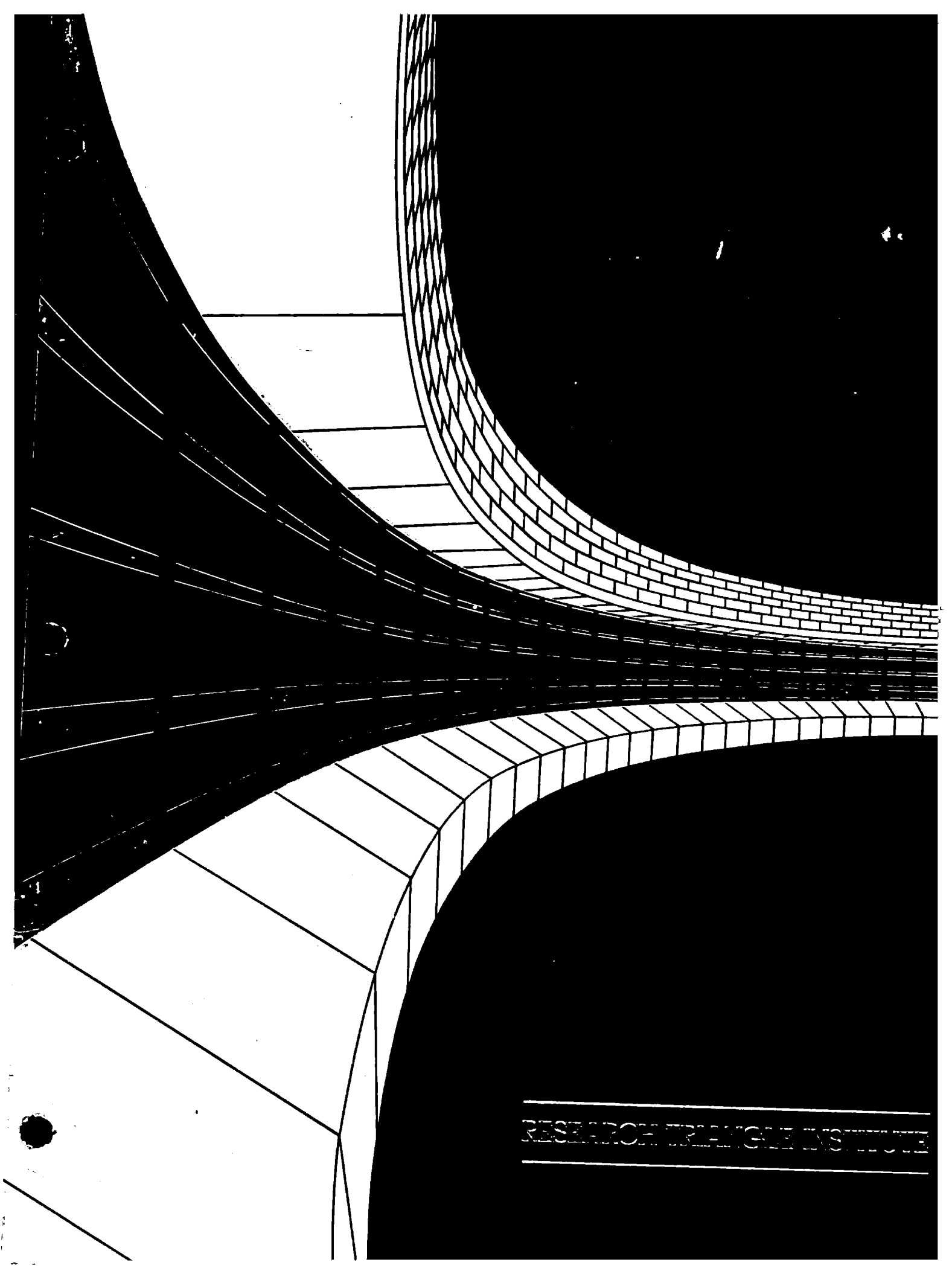


1983





RESEARCH TRIANGLE INSTITUTE

COVER: Research Triangle Institute's 47,000-square-foot engineering sciences building, named by the Board of Governors for Institute president George R. Herbert, opened in the spring of 1984. Its airy, open design provides space for research staff and programs in semiconductors, digital systems, energy, systems engineering, geosciences, and technology applications. Special features include a general laboratory for high speed computers, facilities for semiconductor device fabrication, and clean rooms for semiconductor materials growth.

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RESEARCH TRIANGLE INSTITUTE

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## RESEARCH TRIANGLE INSTITUTE . . . *in brief*

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... RTI performs interdisciplinary research in the physical, chemical, life, engineering, environmental, statistical, social, and policy sciences under contract to clients in business, industry, and government.

... RTI is entirely self-supporting from contract revenues generated by project charges.

... RTI was established at the end of December 1958 as a freestanding corporate entity to be the focal point and first step for growth in the new Research Triangle Park. Start-up funding for RTI was provided through a \$500,000 grant from contributions made to the Research Triangle Foundation. Research operations began on March 1, 1959.

... RTI was designed to work closely at many levels with its three founding institutions, the University of North Carolina at Chapel Hill, Duke University, and North Carolina State University.

... RTI/University relationships extend from board governance to professional consulting agreements with faculty and medical center scientists, adjunct appointments for selected RTI senior staff members, library services, and access to the extensive resources of the Triangle Universities Computation Center. The affiliation is especially productive in collaborative programs which call for a portion of the research to be performed within RTI and a portion at one or more of the universities.

... RTI's Board of Governors includes university officials and scientists, and representatives of the business and professional communities.

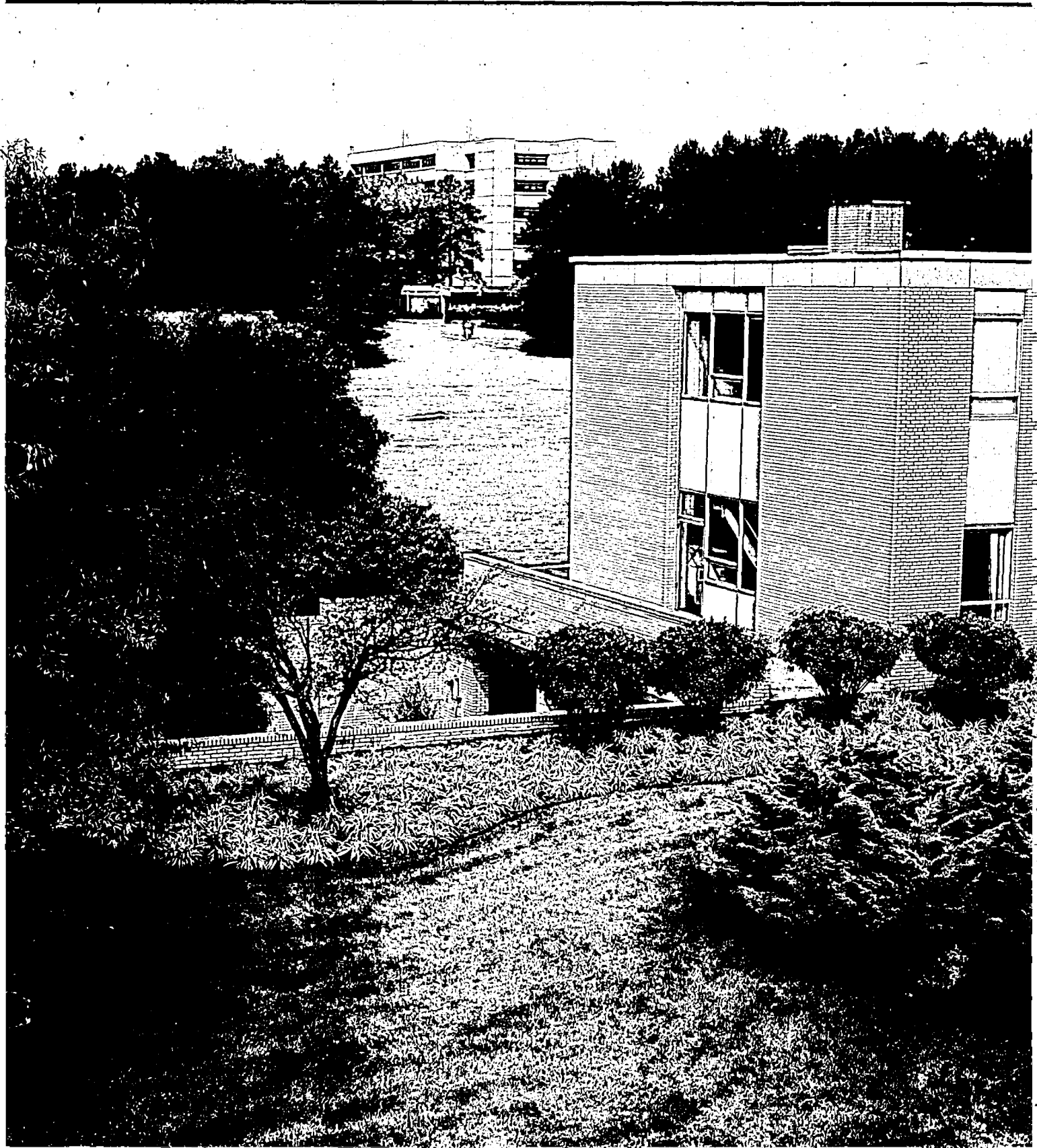
... RTI employs a regular staff of nearly 1,000. Institute research revenues have exceeded \$40 million each year since 1980.

... RTI occupies 391,000 square feet in 15 laboratory and office buildings in the Research Triangle Park between Raleigh, Durham, and Chapel Hill. The Research Triangle Foundation, a separate, nonprofit trusteeship, donated RTI's 180-acre campus and develops the resources of the 5,800-acre Research Triangle Park that has grown around RTI to become one of the world's foremost centers for scientific research and development.

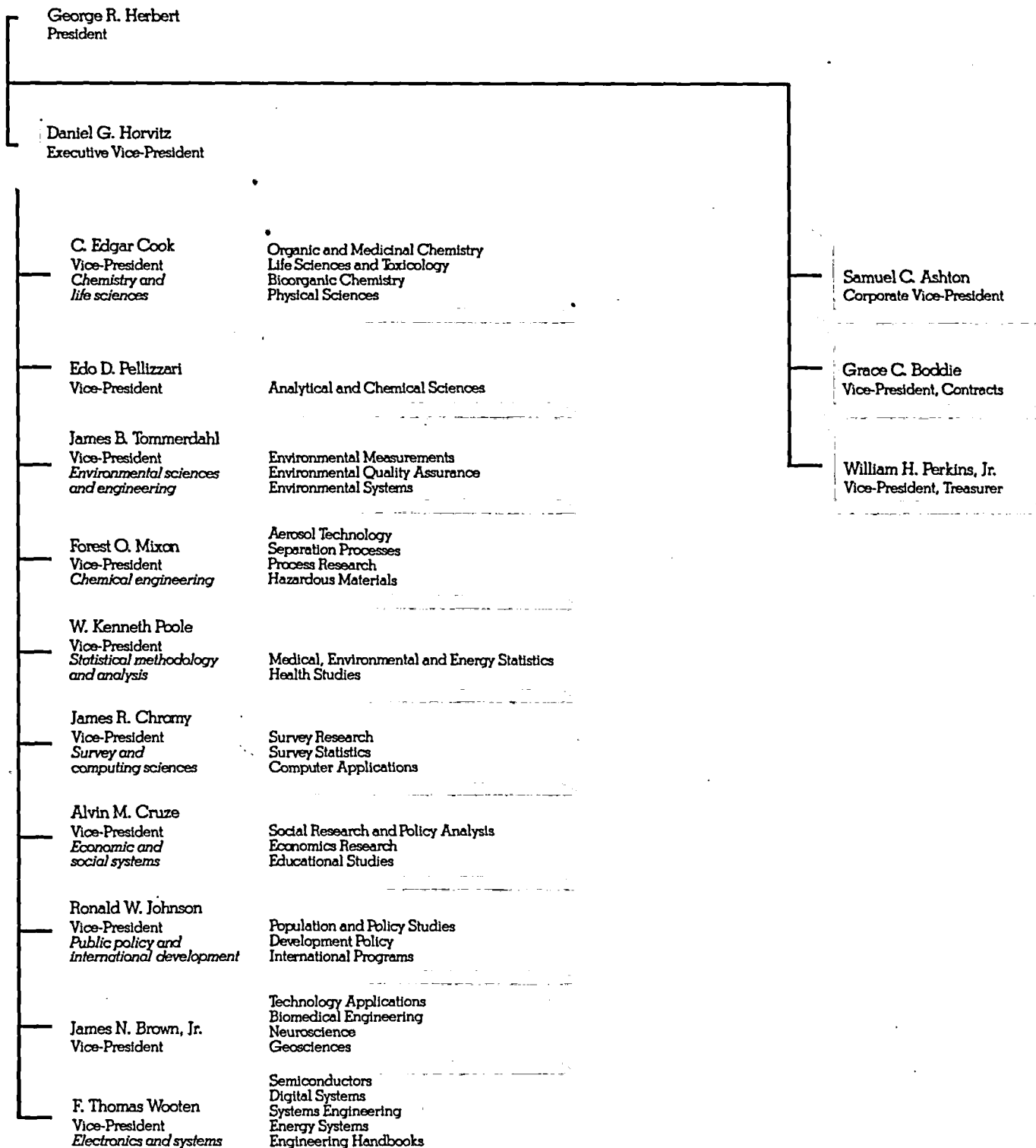
... RTI has a full-time systems engineering staff in Hampton, Virginia, near NASA's Langley Research Center. Project offices are maintained in Washington, D.C., Morocco, Senegal, and at other U.S. and overseas locations as contractual arrangements may require.

... RTI is one of six participating institutions in the unique, state-supported Microelectronics Center of North Carolina. Other MCNC participants are the three major Triangle universities, the University of North Carolina at Charlotte, and North Carolina A&T State University in Greensboro. RTI also shares activities with neighboring North Carolina Central University in Durham.

... RTI enters its second twenty-five years with a strong record of accomplishment and high expectations for service as part of the national scientific research resource.



**RESEARCH TRIANGLE INSTITUTE**  
**Officers and Research Programs**



The growth and diversity of Research Triangle Institute's activities over twenty-five years exemplify the dynamic character of scientific research. We anticipate more of the same, this year and for the next twenty-five.

Fortunately, our operational organization and our staff are well positioned to respond to opportunities across a broad front of scientific, industrial, economic, and social issues.

Looking back to the time of an empty Research Triangle Park and to the standing start RTI made early in 1959 with our first small sample survey projects, and then on to larger programs in statistics, natural products chemistry, polymer science, solid state physics, health, and the environment, it is possible to identify many research undertakings of the past which have contributed to the Institute's reputation. Then and now, the chief ingredient of this reputation is a talented, imaginative, and committed staff.

New technologies, new public and private sector initiatives, and new approaches to technical and quality of life concerns are virtual constants in the life of an institution such as RTI. And RTI has changed and expanded in response. Our initial research efforts have been continually extended until they now embrace the dozens of disciplines and subject areas covered in this publication. RTI's operations are structured so that skills in one or several disciplines can contribute as needed to any subject area.

Another constant throughout past, present, and future, is RTI's distinctive affiliation with its three creators, the University of North Carolina at Chapel Hill, Duke University, and North Carolina State University. Their existence and involvement are fundamental to every aspect of the total Research Triangle enterprise, including even its name, and especially to RTI. The universities conceived, established, and nurtured RTI; they give unfailing encouragement and support; they are active, generous partners in all facets of RTI's planning, development, and performance. Above all, they form a single community of shared educational and scientific purpose that nourishes a research environment unique to our state and region.

RTI's management, shown at left, and the professional capabilities described in the following pages give our scientists and managers a flexibility, a rich mix of research resources, an organizational unity, and a base of mutually-supporting experience and talent that assure the highest quality of service to our business and government clients. That service is delivered by an accomplished staff whose members are RTI's most notable asset.

*George R. Herbert*



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**ORGANIC AND MEDICINAL CHEMISTRY**

*Dr. F. Ivy Carroll, Director*

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Conducts basic and applied research to support development of pharmaceutical, agricultural, and chemical products.

***Synthesis of Organic Compounds***

Research in synthesis of organic compounds and development of improved synthetic sequences and procedures; Synthesis of known and unknown drugs and their metabolites, vitamins and analogs, dyes, steroids, alkaloids, amino acids, prostaglandins, other natural products, heterocycles, herbicides, insecticides and other organic compounds.

***Synthesis of Isotopically Labeled Compounds***

Preparation of compounds labeled with carbon-14, carbon-13, tritium, deuterium and iodine-125; Synthesis of high specific activity, specifically labeled tritium compounds for radioimmunoassay and receptor studies.

***Separation and Structural Analysis***

Apply coupled separations and spectroscopic techniques such as GC/MS, HPLC/MS, GC/FTIR, TG/MS to analysis of complex mixtures;

Separation methodology including use of adsorption, partition, exclusion and ion exchange chromatography;

High pressure analytical and preparative equipment for separation of small to large quantities of synthetic compounds, natural products, drug metabolites, and environmental samples;

Nuclear magnetic resonance using hydrogen, deuterium, tritium, carbon-13, nitrogen-15, phosphorus-31, and other nuclei;

Mass spectrometry, both direct probe and via high pressure liquid chromatography and GC/MS combinations;

Optical rotary dispersion, circular dichroism spectrophotometry for optically active compounds.

***Medicinal Chemistry***

Research in chemical structure-biologic activity relationship, drug design and development for cancer chemotherapy, cancer prophylaxis, anticarcinogens, antiparasitics, contraceptives, radiation protectives, narcotics and narcotic antagonists, stimulants, depressants, and hallucinogens.

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**LIFE SCIENCES AND TOXICOLOGY**

*Dr. Jerry R. Reel, Director*

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Designs and executes testing protocols to solve problems presented by efforts to develop products and processes for health care, industrial, and consumer products. Conducts toxicology testing required by regulatory agencies.

***In Vivo Toxicology/Oncogenicity***

Acute, subchronic, and chronic toxicity studies in rodents; Special toxicology studies.

***Cellular and Genetic Toxicology***

Ames Salmonella/microsome assay; Unscheduled DNA synthesis in rodent hepatocyte cultures; L5178Y/TK mouse lymphoma mutation assay; CHO mutagenicity and cytotoxicity assays; Pulmonary alveolar macrophage cytotoxicity assay; Metabolic cooperation assay in V79 Chinese hamster cells (tumor promoter assay).

***Mammalian Genetics/Mutagenesis***

Detect and identify chemically-induced point mutations in mice by electrophoretic and catalytic activity analyses of tissue enzymes and blood proteins; Genetic monitoring by electrophoretic analysis.

***Teratology/Neurobehavioral Toxicology***

Conventional teratology studies in laboratory animals; Neurobehavioral testing in rats and mice.

***Reproductive Endocrinology/Toxicology***

Contraceptive research and development; Hormone/antihormone assays; Hormone receptor assays and radioimmunoassays; Fertility and antifertility assays; FDA three-segment reproduction studies; FDA and EPA single/multigeneration reproductive studies; National Toxicology Program continuous breeding protocol; Dominant lethal mutation assay.

***Research Facilities***

Sterile environment tissue culture laboratory; Special laboratory for handling radioactive, toxic, and carcinogenic substances; Automated testing facility for neurobehavioral studies; Animal research facility of 13,800 square feet.

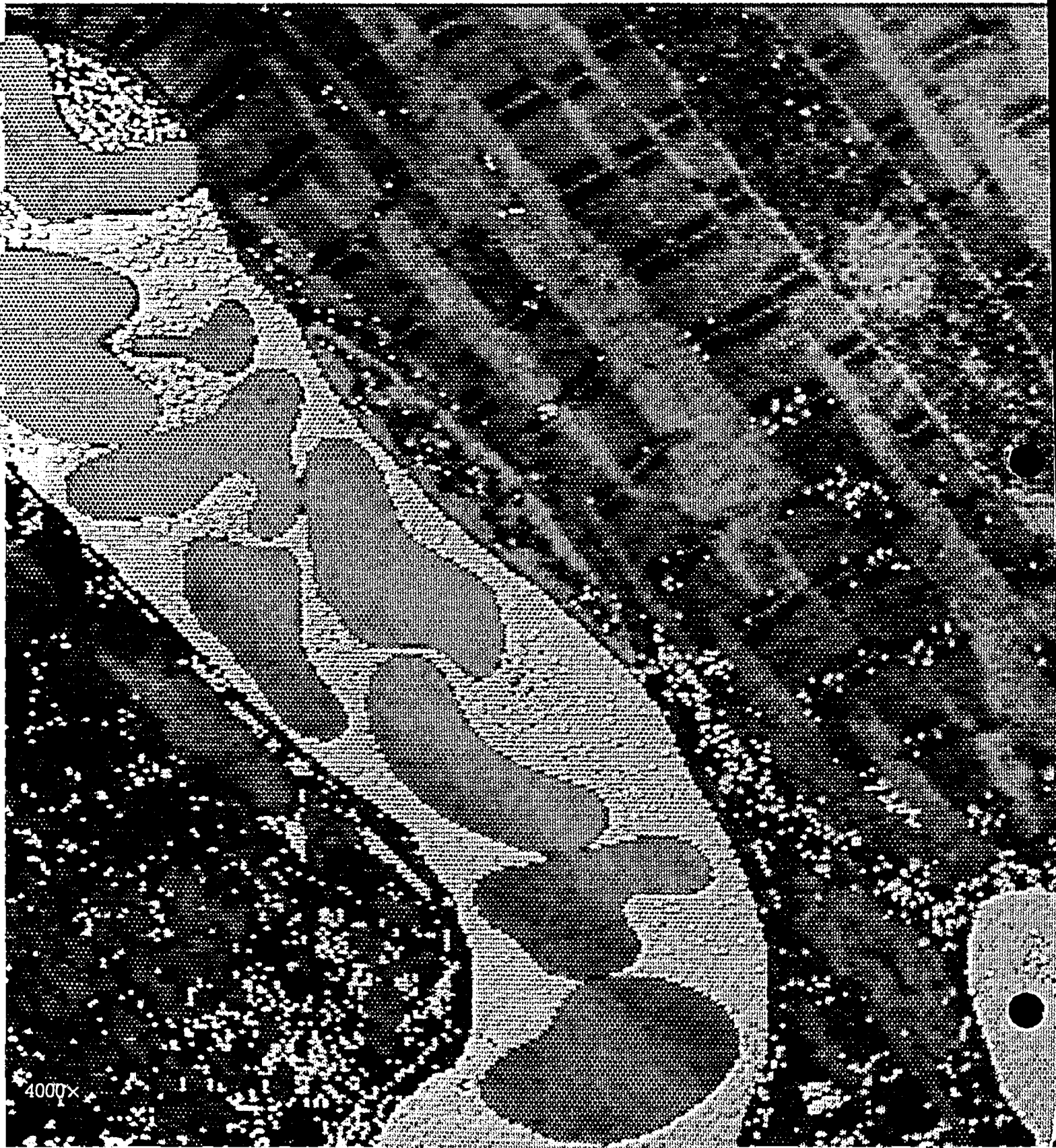
*transferring radioactive, toxic, and carcinogenic substances. The laboratory supports chemistry experiments such as syntheses of radiolabeled compounds, and toxicology experiments that involve mutagenesis, carcinogenesis, teratogenesis, neurotoxicity, and reproductive toxicity/ endocrinology.*

*Glove boxes and protective clothing are used in RTI's special laboratory for measuring and*



*Digitized scanning electron micrograph of cardiac muscle fibers. An electron microscope with X-ray microanalysis determines the spatial distribution and concentrations of such biologically important elements as calcium, magnesium, sodium, phosphorus, and potassium. Artificially color-coding the elements is an aid in determining their location*

*and distribution within a specimen. Much of RTI's medically-related analytical electron microscopy research is carried out in collaboration with Duke University's Department of Physiology.*



4000x

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**BIOORGANIC CHEMISTRY**

*Dr. C. Edgar Cook, Vice-President and Director*

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Conducts molecular-level studies on the interactions between chemicals and biological systems.

***Pharmacology and Metabolism***

Metabolic disposition of drugs and other xenobiotic compounds in human and animals;  
Measure xenobiotic compounds, including drugs, in blood and other biofluids;  
Identify, analyze, synthesize, and test metabolites;  
Conduct metabolism, pharmacokinetic, and bioavailability studies for NIH, pharmaceutical companies, chemical companies, and industry associations.

***Immunoassay Development***

Synthesize specific immunogens and radiolabeled ligands;  
Produce antisera in animals;  
Produce monoclonal antibodies by hybridoma technology;  
Develop radioimmunoassay kits for analysis of therapeutic drugs and drugs of abuse in physiological fluids.

***Specialty and Natural Products Chemistry***

Isolate, identify, and test natural products for chemotherapeutic potential and other biological activity;  
Develop and test biologically active steroids, including a new class of progestational agents;  
Synthesize and test steroid hormone analogs for contraception;  
Synthesize and test antineoplastic agent analogs;  
Develop, synthesize, and test food additives such as improved artificial sweeteners.

***Toxicological Applications***

Clinical chemistry and hematology on microsamples collected from humans and laboratory animals.

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**PHYSICAL SCIENCES**

*Dr. Colin G. Pitt, Director*

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Specializes in polymer research and has broad capabilities in polymer synthesis, characterization, and application. Addresses both physical and chemical aspects of problems and applications involving polymers.

***Polymer Synthesis***

Conventional syntheses such as free radical, ionic, emulsion, condensation, and coordination synthesis;  
Solid state polymerization;  
Grafting and glow discharge modification;  
Radiation processing;  
Synthesize novel monomers;  
Plasma polymerization and chemistry.

***Polymer Applications***

Polymer coatings such as corrosion resistant, antistatic, antifouling, conductive, blood compatible, diffusion barriers, and chemical, abrasion, and/or scratch resistant;  
Heat resistant polymers;  
Polymers for controlled delivery of human and animal drugs;  
Porous and nonporous membranes for separation processes;  
Polymer supports for catalysis;  
Adsorbent materials;  
Metal plating of polymers.

***Materials Science Research Facilities***

NMR, FTIR, ESCA, and mass spectroscopy;  
Surface analysis, X-ray scattering;  
Determination of porosity, diffusion, and sorption properties;  
Determination of thermal, mechanical, elastic, electrical, and flammability properties;  
Determination of molecular weight and molecular weight distribution;  
Coupled thermogravimetric analysis/mass spectroscopy;  
Transmission and scanning electron microscopy;  
Electron-probe X-ray elemental microanalysis.

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## **ANALYTICAL AND CHEMICAL SCIENCES**

*Dr. Edo D. Pellizzari, Vice-President*

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Develops and applies analytical techniques to trace organic and inorganic chemical measurements in biomedical, environmental, energy, and manufacturing processes.

### **Methods Development**

Develop, evaluate, and apply methods for analysis of complex mixtures such as hazardous wastes, sludges, sediments, water, air, biological media, industrial products, and biota; Develop and apply instrumental measurement techniques; Integrate measurements on hazardous substances with RTI toxicology testing and chemical engineering centers.

### **Indoor Air**

Identify and quantify potentially hazardous compounds introduced into air from building materials; Determine concentrations of potentially hazardous compounds in residences; Develop methods to sample and analyze indoor air pollutants; Measure emissions of hazardous compounds from office equipment.

### **Human Exposures and Body Burdens**

Measure environmental pollutants in air, water, food, human tissue, breath, and biological fluids; Establish exposure, body-burden, and dosage relationships and inferences; Apply models for population exposure, and collaborate with RTI statisticians to generalize exposure frequencies to large populations.

### **Surface Analysis**

Morphology, topography, and chemical nature of corrosion; Gravimetric and electrochemical methods for measuring solution corrosion rates; Chemistry and morphology of semiconductor surfaces; Identify surface and subsurface chemical species; Chemically characterize catalytic substrates.

### **Miniature Sensors**

Develop immobilization techniques for biological catalysts used as sensing devices, and immobilize biological catalysts on electrodes and semiconductors; Develop transducers/sensors to measure atmospheric and marine chemicals.

### **Quality Control and Quality Assurance**

Analytical techniques and sensors to monitor manufacturing processes in industries such as pharmaceuticals, food, plastics, fine chemicals, and commodities; Prepare standard operating procedures and controls; Audit systems to determine compliance.

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## **ENVIRONMENTAL MEASUREMENTS**

*Clifford E. Decker, Director*

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Develop, evaluate, and apply methods for analysis of ambient air, source emissions, hazardous wastes, and industrial hygiene pollutants.

### **Atmospheric Chemistry**

Field measurements, laboratory studies, modeling, and smog chamber studies of atmospheric interactions of chemical species.

### **Acid Precipitation**

Wet and dry deposition studies of acid species; Develop monitoring devices and protocols; Develop and evaluate measurement methods and innovative quality assurance procedures.

### **Hazardous Waste**

Sampling and analysis of hazardous waste; Hazardous waste management plans, training programs, and permit applications.

### **Reference Materials**

Develop and evaluate solid, liquid, and gaseous reference materials; Use reference materials for performance audits of outside laboratories.

### **Groundwater**

Characterize area and site-specific hydrogeology; Evaluate groundwater properties, and characterize groundwater contamination; Supervise well installation, and collect and analyze samples; Water quality monitoring and data base management.

### **Environmental and Occupational Health**

Industrial hygiene surveys; Hazard assessments of chemical and physical agents; Air sampling in occupational and non-occupational environments;

Chamber studies and modeling to support indoor pollutant monitoring.

#### ***Ambient Air Quality Measurements***

Short and long-term monitoring of ambient or captive air for O<sub>3</sub>, NO<sub>x</sub>, CO, SO<sub>2</sub>, TSP, and other gases and parameters; Compliance monitoring; Monitoring for acid precipitation, indoor air quality, and atmospheric chemistry research.

#### ***Methods Testing and Evaluation***

Test and evaluate EPA-designated reference and equivalent methods, personal monitors, wet chemical methods, and static or passive monitors; Ambient air, particulate, and source emission measurement methods.

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## **ENVIRONMENTAL QUALITY ASSURANCE**

*Frank Smith, Director*

Provides technical support to ensure that environmental research and data collection yield accurate, defensible results.

#### ***Air Monitoring***

Technical quality assurance (QA) support for ambient air, stationary source and meteorological monitoring; Method specific and program oriented guidelines for systems and performance audit standards and procedures, equipment and personnel validation, and error analyses.

#### ***Industrial Processes***

QA for stationary source, chemical, and biological measurements to characterize effluent and influent streams of stationary pollution sources; Systems and performance audits of sample collection, handling, analysis, and reporting.

#### ***Health Effects Research***

QA for research in analytical chemistry, inhalation studies, clinical and epidemiological research, mutagenicity and carcinogenicity studies, and biophysics and bioengineering.

#### ***Hazardous Material Sampling and Analysis***

for sampling and analysis of asbestos in building materials and in ambient air; National performance audit program for laboratories conducting bulk sample analysis for asbestos;

WATS line information service for EPA's asbestos abatement program.

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## **ENVIRONMENTAL SYSTEMS**

*Deane F. Tolman, Director*

Provides engineering analysis to guide regulation, assess environmental impacts, and support environmental planning.

#### ***Regulatory Processes***

Identify emission sources; evaluate alternative emission control techniques; formulate regulatory options considering cost, environmental impacts, and energy requirements; Assess alternatives, costs, benefits, and rationale for proposed regulations and standards; Technical support to determine compliance of individual sources and source categories; Evaluate effectiveness of abatement programs and develop enforcement strategies.

#### ***Environmental Engineering***

Engineering and cost feasibility of environmental and energy projects such as review of proposed gasification plant for compatibility with environmental requirements.

#### ***Emergency Response***

Assess lifesaving potential of emergency responses to natural and technological disasters, and assess health problems associated with disasters.

#### ***Water Resources***

Drought management planning; Water quality impacts of agricultural practices and wetlands development.

#### ***Environmental Impact Assessment***

Determine biophysical and socioeconomic impacts of contemplated actions such as construction projects, wetlands development, and federal policies; Prepare environmental impact reports.

#### ***Environmental Risk Assessment***

Identify, estimate, and evaluate risks to health and the environment; Risk assessments to help define emission standards for hazardous air pollutants.

**Training Materials**

Analyze environmental, health, and safety training requirements;  
 Develop and validate training and testing materials, including instructor and trainee manuals, visual aids, handbooks, and on-the-job training guides.

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**AEROSOL TECHNOLOGY***Dr. David S. Ensor, Manager*

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Provides engineering to transfer fundamental aerosol technology to practical application in environmental and personnel protection, clean-room technology, defense, and industrial processes. Conducts basic research in aerosol science.

**Environmental Protection**

Engineer, fabricate, and evaluate particulate control technologies from bench scale to field pilot plants, including electrostatically augmented fabric filtration and high gradient magnetic separation;  
 Mathematical models to predict performance and costs of electrostatic precipitation and fabric filtration;  
 Microcomputer programs for engineering design of control technologies;  
 Predict plume opacity and visibility reduction from industrial sources.

**Clean-Room Technology**

Study sources and fates of aerosols in clean rooms used in industries such as electronics and pharmaceuticals;  
 Characterize dynamics of air- and liquid-borne contamination and deposition on clean-room work surfaces;  
 Measure submicron component of aerosols in semiconductor clean rooms;  
 Study mean free path effects on the growth of ultrafine metallic aerosols;  
 Develop semiconductor clean-room technology.

**Defense**

Improve basic understanding of particle filtration to protect personnel from chemical and biological warfare agents;  
 Generate challenge aerosols with controlled particle shapes (fibrous and spherical) and sizes from 0.001 to 10 micrometers;  
 Determine dynamics of submicron aerosols;  
 Study and predict light scattering from metallic aerosols;

Develop test methods for filter media.

**Industrial Processes**

Demonstrate industrial applications for high gradient magnetic separation;  
 Develop manufacturing and product testing applications of aerosol technology.

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**SEPARATION PROCESSES***Dr. Madhav B. Ranade, Manager*

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Develops methods to separate components in mixed systems for engineering operations such as environmental control, product recovery, and mineral enrichment. Conducts research, development, and engineering evaluations of chemical engineering separation techniques such as distillation, absorption and extraction, and novel techniques such as supercritical extractors, membranes, and biological systems (e.g., biosponge).

**Carbon Adsorption**

Prepare activated carbon for specific applications;  
 Develop and evaluate adsorption-based processes.

**Particle Adhesion**

Characterize interparticle interactions and powder treatments for improved dispersion of powders in air and liquids;  
 Measurements such as contact angle, particle morphology, and particle size.

**Environmental Protection**

Study permeation of toxic chemicals in polymers;  
 Develop methods for sulfur recovery from coal gasification waste;  
 Model dry-sorbent sulfur dioxide scrubbing;  
 Assess migration of pollutants in soil.

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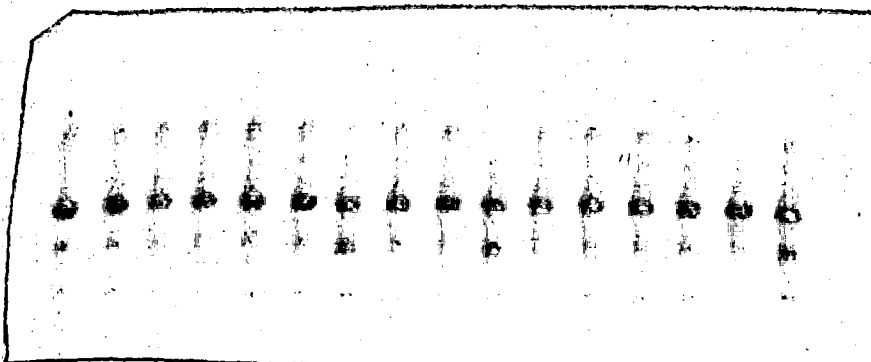
**PROCESS RESEARCH***Dr. James J. Spivey, Manager*

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Conducts bench- and pilot-scale chemical engineering studies of unit operations and transport processes in pollution control, synthetic chemical and fuel production, chemical feedstock production, and vapor and solid phase decontamination.

In research for the National Toxicology Program, scientists in RTI's mammalian mutagenesis laboratories discovered and characterized a rare mouse mutation similar to one that causes

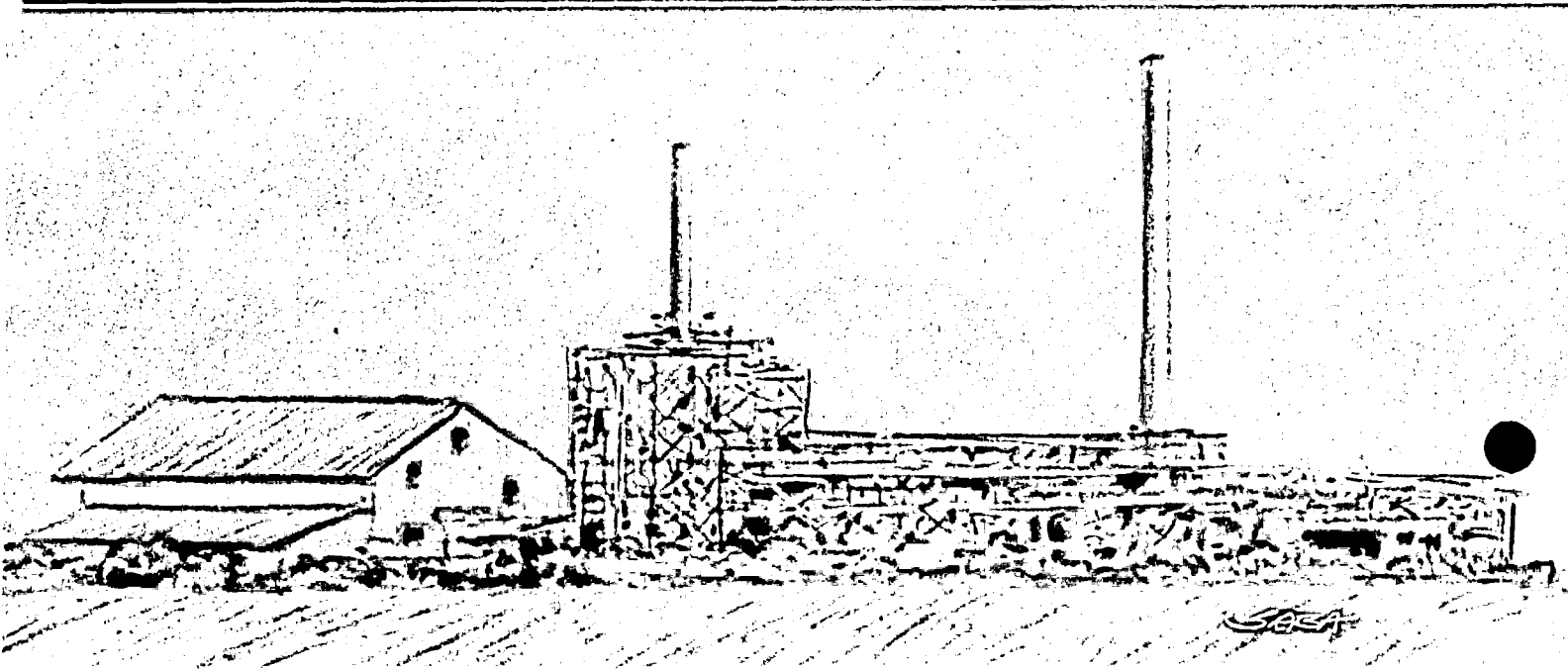
$\beta$ -thalassemia, or Cooley's anemia, a serious inherited disease in humans.  $\beta$ -thalassemia affects the body's ability to produce hemoglobin, the iron-based chemical that allows red blood cells to carry oxygen. The blue rectangular object below is a starch gel electrophoretic block similar to the one that helped researchers identify the mutation.





The treatment and disposal of hazardous wastes are research priorities at RTI. Under multi-year programs with the EPA, Institute chemical engineers, chemists, economists, and regional planning specialists investigate technology and policy options for dealing with toxic materials safely and cost-effectively. Studies include landfill

caps and liners, disposal site cleanup and rehabilitation, environmental and economic analyses of control regulations and, as shown in the lower illustration, organic waste incineration methods.



**Catalyst Research**

Develop and characterize catalysts for oxidation, hydrocarbon conversion, and fuel production;  
Develop kinetic models and bench- and pilot-scale systems.

**Process Engineering**

Study transport of potential pollutants from liquid media to vapor phase;  
Pilot-scale gasification, including analyzing products, identifying possible pollutants, and reducing data on-line.

**Process Evaluation**

Pilot studies and literature review to determine technical feasibility of new processes and improvements;  
Develop and evaluate technical alternatives and process modifications based on regulatory or economic conditions.

**Biotechnology**

Pollution control using microorganisms and immobilized species for removing trace constituents;  
Biological techniques as alternatives for production of chemicals and fuels;  
Bench- and pilot-scale studies of biological processes and scale-up problems.

**Reaction Engineering**

Mathematical models of chemical reactions, including heterogeneous catalytic conversion processes;  
Laboratory studies to analyze products of chemical reactions and verify postulated reaction mechanisms.

**Engineering Economics**

Engineering cost estimates for proposed processes or process modifications;  
Analyze regulatory and tax impacts on process economics.

**Technical Services**

Consultation on scale-up of chemical reactions;  
Bench- and pilot-scale programs using in-house and on-site chemical reaction equipment and analytical facilities.

**HAZARDOUS MATERIALS**

*Dr. C. Wayne Westbrook, Manager*

Research on hazardous waste management, treatment, and disposal technologies. Engineering studies for land disposal, incineration, waste treatment, and regulatory activities.

**Land Disposal/Storage**

On-site performance evaluations of hazardous waste management;  
Advanced treatment techniques for leachates;  
Groundwater risk assessment;  
Evaluate geotextiles and unconventional materials in containment systems;  
Develop *in situ* treatment methods;  
Determine reactivity of construction materials with wastes;  
Develop techniques to control volatilization of wastes;  
Evaluate surface impoundment technology.

**Thermal Methods**

Determine incinerability of hazardous wastes;  
Develop scale-up criteria for incineration and treatment;  
Develop models for hazardous waste treatment processes;  
Evaluate co-firing of wastes in industrial processes;  
Test advanced incineration and control techniques;  
Develop novel thermal methods for destroying mixed wastes.

**Waste Treatment**

Study chemical, physical, and biological treatment;  
Develop methods to separate heavy metals from mixed wastes, and refractory organics from biodegradable wastes;  
Survey industrial manufacturing facilities;  
Develop sampling and analytical protocols for assessing control technologies;  
Assess cost-effectiveness of technologies for managing uncontrolled waste sites.

**Regulatory Support**

Write technical documents to support RCRA and Superfund;  
Develop and verify hazardous waste characterization procedures;  
Help identify, characterize, and monitor Superfund sites.

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**MEDICAL, ENVIRONMENTAL, AND ENERGY STATISTICS**

*Dr. Tyler D. Hartwell, Director*

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Designs studies and analyzes data for investigations related to medicine, the environment, and energy. Capabilities include analyzing weighted data from complex survey and data collection designs. Often collaborates with RTI chemists, life scientists, engineers, and economists. Works with RTI computer scientists to design generalized and special-purpose software for efficient, cost-effective analysis of data from complex survey designs.

***Clinical Trials***

Data coordinating center for large multi-center clinical trials (design trial, data collection, and randomization procedures, collect and analyze data, report results):

- Multi-center investigation of treatments to limit infarct size;
- Test efficacy and safety of antenatal treatment to prevent respiratory distress syndrome;
- Compare efficacy of treatments for hemophilia;
- Five-year study of treatments for urinary tract infections.

***Health Promotion***

Quasi-experimental evaluation of Johnson & Johnson's "Live for Life" employee wellness and preventive health care program;

Develop standard methods to evaluate similar programs.

***Environmental Studies***

Design data collection and statistical procedures for studying exposure to and body burdens of environmental agents;

Assess exposure to and body burden of hazardous organic compounds for populations in selected U.S. cities;

Study exposure/body burden of heavy metals;

Collect data using personal CO monitors.

***Energy Statistics***

Analyze utility rates, markets, and policies to determine impact and effectiveness of programs for load management and conservation.

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**HEALTH STUDIES**

*Dr. Fred A. Bryan, Director*

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Designs and conducts evaluations and analytical studies of programs for delivering health care services, and of the efficacy and safety of pharmaceutical products and biomedical technology systems. Staff skills include biophysics, biometrics, biostatistics, epidemiology, health policy and administration, medical sociology, and health survey research.

***Health Program Evaluation***

Compare alternative health care funding mechanisms, delivery systems, health care policies, and cost containment efforts;

Economic and social impacts on consumers and suppliers of health care;

Health care manpower planning and projections;

Design, conduct, and analyze national health statistics surveys;

Health and process outcomes of pre-paid dental care.

***Biomedical Evaluations***

Compare alternative diagnostic tools and techniques;

Clinically evaluate safety, efficacy, and acceptability of medical technologies, therapeutic drugs, and other treatments (recruit clinical investigators, develop protocols and forms, coordinate studies, collect, manage, and analyze data);

Bioavailability and bioequivalence studies of pharmaceutical products;

Evaluate acceptability of pre-paid health care provided by health maintenance organizations (HMOs).

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## **SURVEY RESEARCH**

*R. Paul Moore, Director*

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Designs and manages small- and large-scale surveys for commercial, industrial, and governmental clients.

### ***Survey Design and Management***

Specify alternative survey designs and methodologies considering costs and quality;

Design, develop, and format questionnaires, forms, and test instruments;

Conduct and evaluate pretests and pilot surveys;

Select and train data collection personnel;

Plan and schedule data collection;

Prepare government clearance packages;

Control, estimate, and forecast costs;

Assure quality of data collection and reduction.

### ***Methodology Research***

Design and administer studies and experiments on survey methodology;

Study interviewer-respondent interactions, modes of data collection, maximization of mail survey response rates, optimum time of day for household interviewing, and use of respondent memory aids.

### ***Field Survey Capabilities***

National field supervisory staff, sample capability, and interviewing capability for national, regional, state, and local surveys;

Experience with household interviews, group-administered tests and questionnaires, abstraction of data from administrative and medical records, and collection of environmental and biological specimens.

### ***Telephone and Mail Surveys***

Central telephone interviewing with national WATS service;

On-line Computer-Assisted Telephone Interviewing;

Procedures to obtain high response rates from mail surveys;

Design cost-effective surveys using combined data collection modes;

Trace and locate panel survey participants, including vital record searches.

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## **SURVEY STATISTICS**

*Dr. Robert E. Mason, Director*

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Designs, specifies, and selects samples, estimation procedures, and analysis procedures for RTI sample surveys. Specifies and performs inferential analyses, including development of analytic and data management computer software. Conducts research related to statistical sampling theory and practices. Staff experience includes projects in social sciences, education, economics, energy, health, behavior, medical care, environmental monitoring and measurement, and engineering applications.

### ***Survey Issues***

Construct and stratify sampling frames, including overlapping and indirect frames with associated multiplicity;

Determine appropriate randomization procedures;

Develop procedures for linearly unbiased estimates;

Modeling, including population-based regression analyses;

Sampling for rare events;

Minimize both sampling and nonsampling errors subject to cost constraints;

Assess nonsampling errors and apply missing data compensation procedures.

### ***Methodology Research***

Randomized response;

Population regression analysis;

Imputation of missing data;

Nonresponse bias assessment;

Double sampling designs for nonresponse in longitudinal surveys;

Nonresponse compensation procedures;

Measurement response error models;

Unequal probability randomization procedures;

Minimum variance optimization and nonlinear estimation procedures.

### ***Computer Support***

Develop methods to use computer-accessible census data to select efficient samples and subsamples;

Develop generalized computer software to provide descriptive statistics, regression estimates, and variance components of survey data with complex sampling error structures.

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## COMPUTER APPLICATIONS

*Robert H. Thornton, Director*

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Conducts research in software design, systems analysis, and computer applications. Supports data collection projects in other RTI centers with programming, data base management, and data analysis.

### *Research Capability*

Simulation models;  
Systems analysis;  
Data base design and large-scale data systems;  
Statistical analyses using standard packages and specially written routines;  
Linear and dynamic programming.

### *Survey Support*

Support large-scale, national, multi-year surveys, and smaller studies;  
Develop and maintain software for sample selection, data collection, data processing, and file management;  
Develop and maintain sophisticated software for computer editing, monitoring document flow, receipt control, key-to-disk data entry, file documentation through computer-readable codebooks, automatic file backup and maintenance.

### *Computer and Programming Experience*

IBM 360/50, IBM 360/75, IBM 370/165, Amdahl 470V/8, IBM 3033, IBM 3031, IBM 3081, and DEC's VAX series;  
Additional experience with CDC 3600, CDC 1700, CDC 6600, Burroughs 3500, UNIVAC 1108, and Gould Concept 32/8750;  
Staff skills with FORTRAN, PL/I, IBM Assembler, SAS, SPSS, COBOL, APL, ALGOL, COMPASS, BASIC, C, and Ada.

### *RTI Computer Facilities*

PDP11/60, VAX 11/750s, VAX 11/780, and Gould Concept 32/8750 computers, plus numerous other mini- and microcomputers;  
Local Area Network interconnects these devices;  
Computer-Assisted Telephone Interviewing, file management, and programming.

### *Shared Computer Facilities*

Triangle Universities Computation Center (TUCC), which also serves UNC-Chapel Hill, Duke, and N.C. State universities, and small colleges throughout North Carolina. TUCC

has an IBM 3081 and an IBM 370/168 computer, and simultaneously supports approximately 230 interactive users and 12 batch jobs.

Remote computer facilities, including HHS's Data Management Center, EPA, HCFA, COMNET, NIH, Data Crown Ltd., and NCHS.

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## SOCIAL RESEARCH AND POLICY ANALYSIS

*J. Valley Rachal, Director*

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Research on social and economic behavior of individuals, groups, and populations. Staff capabilities include sociology, social psychology, psychology, criminology, social policy planning, statistics, economics, public administration, and political science.

### *Substance Abuse and Use*

Determine extent, nature, context, and causes of alcohol and drug abuse;  
Evaluate prevention, intervention, and treatment programs;  
Improve methods to estimate prevalence, treatment effectiveness, and social costs associated with substance abuse;  
Determine relationships between substance abuse and behaviors or conditions such as crime and employment.

### *Criminal Behavior*

Determine extent and nature of criminal activity among selected population groups;  
Develop and improve methodologies for studying criminal behavior;  
Study the association of criminal behavior with behaviors or conditions such as unemployment and mental illness.

### *Mental Health*

Determine incidence and prevalence of mental health problems;  
Examine need, availability, and use of mental health services.

### *Human Services and Human Resources*

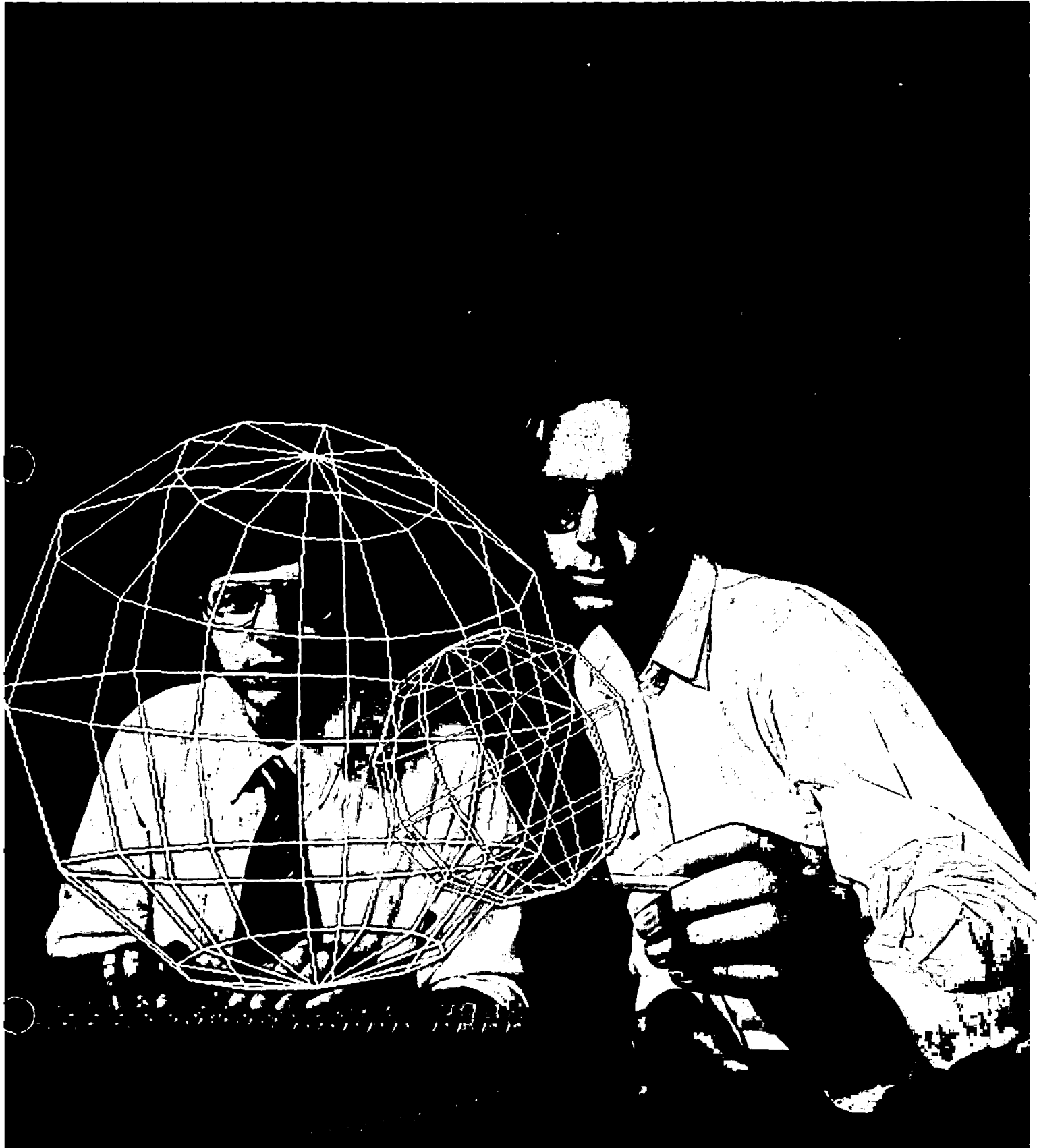
Develop and test management practices used in delivery of public services;  
Determine needs for human services;  
Analyze attitudes toward occupational choice.

### *Recent Projects*

Evaluate effectiveness of drug treatment programs;  
Study alcohol/drug abuse among U.S. military personnel;

*RTI models for improving aircraft safety, energy efficiency, traffic management, and signal process-*

*ing systems are tested in real time and fast time by computer simulations of cockpits and traffic flows. This composite of the earth's orbit, as it might be seen from inside a display terminal, illustrates the perspective-rendering abilities of a graphics computer in research to improve the quality of cockpit instrumentation.*



*RTI's international research experience covers more than 20 years and nearly 60 countries around the world. Current overseas studies include health, nutrition, sanitation, alternative energy, agricultural policy, microcomputer technology transfer, urban financial management, family planning and fertility research, and a multi-year analysis of the*

*many issues associated with population and economic development policies.*



Evaluate strategies to reduce errors in public assistance programs;  
Study propensity of youths to enlist in the military.

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## **ECONOMICS RESEARCH**

*Dr. Allen K. Miedema, Director*

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Specializes in economic analysis of public and private policies for both government and business clients. Staff capabilities include applied microeconomic theory, econometrics, regulatory economics, engineering economics, health economics, applied welfare economics, industrial organization, and business administration.

### ***Environmental Economics***

Design and evaluate environmental policies;  
Forecast economic responses and changes in residual flows caused by policy options;  
Estimate environmental policies' benefits and costs, and determine their distribution.

### ***Energy Economics***

Estimate and compare costs and benefits of conservation and load management programs to electric utilities and their customers;  
Develop innovative rate and service practices for utilities;  
Project customer acceptance of new technologies, conservation, and load management, and estimate impacts on energy usage patterns;  
Use economic, financial, and engineering criteria to compare costs and effectiveness of alternative energy options for utilities.

### ***Economic Issues***

Apply economic analysis to issues in agriculture, health, labor, occupational health and safety, and markets for new technologies.

### ***Recent Projects***

Aid in developing emergency energy plans;  
Examine structure, conduct, and performance of the U.S. geothermal industry;  
Develop an engineering-economic model for U.S. coke plants;  
Analyze impacts of socioeconomic variables on use of health care services.

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## **EDUCATIONAL STUDIES**

*Marie D. Eldridge, Director*

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Conducts educational research, evaluates education programs, and provides technical assistance on educational studies. Staff skills include quasi-experimental design, test and questionnaire development, evaluability assessment, needs analysis, process evaluation, histogrammic and case study analysis, cost effectiveness studies, programmed instruction design, and longitudinal analysis.

### ***Policy and Evaluation Studies***

Evaluate effectiveness of programs and institutions, including special programs for targeted student populations, teacher training, and selected curricula;  
Develop specialized analytical methodologies for studies of educational problems, programs, and issues.

### ***Surveys***

Analyze teacher supply and demand;  
Assess incidence of educational problems such as violence;  
Describe science curricula and materials;  
Inventory community education programs.

### ***Educational Development***

Longitudinal studies of students' progress and development after high school;  
Assessments of educational progress.

### ***Higher Education Issues***

Assess factors related to development or decline of educational institutions;  
Assess federal, state, and local educational policy;  
Analyze fiscal and enrollment trends.

### ***Institution and System Management***

Develop information and long-range planning systems;  
Analyze and audit local education programs;  
Assess teacher evaluation programs;  
Provide technical assistance to program managers, school administrators, and teachers.

### ***Instructional Materials and Technologies***

Develop and evaluate materials and technologies such as programmed instruction, computer and video applications, and instruction manuals.



**Recent Studies**

Determine factors associated with positive development of higher education institutions;  
 Develop programmed instruction materials in basic mathematics;  
 Prepare policy recommendations for occupational education;  
 Analyze issues in school system mergers;  
 Develop models and provide technical assistance to high schools in attracting women to science careers.

**POPULATION AND POLICY STUDIES**

*Dr. Ronald W. Johnson, Vice-President and Director*

Staff specialties include political science, economics, sociology, demography, planning, and psychology.

**Population and Demographic Studies**

Analyze family structure changes and population trends in marriage and remarriage patterns, childbearing decisions, teenage pregnancies, sex roles and fertility, and aging.

**Public Policy Analyses**

Impact of federal procurement policies on industrial innovation;  
 Alternative post-release programs for ex-offenders;  
 Federal policy implications of condominium conversions;  
 Neighborhood revitalization patterns;  
 Evaluate the effectiveness of the Women, Infants and Children's Supplemental Food Program;  
 Analyze impact of changes in entitlement rules and employment income on the Aid to Families With Dependent Children (AFDC) program.

**Public Service Delivery and Performance**

Evaluate service delivery by local, state, and federal agencies, and assess factors that influence efficiency and effectiveness;  
 Develop methods for measuring governmental performance;  
 Assist governments in improving functions such as fire and police protection, solid waste collection, transportation, judicial systems, and human services;  
 Assess roles and effectiveness of volunteer organizations in service delivery.

**Human Resource Development Planning and Analysis**  
 Support national, state, and developing country planning to link educational programs, employment patterns, and public occupational information systems;  
 Develop occupational classifications and job skill taxonomies for educational planning;  
 Evaluate training programs' responsiveness to local or regional labor markets.

**DEVELOPMENT POLICY**

*Dr. James E. Kocher, Director*

Staff specialties include development economics and planning; agricultural economics; population economics; population policy and planning; econometrics; economic-demographic modeling; agricultural policy, marketing, and statistics; transportation economics; mainframe and microcomputer systems, simulation, and applications; computer graphics, and forest resources planning.

**Population and Development Economics**

Design economic-demographic national and regional planning, forecasting, and policy models for population, employment/labor supply and demand, education and human resources, health, family planning, agricultural and rural development, and forest resources;  
 Design and implement cost-benefit analyses of family planning programs;  
 Research on fertility, mortality, family planning, and migration;  
 Develop strategies for integrating population characteristics into development planning;  
 Analyze household, demographic, and family planning survey data;  
 Prepare and analyze population projections.

**Agricultural Economics**

Analyze the effects of government intervention;  
 Assess constraints on policy reform;  
 Develop and evaluate agricultural and rural development projects;  
 Develop new method to anticipate the rate of adoption, impact on farmers' incomes, social rate of return, and the distribution of gains and losses from new technologies;  
 Study small farmer marketing problems;

Assess effects of transportation costs on agricultural production;  
 Evaluate agricultural insurance schemes;  
 Institutional analysis of agricultural and rural development agencies in developing countries;  
 Design and analyze systems for agricultural data management and analysis.

#### ***Micro and Macro Models***

Models of farm households to simulate policy impacts or product supply response, labor supply, and input demands;  
 Risk-programming models of households and institutions to design optimum portfolios for agricultural institutions, and to evaluate impacts of risk on farmers' product supply and credit market behavior;  
 Forest and natural resource utilization models.

#### ***Training and Microcomputer Applications***

Train developing country officials to use computers for planning and policy models;  
 Training in population and development issues;  
 Training in agricultural statistics and policy analysis;  
 Transfer analytical systems to developing countries.

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### **INTERNATIONAL PROGRAMS**

*Dr. James S. McCullough, Director*

Serves as the focal point for RTI involvement in research and technical assistance overseas. Staff disciplines include public finance, management information systems, municipal administration, urban and regional planning, and public health administration.

#### ***Technical Assistance***

Design microcomputer-based information systems for economic development and local government;  
 Shelter sector assessments and urban infrastructure project design;  
 Design and advisory services in national population, family planning, and health programs;  
 Design programs to improve local government financial management;  
 Assistance to, and management audits of, municipal development banks.

#### ***Training and Manpower Planning***

Courses in urban financial management for developing country officials;  
 Local government revenue improvement workshops;  
 Short courses in microcomputer applications;  
 Develop manpower planning guidelines in water supply and sanitation.

#### ***Institution Building***

Management assistance to rural development agencies;  
 Long term technical assistance in establishing research institutes in developing countries;  
 Design programs to strengthen municipal development institutions, particularly municipal management;  
 Assistance in designing institutions to support small scale enterprise.

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### **TECHNOLOGY APPLICATIONS**

*Dr. Doris J. Rouse, Director*

Interdisciplinary research on applications of advanced technology to industrial processes, bioengineering products, and rehabilitation methods.

#### ***Technology Transfer***

Manage a NASA technology applications team to transfer aerospace technology to applications in industry, bioengineering, and rehabilitation;  
 Transfer aerospace and industrial technology to develop CAD/CAM systems;  
 Product feasibility studies for medical device manufacturers.

#### ***Manufacturing Engineering***

Develop, model, and evaluate computer-aided logistics systems for automated materials handling and warehousing, flexible manufacturing cells, production and inventory control, and CAD/CAM;  
 Characterize, identify, and measure manufacturing workloads and available production capacity;  
 Develop behavioral models for improvements over current systems;  
 Construct and validate control models of proposed systems;  
 Implement proposed systems with real-time feedback control functions.

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## BIOMEDICAL ENGINEERING

*Robert L. Beadles, Director*

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Develop electronic, optical, and mechanical biomedical technology for diagnostic, monitoring, and prosthetic applications.

### *Noninvasive Physiological Monitoring*

Clinical and wearable electronic instrumentation for exercise stress testing, ambulatory and intensive care monitoring, and field and workplace studies of pollutants and related physiological responses;

Exercise Stress Processor for heart diagnosis based on impedance cardiographic estimates;

Special cardiac instrumentation for studying high pressure physiology, high altitude physiology, and transient exposures to carbon monoxide;

Wearable microcomputer system to record cardiac and respiratory parameters in field and workplace settings;

Gamma camera and impedance cardiography measurements to determine safe levels of carbon monoxide exposure for angina patients.

### *Speech and Sensory Prostheses*

Prosthetic devices for deafness, low vision, and other sensory disorders;

RTI's "Autocuer" processes speech and displays visual cues to improve the efficiency of lip reading;

Electronic speech recognition combining acoustic and visual analysis;

Unobtrusive low-vision aid.

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## NEUROSCIENCE

*Blake S. Wilson, Manager*

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Capabilities in neurobiology, neurophysiology, electrical engineering, and speech analysis. Collaborates with medical researchers, particularly at Duke University and the University of California at San Francisco.

### *Speech Processors*

Design processors to extract speech parameters essential for intelligibility, and encode these parameters for excitation of the auditory nerve on a sector-by-sector basis via implanted electrodes;

Develop a computer-based system for emulation of speech processors in software;  
Develop speech processors to improve performance of hearing aids.

### *Neurophysiology*

Develop and test mathematical models of the vestibular system;

Investigate temporal processing mechanisms in the auditory system.

### *Biological Effects of Microwave Exposure*

Identify effects of microwave exposure on brain activity in animals;

Record electrical activity in brain structures using single-unit techniques;

Record patterns of brain metabolic activity using radiolabeled deoxyglucose.

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## GEOSCIENCES

*Dr. Fred M. Vukovich, Manager*

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Basic and applied research programs involve application of remotely-sensed satellite data and numerical modeling of atmospheric processes.

### *Meteorology*

Select optimal sites for meteorological and pollution sampling;

Develop mathematical techniques to determine wind statistics in remote locations;

Apply heat capacity mapping mission satellite data to define initial and boundary conditions for numerical models;

Analyze surface temperature patterns related to cloud and storm initiation;

Apply GOES satellite data to determine cloud parameters for the NEROS program;

Assess influence of synoptic-scale ozone perturbations on the global ozone budget;

Develop parametric methodologies on convective-cloud vertical mass transport for acidic deposition models;

Assess wind energy resources.

### *Oceanography*

Dynamics and physics of ocean circulation:

Analyze boundary current perturbations associated with the Gulf Stream;

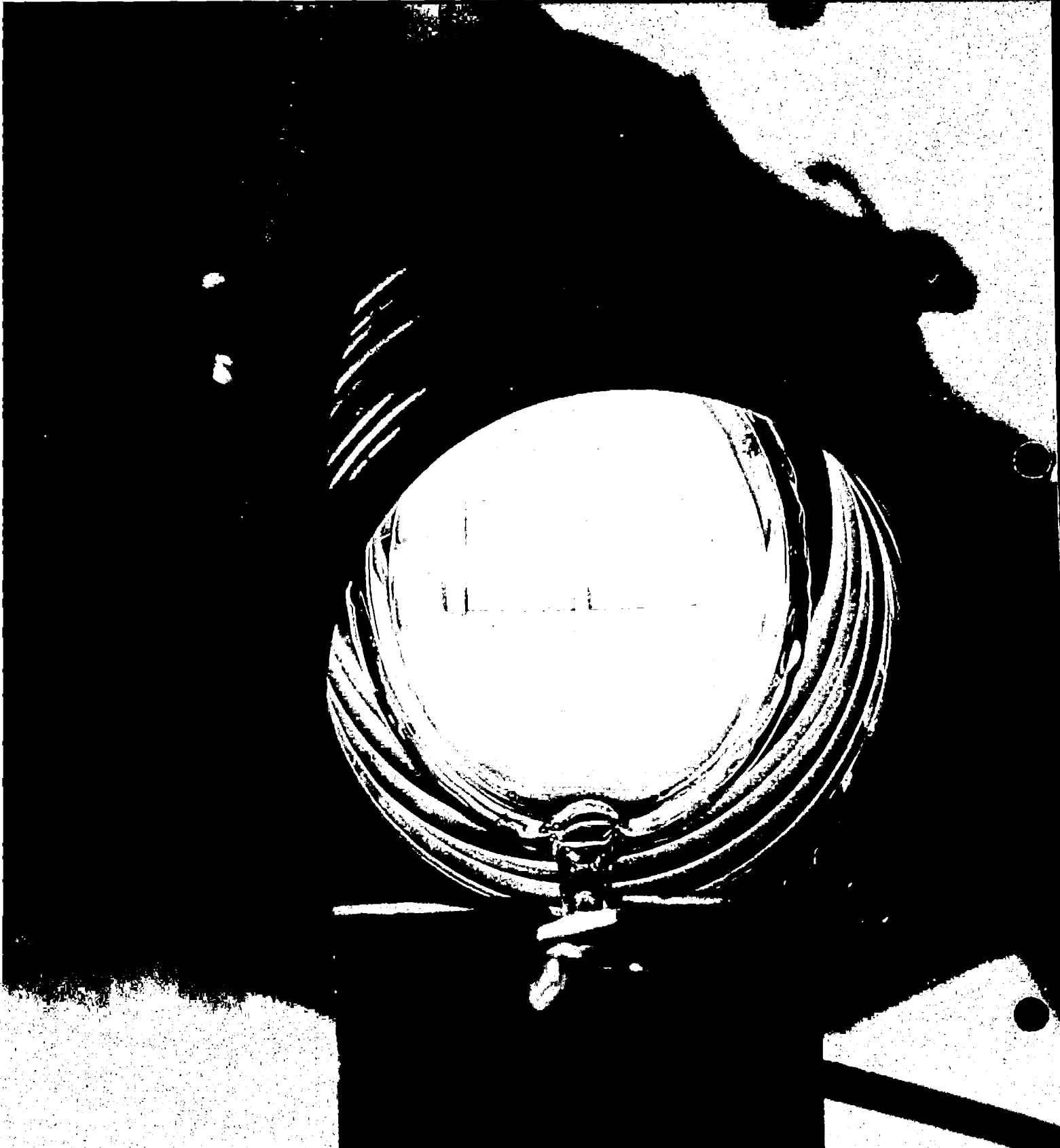
*Virtually everyone is routinely exposed to a variety of potentially harmful chemicals, both indoors and outdoors, but little is known about how much the body's fluids and tissues retain. RTI analytical chemists, survey specialists, and statisticians collaborate in the first national study that uses a statistically sampled population to help unravel relationships between exposure and body burden.*

*For 24-hour periods at sites in California, New Jersey, North Carolina, and North Dakota, study participants have worn special vests fitted with monitoring devices that record personal exposure levels to specific chemicals. The monitors contain cartridges of a polymeric sorbant that traps air contaminants for later analysis in gas chromatography/mass spectrometry facilities at RTI.*



*Metalorganic chemical vapor deposition systems support semiconductor materials research for several RTI clients, including assistance to Duke University in developing a heterojunction bipolar transistor. Two gallium arsenide substrates appear below in an experimental fast response reactor that is being performance tested. Fast reactor response times are*

*required for growing superlattices or other ultra-abrupt structures. Despite maintenance of arsine flow, the abnormally high temperature needed for making this photograph has created a cold-wall deposition that partially obscures the substrates.*



Evaluate problems and potential of ocean thermal energy conversion in the eastern Gulf of Mexico and the East Florida Shelf;  
Assess methodologies for handling oil spills along the southeastern U.S. coast and the West Florida Shelf.

#### **Research Resources**

Satellite receiving station with direct receiving capability for polar orbiting satellite, a direct tap for geostationary satellites, and data enhancement capabilities;  
Access to mainframe computer facilities to manage large digital data bases.

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### **SEMICONDUCTOR RESEARCH**

*Dr. James A. Hutchby, Director*

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Conducts basic and applied research on materials and fabrication technologies used to construct microelectronic devices; develops new designs for microelectronic devices; improves device and material production processes.

#### **Metalorganic Chemical Vapor Deposition**

Develop MO-CVD as a vapor-phase epitaxial process for manufacturing III-V semiconductor devices;  
Grow multiple, thin layers of III-V semiconductors with abrupt composition changes for solar cells, transistors, detectors, and superlattices;  
Identify sources of impurities in MO-CVD III-V epitaxial growth process, and develop methods to improve purity;  
Develop new MO-CVD techniques for chalcopyrite semiconductors.

#### **Microelectronic Devices**

Prototype devices such as solar cells, lasers, and transistors using MO-CVD;  
New III-V devices such as cascade solar cells, heterojunction bipolar transistors, lasers, detectors, FETs, IMPATT diodes, and superlattice structures;  
Theoretical models for advanced III-V devices;  
Advanced solar cell designs in silicon and III-V semiconductor materials.

#### **Semiconductor Materials and Processes**

Plasma-enhanced chemical vapor deposition (PECVD) insulator fabrication technology;  
Insulator technology for passivating III-V devices;

Liquid-phase epitaxy to grow state-of-the-art III-V structures;  
Electron-beam deposition of dielectric and metal layers.

#### **Radiation Hardness**

Design and test microelectronics for radiation hardness required in space, military applications, and nuclear power plants;  
Basic research to characterize interaction of radiation with III-V and silicon microcircuits;  
Formulate standard procedures and oversee radiation testing in the Department of Defense VLSI research program.

#### **Research Facilities**

MO-CVD and liquid-phase epitaxy reactors;  
Photolithographic device fabrication;  
Plasma-enhanced chemical vapor deposition system;  
Electron-beam vacuum deposition systems;  
Facilities for physical, chemical, and electrical characterization and testing of semiconductor materials.

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### **DIGITAL SYSTEMS**

*James B. Clary, Director*

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Designs and develops microelectronic systems, including very large scale integrated (VLSI) circuits and software.  
Develops theoretical concepts, analyzes systems, designs circuitry, and verifies function and reliability.

#### **VLSI Systems and Circuits**

Develop theoretical concepts and test prototypes for fault-tolerant, self-testing, and signal-processing VLSI chips and systems;  
Design NMOS and CMOS integrated circuits;  
Design full custom and standard cell chips.

#### **Fault Tolerance**

Develop theory and technology for fault-tolerant aircraft control systems;  
Help establish a joint NASA/industry/RTI study to integrate fault-tolerant avionics;  
Develop methods to validate reliability in fault-tolerant hardware and software;  
Fault-tolerant systolic array design;  
Develop self-testing VLSI chips and systems;  
Evaluate cost/effectiveness of self-test and self-repair.

***Digital Signal Processing***

Use analytical models and computer simulations to identify and develop signal processing architectures for high throughput radar, sonar, and missile systems;  
 Determine signal processing needs for military and industrial systems, develop and evaluate signal processing approaches for radiation and space environments;  
 Identify electro-optical instrumentation and computer image analysis methods for weapons testing;  
 Analyze adaptive temporal and spatial signal detection and estimation algorithms;  
 Develop computational error models for signal processing algorithms.

***Software Engineering***

Design software for innovative computer architectures;  
 Develop means to assess software reliability;  
 Develop computer-aided design and engineering (CAD/CAE) software for designing digital systems;  
 Integrate CAD/CAE tools into a hierarchical design system;  
 Customize CAD/CAE tools and other software for selected computers;  
 Verify software systems for security.

***Research Facilities Include***

Gould Concept 32/8750 and VAX 11/750 computers;  
 Direct connection to the Microelectronics Center of North Carolina's VAX 11/780, and communications with VAX 11/780s at five MCNC participating universities;  
 Access to prototype chip fabrication facilities;  
 VLSI circuit chip test laboratory;  
 Communications via ARPANET and local networks;  
 Programming skills in Ada, C, Fortran '77, Lisp, and Pascal.

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**SYSTEMS ENGINEERING***Dr. James G. Haidt, Director*

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Research, exploratory development, and engineering to define, design, implement, test, and evaluate electronic systems.

***Aviation Systems***

Advanced cockpit displays;  
 Automated air traffic control;  
 Advanced avionics signal processing;  
 Automated track-while-scan radar.

***Space Systems***

Satellite on-board signal processing;  
 Automatic image classification;  
 Target tracking with staring sensors, radiometry, and scatterometry.

***Underseas Systems***

Multi-array signal processing;  
 Propagation effects modeling.

***Information Systems***

Automated data management;  
 False-color displays;  
 Computer networks.

***Instrumentation Systems***

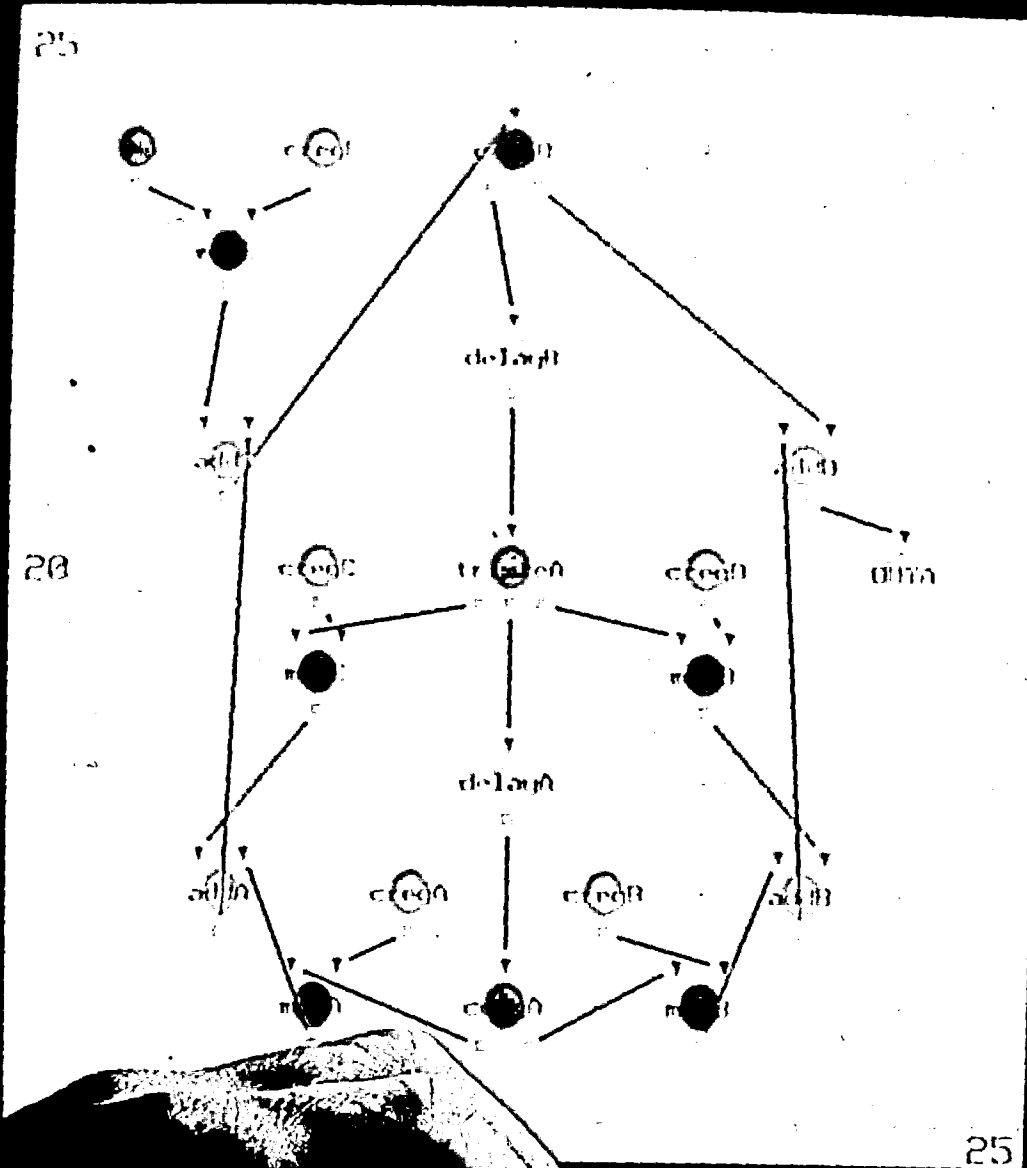
High-speed digital transient recorders;  
 Flight status recorders;  
 Raster-graphic display technology;  
 Airborne air quality monitoring.

***System Development***

Laser/radar tracking system;  
 Automatic pilot advisory system;  
 Stall/spin research facility;  
 Landing guidance facility;  
 Crew station technology laboratory;  
 Information adaptive systems laboratory;  
 Computerized occupational health system.

performance of new computer designs. It incorporates concepts from research conducted at RTI, Duke University, the University of North Carolina at Chapel Hill, and North Carolina State University. The system runs under the UNIX operating system on RTI's Gould Concept 32/8750 computer and was developed, in part, with funding from the Department of Defense.

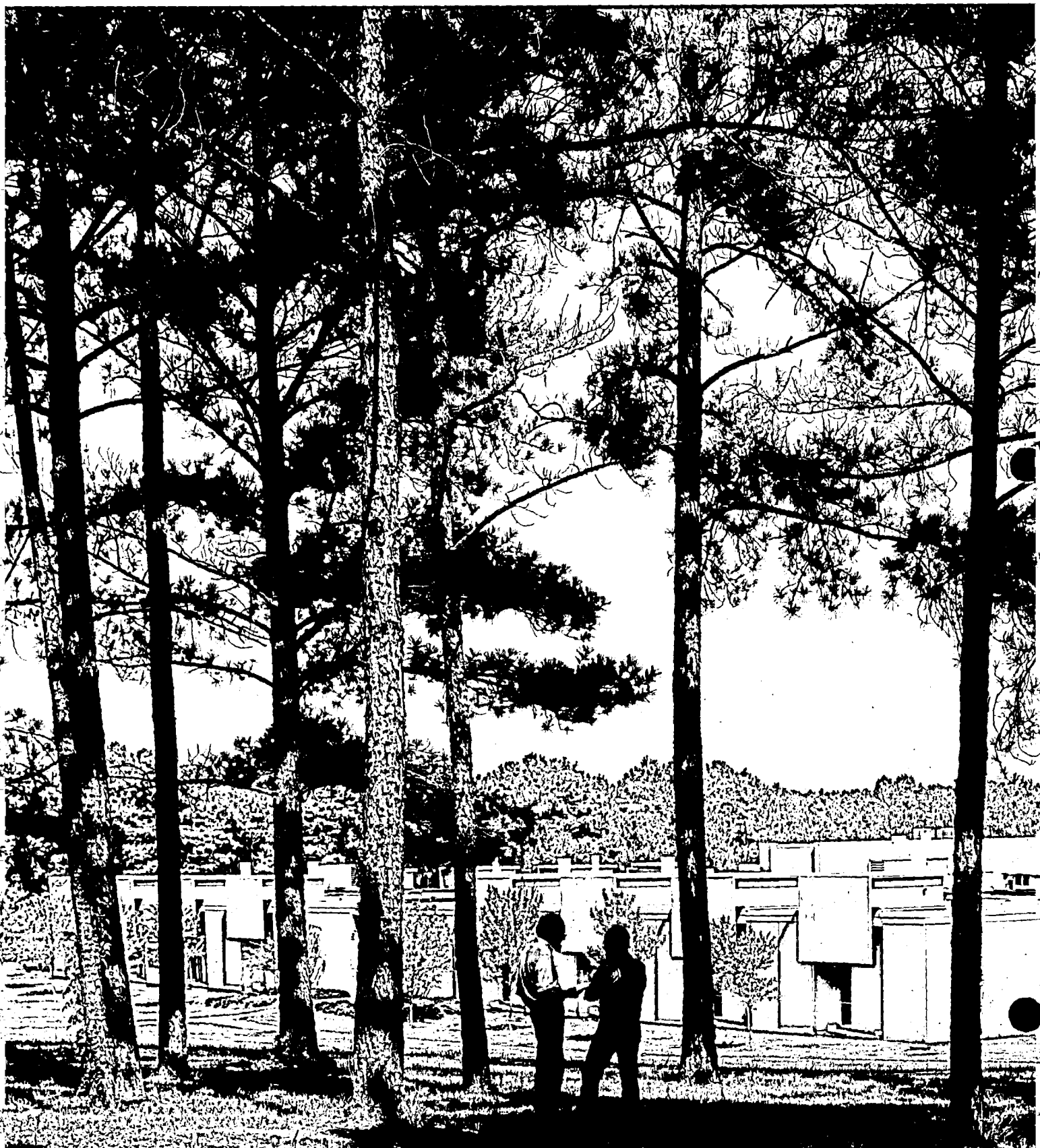
RTI digital systems scientists have developed an interactive graphics system for assessing the



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move  
stats  
add  
reload







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**ENERGY SYSTEMS**

*Dr. Richard A. Whisnant, Manager*

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Assists industry and government to analyze and develop new energy technologies. Conducts modeling, simulation, conceptual design, cost analysis, and engineering economics on fossil and renewable supply technologies, conservation, load management, and innovative energy use and conversion.

***Photovoltaics***

Analyze potential of photovoltaics for electric utilities, and for markets in service, commercial, industrial, and institutional sectors;

Technical assistance to the Kingdom of Morocco's renewable energy center.

***Energy Storage***

Analyze performance and economics of energy storage technologies;

Measure and analyze performance of commercial-scale thermal systems, and evaluate new battery technologies.

***Heat Pumps***

Analyze performance and benefits of heat pumps combined with thermal storage;

Evaluate and analyze dual-fuel heat pumps for load management;

Analyze performance, benefits, and market penetration of advanced heat pump systems in utilities' service areas.

***Fossil-Fired Electric Generation***

Evaluate the potential of a proposed peat-fired power plant;

Evaluate fluidized beds, gasification/combined cycle plants, and wood-fired plants for use by utilities.

***Utility System Planning***

Assist electric utilities to plan, conduct, and review comparative studies of energy supply and demand technologies;

Prepare technical summaries of performance and cost of new technologies.

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**ENGINEERING HANDBOOK OFFICE**

*Lawrence E. Stockett, Director*

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Scientists throughout the country contribute to an Engineering Design Handbook series published by the U.S. Army Materiel Command. The handbooks provide fundamental design information and up-to-date records of advancing technologies. Manuscripts are prepared at industrial and government laboratories, universities, and other scientific organizations. RTI is responsible for handbook editing and administration.

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George Watts Hills  
 Paul M. Gross

**Lifetime Governors.** A special category of nonvoting Lifetime Governor recognizes and honors those retired Board members who have made extraordinary contributions to the progress and welfare of the Institute. RTI Lifetime Governors are:

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 Saluda

Frank A. Daniels, Sr.  
 Raleigh

\*Member, Executive Committee

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*Telephone: 919/541-6000 Cable RESTRINS, Raleigh, NC Telex 802509*