lamps for aid disinfection in hospital rooms has been completed. This study has provided quantitative information on the effectiveness of germicidal UV lamps in killing airborne bacteria and has established recommended standards for the use of UV installations in hospitals.

Work has continued on the development of techniques to process and degrade insecticide, textile and other chlorinated hydrocarbon wastes by the use of radiation sources (^{60}Co) and chemical oxidants.

Investigations have continued on the determination of the ionic or molecular form in which manganese exists in natural waters in order to provide the technology required for removal to make the water potable. Preliminary studies were undertaken to determine the fate of stable chlorinated organic compounds formed by chlorinating waste water and the impact of these on the food chain associated with river water.

Research related to energy management and conservation has addressed wind power systems, electric power needs in the Southeastern United States, resource development, and technology transfer for implementation.



Physical Sciences Division

The Division has continued to conduct research programs in x-ray and neutron studies of tooth enamel, surface and chemical properties of materials, solid state electronics, and micromechanical properties of materials.

The **Analytical Instrumentation Laboratories (AIL)** have continued to conduct a strong research and analytical support activity. As part of NASA's Skylab program, a project was directed toward the evaluation of two of the metallurgical experiments. One experiment involved containerless casting of metal in the form of small spheres which were melted and allowed to float and solidify under zero gravity conditions. The second experiment involved the melting in a graphite-lined furnace of metal rods consisting of an aluminum-copper eutectic. This eutectic formed a lamellar structure with planar spacings as small as 2 to 3 microns. Analysis of the samples definitely indicated that those prepared in Skylab exhibited a higher degree of perfection in the formation of lamellar structure. This type of space manufacturing may have an impact upon the production of special devices used in electronics, magneto-optics, and magnetics.

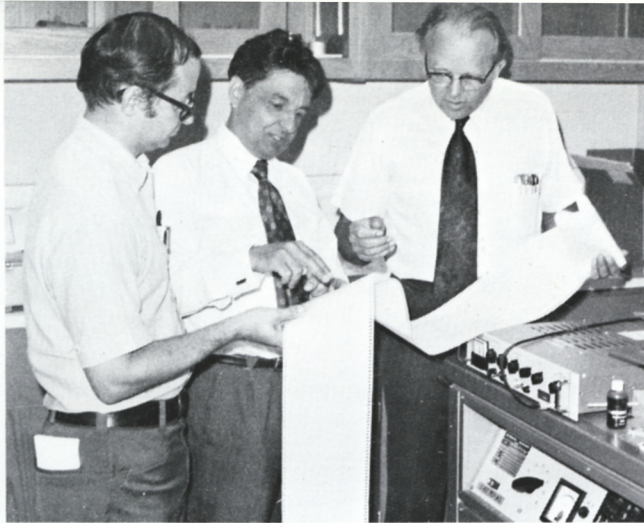
Over 100 projects were active in AIL during the fiscal year. In the field of materials science the usual variety was encountered. Some of them were: evaluation of catalysts; metallurgical failure analysis; defects in telephone cable wire; surface characteristics of fabrics and fibers; quantimet analysis of porosity in reactor fuel elements; and diffraction studies of silicon substrates for solid state devices. Also real-time SEM analysis of tensile failure of plastics (recorded on TV tape); SEM and x-ray microanalysis of rocket exhaust effluent; evaluation of plastic writing pen tips; hot stage transmission electron microscopy of experimental photographic emulsions; and evaluation of solid state devices.

Biological materials studied include spermatozoa, water dwelling parasites, head and body lice, teeth and body implant materials.

The AIL is also actively involved in the evaluation of solid state devices using optical, SEM and microprobe equipment for reliability and product assurance documentation.

The activities of the **Surface Science Group** have centered around two programs. One on precision single sideband crystal units, sponsored by the U.S. Army Electronics Command, was a detailed investigation of cleaning procedures for quartz resonators, and the characterization of the resultant surfaces. Special emphasis was placed on the ion cleaning method. Ion cleaned resonators showed an appreciable negative aging characteristic for the first month or so and then settled down to an aging rate of about 10-8/week, which is comparable with resonators cleaned by other methods. Surface experiments showed argon ion-cleaned quartz to be as free, or freer, from contaminants as those surfaces prepared by the best wet cleaning techniques. The other program, for a project to develop a high intensity electron gun sponsored by NASA Marshall Space Flight Center, an electron gun was designed and developed specifically as a 20 keV write gun for an experimental image forming light modulator (IFLM).

The activities of the **Materials Sciences Group** during the year were directed toward reliability and failure of integrated or hybrid electronic circuits. A new approach for predicting mechanical failure of fragile components, such as thin multi-layer films and fine wire bonds, is under development. These miniature components suggested a mechanical approach to reliability that possibly will enable prediction of failure more accurate than do statistical predictions based on electronic measures alone.



Applied Sciences High Temperature Materials Nuclear and Biological Sciences Research Reactor Physical Sciences Analytical Instrumentation

Solid state devices and materials is one of the new areas of research in the Physical Sciences Division. Initial emphasis is being placed on microwave solid state devices, materials and components. The prime facility supporting this activity is 3,000 square feet of micro-electronic/semiconductor clean room space now equipped and operational. An investigation of interconnecting multi-chip microwave IMPATT devices to increase power output is being conducted for the Air Force Avionics Laboratory.

The Crystal Physics Branch has continued emphasis on a wide range of applications of diffraction techniques, complemented by other techniques. Applications are to the elucidation of the details of the atomic packing arrangements, both ideal and real, and atomic motion in materials in relation to material properties and behavior under various stresses.

One consequence of the crystalline nature of the atomic packing arrangement of materials is the possibility for the development of texture in polycrystalline materials such as metals, ceramics, soils, fluvial sediments, biological tissues such as bones and teeth. A fully automated, computer interfaced x-ray pole figure device has been applied during the year to the study of textures in geologic formation (which relate to geologic history), of tex-

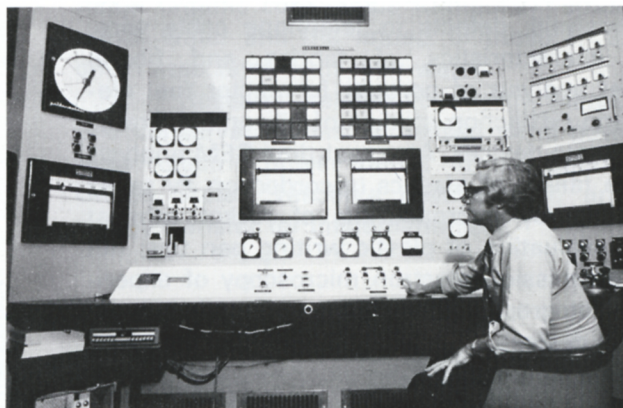
tures ("preferred orientation") in powder diffraction samples, of textures in cordierite and of the preferred orientation of kaolinite clay particles used for paper coatings.

Another area of particular advancement in techniques is that in an old field, powder diffraction. A substantial effort was devoted to improvements in x-ray and neutron powder diffraction pattern analysis, as such patterns provide the principal means for testing conceptual models against real, natural materials of biological, minerals and, even, botanical origin.

Material studies have concentrated on human tooth enamel (TE) and the apatites hydroxyapatite (OHAp), fluorapatite (FAP) and chlorapatite (ClAp). Progress has been made in several areas, all of which relate either directly or through one intermediate step to the nature and properties of biological apatite in human tooth enamel.

Nuclear Research Center

Much of the year was devoted to converting the reactor for 5 Megawatt operation. The reactor was refueled for operation on June 10, 1974. With capability for operation up to 5 Megawatts, the research utility of the reactor has been greatly enhanced.



Systems and Techniques Department

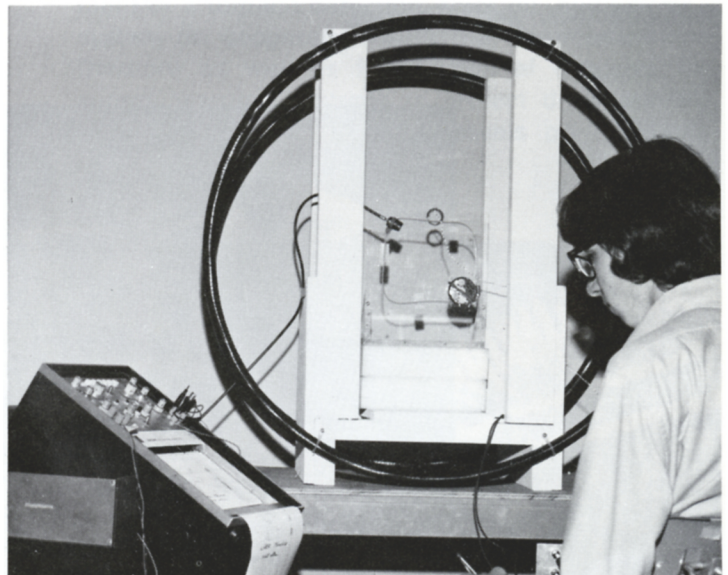
Research Operations

The Systems and Techniques Department is engaged primarily in electronics and closely related research, but there is also considerable activity in mechanical research and development. The fundamental strength of the Systems and Techniques Department is the ability to conduct high-quality, client-oriented research with a competent and dedicated technical and administrative staff.

Most of the funding for sponsored research projects comes from the Federal Government (primarily DoD and NASA), but considerable support also comes from the State of Georgia and other sources. Areas of sponsored activities include antennas, radar systems, electromagnetic compatibility, radar reflectivity measurements and analysis, electromagnetic properties of materials, communications, radiolocation/direction finding, coherent optics, guidance and control, systems analysis, and biomedical electronics. About 115 sponsored projects were active during the year, but brief mention will be made of only a few of the program areas.



Richard C. Johnson
Assistant Director for
Systems and Techniques





Communications Radar Sensor Systems Special Techniques Mechanical Research and Development

Communications Division

Research activities in the Division continue to include communication concepts, communications techniques, and electromagnetic compatibility. Projects in these areas have tended to encompass a diversity of specific research activities built upon the background and capabilities of this Division.

Digital communications and signal processing have been the topics of several research efforts. Typical investigative areas have included link sensitivity analyses for satellite and remotely-piloted vehicle [RPV] relay systems, bit-error-rate computations for multiphase PSK modulation, time delay profiles for satellite based control and communication networks, and wideband predetection processing techniques for surveillance receivers. In connection with some of these activities, general purpose computer analysis models have been constructed.

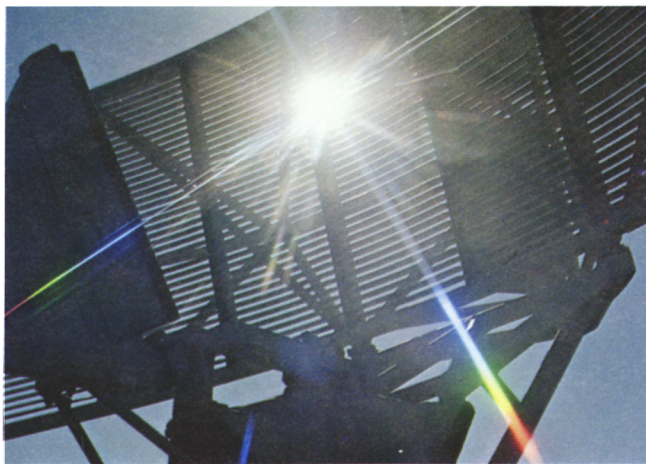
For assessment of survivable ELF/VLF communications networks, a scale model facility for underground antennas was constructed. This facility, which is being used in connection with evaluation of buried dipole antennas, allows empirical determination of key performance parameters such as antenna gain, directivity, and efficiency.

The interaction and impact of electromagnetic fields on the environment continue to be the subjects of several projects. With a view toward improved design, implantable heart pacemakers have been assessed for their susceptibility to high power electromagnetic radiation. Similar efforts have identified the nature and extent of consumer product susceptibility to EM radiation sources. Bonding, grounding, shielding, and the general compatibility of air traffic control centers was the subject of a comprehensive effort to develop a standard design handbook.

The Communications Division has remained active in its support of the needs of the State of Georgia. Previously developed technology in the area of radio location is being applied to the development of a tornado tracking network for improved public notification of severe weather conditions. State-wide frequency management plans have been improved through the use of computerized allocation methods.

New capabilities include a software model for performance assessment of digital systems, an interactive graphics display system for parametric analysis, and a software controlled portable data acquisition system.





Radar Division

Within the Radar Division, research activities have expanded in the following areas: radar, electronic countermeasures, systems analysis, new electromagnetic measurement techniques, technology assessment, electromagnetic interference evaluation, and biomedical electronics. New ways to distinguish one radar target from another have been developed using advanced antenna and digital processing techniques. This research has been identified by the U.S. Air Force as one of the most significant achievements in radar technology during the past year. Also, simulators are being developed to inject realistic target and jamming signals into radars to test their performance in a variety of environments.

Analyses and experiments have been conducted to determine the vulnerability of selected radars to new types of electronic countermeasures.

Projects in the systems analysis area include analysis and planning related to military radar and electronic countermeasure systems, the reliability of electronic devices, and the benefit-cost assessment of unexploited energy forms such as wind. The development of large-scale computer models and the use of minicomputers with graphics displays have been instrumental in our achievements in systems analysis.

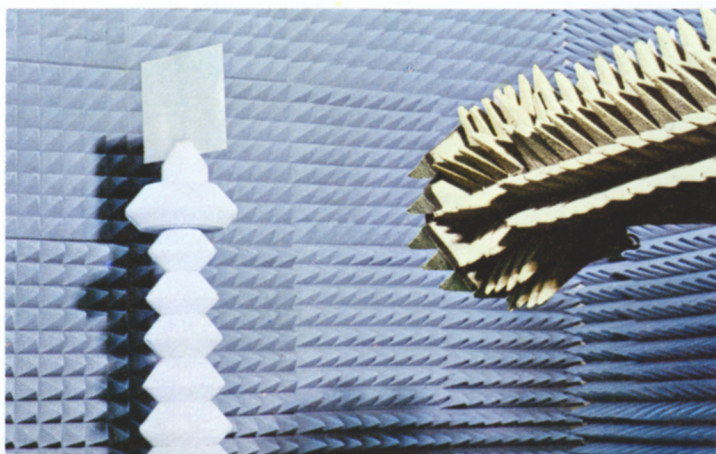
The development of new methods for electromagnetic measurements involving antenna patterns, radar reflectivity, electromagnetic interference, and the effects of obstacles near radiating antennas have made major contributions to the

understanding of these important subjects. An automated near-field measurement facility was developed to provide computer-controlled electromagnetic near-field measurements with the associated pattern computation and display.

Radar Division projects on integrated circuits for improving digital processing and on solid-state devices for radar and electronic countermeasures include work on assessing the current capabilities of these devices and identifying requirements for efficient future research and development.

The Radar Division has built on its strength in electromagnetic measurements and instrumentation to develop new applications of electromagnetic energy in biology and medicine. In collaboration with the Emory University School of Medicine and the Medical College of Georgia, methods for using electromagnetic energy to selectively heat cancer tumors and to thaw frozen organs and granulocytes have been developed. Also, methods for using electromagnetic energy to kill insects infesting wood products have been investigated.

In programs directly related to the State of Georgia, the Radar Division has initiated development of a tornado detection, tracking, and warning system (in cooperation with the Communications Division) as well as formulation of concepts for sensor warning systems to protect draw and lift bridges from collisions by vessels on navigable waterways.





Sensor Systems Division

Research efforts within the Division are varied and span several aspects of radar and specialized instrumentation as well as mechanical engineering. Some of the major efforts have been concerned with overall aspects of radar systems and have included: analyses to predict the performance of future radar systems; determination of the effects on overall system performance of specialized radar techniques; design optimization to achieve specific capabilities; interactive analyses of observational data and system designs.

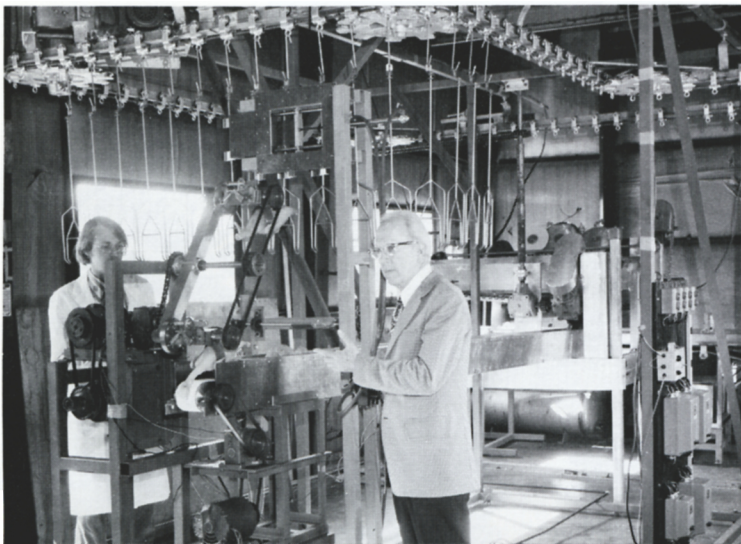
The Sensor Systems Division has a history of successful work in antenna design and development. Recent emphasis has been on electromechanical scanners and tracking antennas. Other programs have been concerned with antennas having rigidly controlled beam shapes and with antennas for satellite use.

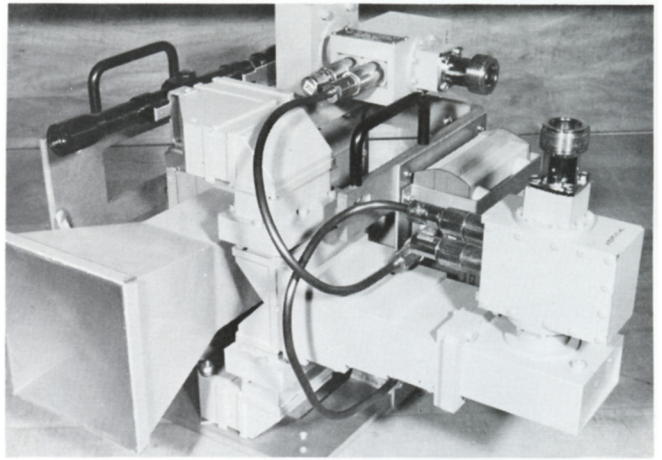
Efforts to characterize and improve the detection of radar targets under marginal conditions of sea, ground, or rain clutter have been the subject of long-term studies. This work has included measurement and analysis of radar cross-section characteristics of targets and clutter. Computerized mathematical models of the entire detection process have been constructed and validated through field operations.

Field measurements of radar data have been conducted at several sites during the year, often in cooperation with government and other contractor activities. The radar field site at Boca Raton, Florida continues to be used for observation of sea targets and clutter. It includes specially designed instrumentation radars and auxiliary data recording and analysis equipment.

The Division has continued its studies of radar systems for observation of ballistic targets. Work has included antenna design studies, mechanical and instrumentation work, trajectory analyses, measurement and analysis of target cross-section, and assistance with test and evaluation of radar systems.

Members of the Mechanical R&D Group participate in projects in this and other divisions. Many antenna development projects, for example, require an interplay of sophisticated electromagnetic and mechanical designs. Also an important continuing effort for the Georgia Department of Agriculture is aimed at developing labor-saving machinery (automation) for the State's poultry industry. Additional State related work includes assistance with the redesign of a carpet making machine and with the development of techniques for reducing fuel requirements in agricultural heating and drying processes.





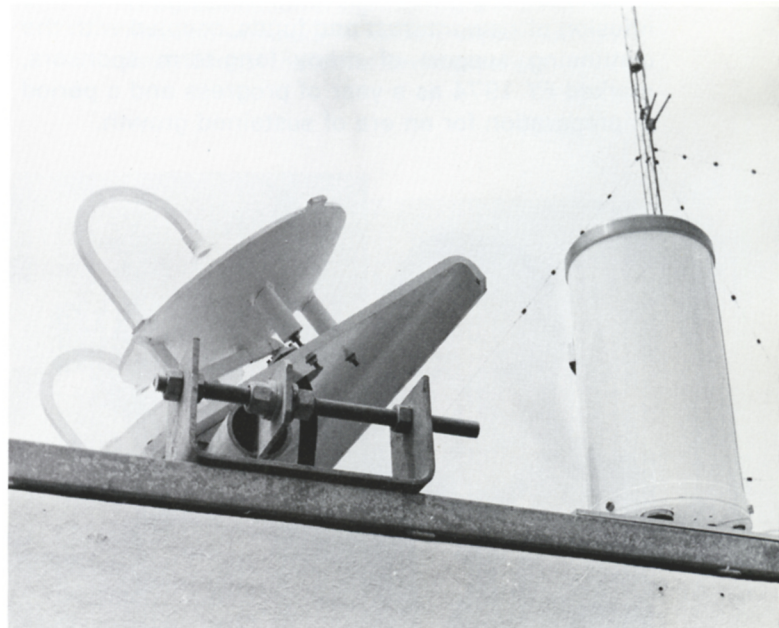
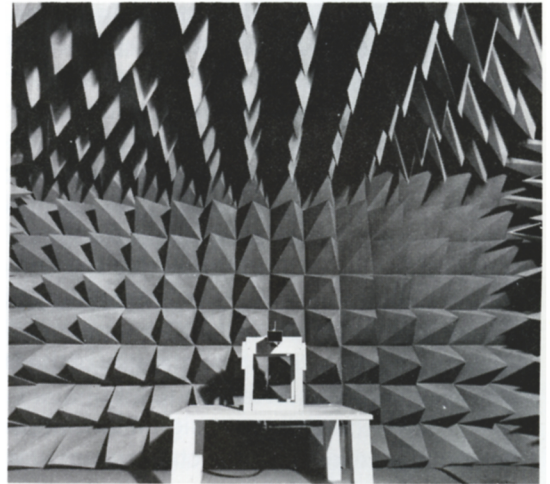
Special Techniques Division

Through both internal and external sponsorship, the Division has continued its studies on the processing and use of remote-sensing data, particularly that available from NASA's ERTS satellite. Identification of land-use categories by automatic data processing techniques are being studied. Computer compatible data tapes from the ERTS multi-spectral sensors including scans of the Atlanta metropolitan area are being processed by the Georgia Tech owned Univac 1108 digital computer, and land-use classifications are being determined from these data. Analysis of such ERTS data can have a significant impact on urban and agricultural planning.

Another remote sensing effort currently being pursued involves the processing of aerial photographic film by a coherent optical processor. The goal of this study is the development of techniques for automatic classification of forested areas. A similar coherent optical processor is also being employed to study the characteristics of aerosol distributions. This program will culminate in the development of a technique for accurately measuring the particle size distribution of aerosols in a field environment.

Projects in areas relating to the space program include participation in satellite communications experiments through operation of a COMSAT ground station in conjunction with the NASA ATS-F (ATS-6) satellite, and the development of omnidirectional microwave antennas for satellites.

Recent advances in laser technology have resulted in a rapid increase in practical applications of lasers in communications and remote sensing. The Special Techniques Division is pursuing programs which will contribute to further advances in this technology area. Development of a highly stable CO₂ laser intended for field applications in communications and radio location is nearing completion, and research on tunable laser sources for spectroscopy has continued.



Industrial Development Division

Review of Research Activities

Research and service activities of the Industrial Development Division were supported by a greater number of outside sponsoring organizations than ever before in the Division's 18-year history. This broad base of support was provided by 52 different sponsors, including 39 Georgia-based agencies, institutions, and organizations. The dependence on federal agencies for major contracts and grants continued but increased diversification of support sources improved IDD's program flexibility and contributed to the future stability of the Division's sponsored research activities.

Perhaps the most significant aspect of the Division's sponsored research program was the fact that half of the 52 funding organizations were new sponsors. Included in the list of those contracting for the first time for IDD research and technical assistance services were one major federal agency, nine city and county governments and local development authorities, nine private companies, three departments and authorities of the State of Georgia, two associations, and two educational institutions. This infusion of new interest and funds, coupled with the continuing support of many long-term sponsors, marked FY 1974 as a year of progress and a period of preparation for an era of sustained growth.

Another indication of the diversity of IDD's sponsored research efforts was the record number of industrial contracts undertaken and/or completed during the year. Sponsored by major metalworking firms, a commercial bank, a foreign investment group, consulting organizations, a private land developer, and an association of small processors, industrial contract activities involved the following:

- An evaluation of the market in 10 south-eastern states for metal springs

- The design of systems for production planning and control

- Seminars and technical assistance in economic development

- A survey of plastic waste in Georgia

- Economic development seminars for rural bankers

- An identification of the existing commercial market for urethane foam structural panels in the Southeast

- Management and technical assistance to minority business enterprises

- An evaluation of the management and production processes of a bedding manufacturer

- Assistance in the development of a privately owned industrial park

- Industrial engineering services for a group of granite processors



Ross W. Hammond
Chief, Industrial Development Division

**Technical Assistance
Economic Development
Management Assistance
Market Evaluation
Employment Generation
International Development**



The Economic Development Administration (EDA) of the U.S. Department of Commerce for the ninth consecutive year supported IDD's widely acclaimed program of management and technical assistance for business and industrial firms in economically depressed areas of Georgia. Continuation of IDD's role as an EDA University Center was assured for another year when EDA extended IDD's technical assistance grant through June 1975.

The Industrial Services Branch staff is assisting the Farmers Home Administration, U.S. Department of Agriculture, to evaluate firms applying for small business loans in rural areas of Georgia and to provide management and technical assistance to enterprises receiving loans from the Farmers Home Administration. With the assistance of the IDD staff, an industrial firm in Calhoun, Georgia, became the first company in the United States to receive a Farmers Home Administration loan under the Rural Development Act loan program.

Fiscal 1974 was the first full year of operation of the five-year 211(d) grant from the U.S. Department of State's Agency for International Development to strengthen Georgia Tech's existing capabilities in employment generation and small-scale industry development in less-developed coun-

tries throughout the world. Directed by IDD and involving the College of Industrial Management, the School of Industrial and Systems Engineering, and Southern Technical Institute, the program's accomplishments included:

- The development of counterpart arrangements with institutions in Ecuador, Brazil, Nigeria, Kenya, Korea, and the Philippines

- The establishment of an International Development Data Center at IDD

- The identification, collection, and analysis of international small-industry case studies

- A published report on the prospect for economic development in Nigeria

- The design of a new graduate curriculum in the School of Industrial and Systems Engineering

- The development of a training program on the analysis and evaluation of industrial projects

- The presentation of eight formal and three informal seminars on various aspects of international industrial development





Published reports on two projects received widespread attention in the Southeast. *Economic Development Approaches for the Southeast* identified overall development goals and suggested action programs in nine economic sectors based on an analysis of the economic development problems and opportunities within the region. An in-depth study of the economic impact of Georgia's deepwater ports on the economy of the State was widely disseminated by the Georgia Ports Authority, the sponsoring organization.

Other major sponsored projects included an identification and analysis of library services and facilities in the Southeast, a program to stimulate profit-oriented housing ventures for low-income families in Georgia, training of community leaders in industrial development, and a continuing study of the economic and technical feasibility of producing alumina from Georgia kaolin. The latter project, shows increasing promise for development of a new multimillion dollar industrial complex in the Fall Line region of Georgia.

The Division's seven area offices comprising the EES Industrial Extension Service provided a growing program of technical services to business and industrial firms and local and area development groups. The State's financial support made it possible for the Area Development Branch to progress to what can be accurately described as a year of solid accomplishment in assisting Georgia's economic growth.

Other State-appropriated funds were used to support successful continuing programs involving the provision of services to Georgia communities, development groups, and institutions; management and technical assistance to Georgia business and industrial firms not located in areas covered by sponsored programs of technical assistance; minority business development; basic data collection and services; housing resources information and special studies; human resources information center; publication of the monthly *Georgia Development News*; and the Georgia Certified City Program. Cosponsored by the Georgia Power Company and the Georgia Municipal Association, the Certified City Program completed its tenth year of service to the cities of the State. During this period, 92 Georgia municipalities participated in this innovative program of community development, and 27 qualified as Georgia Certified Cities.



**Economic Impact Studies
Basic Data Collection
Community Training**

Office of Program Development and Technology Applications Group

General Comments

The Office of Program Development continued its thrust to expand the EES effort on projects of importance for the State of Georgia. As a staff operation for the Director of EES, it played a larger role in working toward overall EES growth through the development of new or broadened areas of sponsored research.

The Technology Applications Group (TAG) consists of the Waste Utilization, the Industrial Chemistry and the Minerals Beneficiation laboratories and of activities in mineral economics and fertilizer technology.

Office of Program Development

As a result of the increased priority of generating EES growth in sponsored research operations, a rationale and guidelines were developed for the planning and budgeting of internal funds for new programs and new activities. Proposals for new or expanded areas of research were reviewed and processed in preparation for implementation in FY 1975 and subsequent years.

Ongoing activities included the continued assessment of the technological needs of the State and the internal sponsorship of appropriate research and service projects. These activities were conducted with the intent to apply the full resources of EES more effectively to State needs in both the business-industrial sector and in the governmental sector. An important part of the activity included the efforts to acquire federal funding for work on State problems and the efforts to assist State agencies in their actions to obtain and allocate funds for their technical needs. Two significant sponsored projects resulting from these efforts were initiated: a technical assistance grant from the Economic Development Administration to assist business and industry in coping with the energy crisis, and a contract with the Georgia Department of Agriculture for automation and waste utilization work for the poultry industry.

A portion of the General Research Funds available to EES is administered by the Office of Program Development. The research and service projects were mostly for support of the State and its industry, and many were exploratory in nature to establish feasibility or to provide the bases for the next appropriate levels of decision-making. Projects were performed in:

- Determination of the technological needs of Georgia industries

- Improvements in the utilization of process heat in Georgia industries

- Industrial applications for solar energy

- Applications of materials in technology for fire prevention

- Improvements in processes for shelling pecans

- Applications of remote sensing technology for various State needs

- Development of a system for use by the State to manage radio frequency assignments

- Determination of effectiveness of microwave energy for insect and weed control

- Determination of the electromagnetic environment in major medical facilities

- Detection of low molecular weight hydrocarbons in the air

- Applications of sensors to the needs of agriculture

- Development of materials for dental implants

- Restoration and preservation of State archival material



Howard G. Dean, Jr.
Manager, Office of Program Development

Waste Conversion Energy Conservation Resource Utilization Minerals Beneficiation

Technology Applications Group

The outlook and basis of planning in the Waste Utilization Laboratory (WUL) was one of major growth through work in two of the areas of national concern—resource utilization with emphasis on energy and waste disposal. A number of highly inter-related areas of thrust were identified: further undergirding research in pyrolysis; energy and fuel work based on waste utilization and the applicability of pyrolysis to conventional fuels such as coal; development of products from the carbonaceous materials, oils and gases produced by pyrolytic waste conversion, and special situation waste disposal.

Sponsored work in the WUL during the year continued with successful projects involving cotton gin wastes, municipal wastes, the beginning of work with poultry wastes and work for the U.S. Department of Agriculture Fire Laboratory. Considerable project work was performed for Tech Air Corporation, the licensee for the waste converter process. Internal funding was applied to broaden the applicability of the waste conversion process and to increase capabilities for performing research in the uses of pyrolytic oils and gases. Work was initiated to build a new pilot model converter with extended capabilities to replace the existing worn-out converter.

The work of the Minerals Beneficiation Laboratory included some industrial projects, but the primary effort was in support of the WUL as part of the broadening scope of both activities.

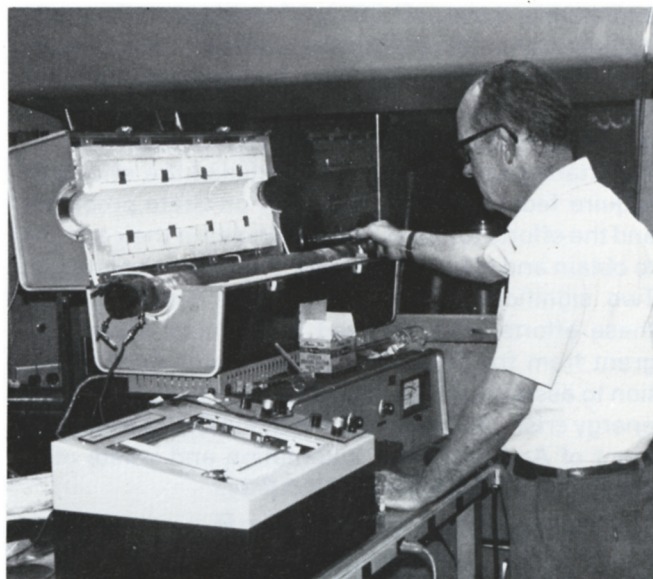
The Industrial Chemistry Laboratory initiated work on the production of methane fuel by anaerobic processes with sponsorship by the Georgia Department of Agriculture. Work was also performed on a number of industrial contracts that included an extensive proprietary effort to develop a synthetic substitute for wood in a consumer product, the solution of quality control and production problems with a "potted" electronics module and proprietary work with novel gasoline pump nozzles.

The minerals economics work continued to be sponsored by the U.S. Bureau of Mines with projects to assess mineral resources for producing

aluminum and titanium, to assess the economic impact of mineral-oriented industries in the six southeastern states and to determine the future capital requirements of mineral equipment manufacturers.

Projects in the field of fertilizer technology included industrial pilot scale work to reduce the flourine content in a colloidal phosphate product used as an animal-feed supplement. Internally sponsored development of an improved process for producing phosphoric acid was concluded with the preparation of a patent application.

There was a considerable amount of interaction with other units related to energy problems. Staff members participated on committees and in planning of the Governor's energy conference at Georgia Tech in December. A technical assistance grant was acquired in June from the Economic Development Administration to aid Georgia business and industry in coping with energy problems. Performance of the work will extend through a number of EES administrative units.

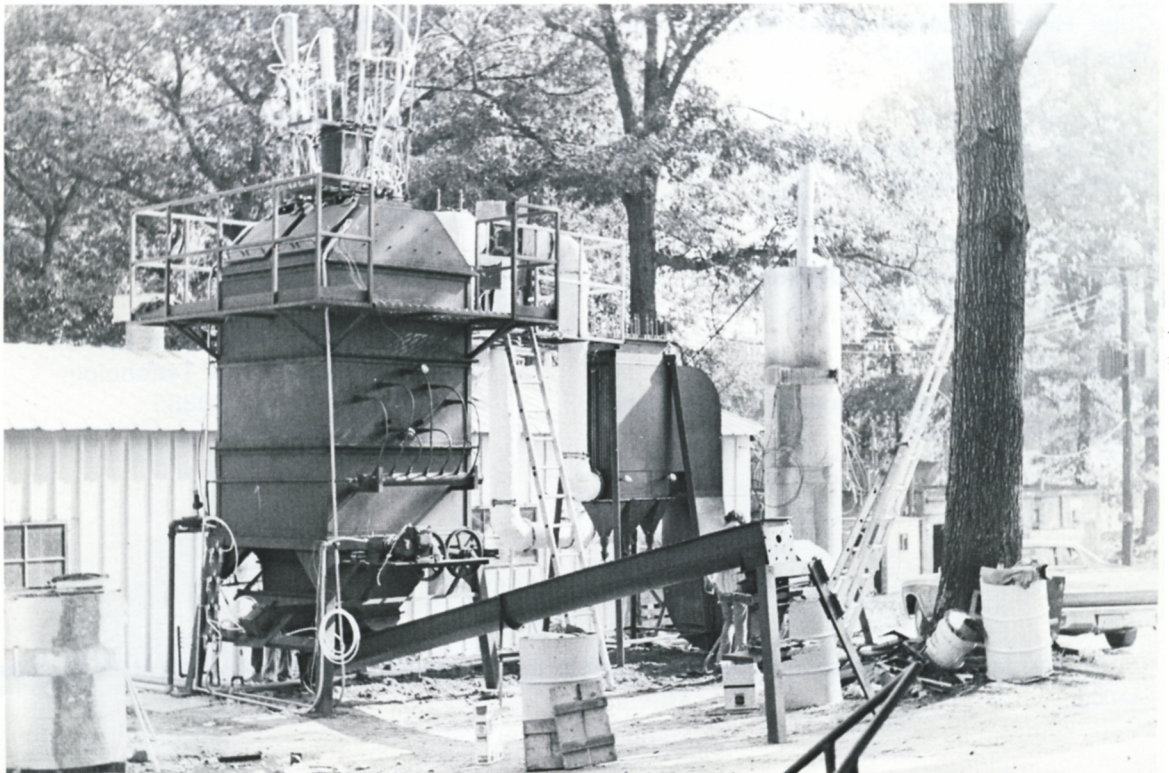


Georgia Tech Research Institute

The majority of research performed at the Engineering Experiment Station is supported by contracts with governmental organizations and private industry. Contracts are based on prior negotiation and formal proposals and are normally established on a cost-reimbursement basis.

The Georgia Tech Research Institute serves as the contract agency for the EES and it handles patent matters in connection with research and development activities. The Research Institute is a non-profit organization incorporated under the laws of the State of Georgia. The Board of Trustees is composed of four members of the Georgia Tech faculty, four from Georgia Tech alumni and four from industry at large.

On June 30, the officers and Board members of the Research Institute were as follows: Richard K. Whitehead, Sr., Chairman of the Board; Fuller E. Callaway, Jr., Vice Chairman; Robert H. Ferst, President; Maurice W. Long, Director of Research, Secretary and Assistant Treasurer; Thomas E. Stelson, Treasurer; Milton W. Bennett, General Manager, Assistant Treasurer and Assistant Secretary, and Rudolph L. Yobs, Assistant Secretary. The total membership of the Board of Trustees was James E. Boyd, Harllee Branch, Jr., Fuller E. Callaway, Jr., Robert H. Ferst, Vernon Crawford, Charles L. Davidson, Jr., Maurice W. Long, Joseph M. Pettit, Glen P. Robinson, Jr., Thomas E. Stelson, William B. Turner and Richard K. Whitehead, Sr.



M. W. Long
Director
Engineering Experiment Station
Telephone: 894-3400

Rudolph L. Yobs
Assistant Director for Technical Support
Telephone: 894-3404

Howard G. Dean, Jr.
Manager, Office of Program Development
Telephone: 894-3492

Gordon R. Harrison
Assistant Director for Applied Sciences
Telephone: 894-3430

J. D. Walton
Chief, High Temperature Materials Division
Telephone: 894-3661

Gordon R. Harrison
Chief, Nuclear and Biological Sciences Division
Telephone: 894-3430

Gordon R. Harrison
Chief, Physical Sciences Division
Telephone: 894-3430

John L. Brown
Head, Analytical Instrumentation Laboratory
Telephone: 894-3460

Richard C. Johnson
Assistant Director for Systems and Techniques
Telephone: 894-3516

D. W. Robertson
Chief, Communications Division
Telephone: 894-3542

H. A. Ecker
Chief, Radar Division
Telephone: 894-3523

R. M. Goodman
Chief, Sensor Systems Division
Telephone: 894-3507

J. W. Dees
Chief, Special Techniques Division
Telephone: 894-3504

Monte V. Davis
Director, Nuclear Research Center
Telephone: 894-3601

Ross W. Hammond
Chief, Industrial Development Division
Telephone: 894-3800

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332
(404) 894-3411

Readers with research and development problems are invited to contact the offices of the Engineering Experiment Station.