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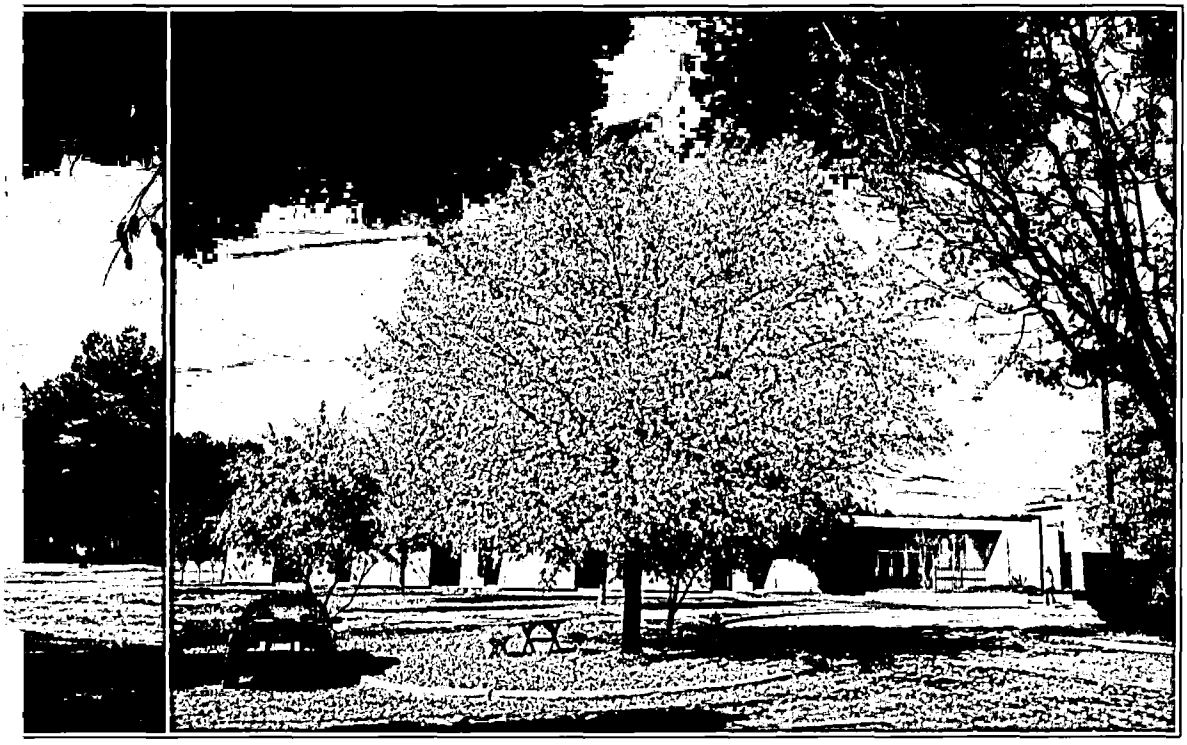
ANNUAL REPORT

RESEARCH TRIANGLE INSTITUTE

Research Triangle Institute's main laboratories and offices are on a 180-acre site in the center of North Carolina's Research Triangle Park. Started at the end of 1958 to be the initial research organization in the Park, RTI now has a staff of more than 1,260 and had revenues of more than $71 million in 1987. Under contract to governmental and industrial clients, RTI conducts applied and fundamental research in many scientific disciplines. Photographs on the cover show some of RTI's largest buildings, and an aerial photo is on the inside back cover.



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ANNUAL REPORT
RESEARCH TRIANGLE INSTITUTE

CONTENTS

PRESIDENT'S DISCUSSION OF 1987

George R. Herbert

Operating Highlights

	Fiscal Year 1987	Fiscal Year 1986	Fiscal Year 1985
Revenue	***$71,105,329***	***$64,036,418***	***$52,186,067***
Direct Research Costs	$42,103,571	$38,274,125	$30,745,851
Other Expenses	$26,560,104	$23,546,195	$19,566,407
Net Revenue	$2,441,654	$2,216,098	$1,873,809
Net Worth	$24,246,403	$21,804,749	$19,581,889

Years ending September 30

While an annual report of operations is heavily weighted with numbers, it would be a mistake to forget that behind those numbers are hundreds of people.

Only people have ideas and conceive novel solutions for tough research problems. Only people put these ideas on paper and test them in the laboratory or model them with computers. In turn, these people are supported by scores of equally important people who print and bind reports, collect data, care for laboratory mice, move furniture into a new building, or maintain older buildings.

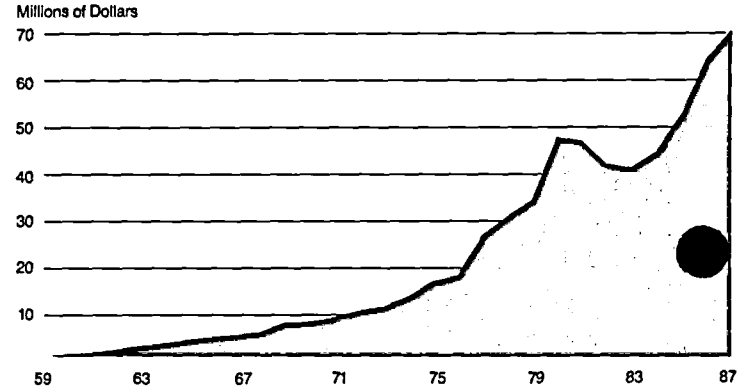
These hardworking people are RTI. The numbers only tally the results of their efforts.

Operating Results

If it can be said that good numbers on the financial statement are a credit to the staff, then I am pleased to call attention to a superb staff tribute: the operating highlights for fiscal year 1987.

At $71.1 million, research revenue again set a record, more than 11 percent above last year's $64 million (graph, below). The project labor portion of revenue increased by nearly 13 percent over last year. Operating expenses rose by 11 percent, yielding an operating income of $2,441,000. Including depreciation, cash generation totalled $5,450,000, an increase of 12.5 percent.

Research Revenue



iversified Client Base

analysis of RTI's client base discloses some changes (pie charts, below). For example, the .S. epartment of Health and Human Services, which includes the National Institutes of ealth, replaced the Environmental Protection Agency as the Institute's largest source of search funds. To a great extent, the growth in DHHS funding is associated with AIDS research NIH. With continued statistical support to this NIH program, and designation of RTI as the inical Trials Coordinating Center for 19 AIDS Treatment Evaluation Units across the U.S., ubstantial growth in AIDS research can be expected (page 16).

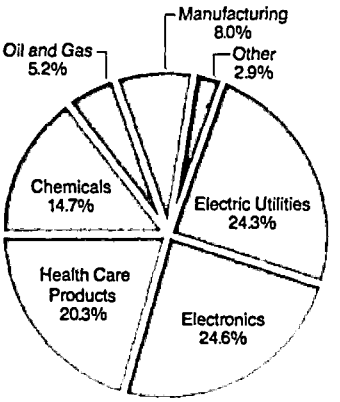
Another significant change is in Department of Defense research, which grew 47 percent. While this growth reflects a variety of programs, much is attributable to a large project to study he effect of family factors on retention and readiness of Army personnel, and to continued owth of defense-related electronics research and development.

rivate-Sector Clients

Research for business and industry reached a record $6.3 million. It is satisfying to report hat this volume is more than two-thirds greater than the level of just two years ago.

Equally encouraging is the diversity of the industrial sectors represented by RTI's clients. pping the list of commercial clients (pie chart, right) are electric utilities and electronics firms, ollowed closely by "health care products" (mainly pharmaceuticals and diagnostics).

Private-Sector Revenue
by Industry



Fiscal Year 1987

ersonnel

During 1987, the regular staff grew from 1,071 to 1,140. Including hourly employees, whose umbers fluctuate with contract requirements, the total staff was 1,260 on September 30, 1987 hart, below). Most of the growth occurred in units involved in AIDS research, in environ- ental sciences and engineering, and in electronics and systems.

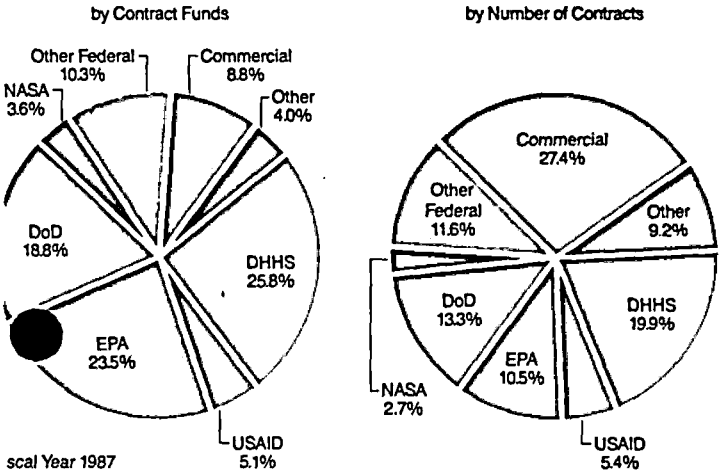
e numbers of staff at locations away from the Research Triangle continue to increase. early 10 percent of project labor in FY 1987 was performed by "off-site" staff.

Activities at Newport News, Virginia, are described within the "Aerospace Technology" opic on page 9. We also have more than 30 people in our Washington, DC, research office, and ve expect our Cocoa Beach, Florida, staff to expand with recent award of a new Department f Transportation project on the safety of commercial space launches.

Overseas locations of resident project staff, mainly for the U.S. Agency for International evelopment and The World Bank, include Nepal, Mali, and the Ivory Coast. In addition, gional survey supervisors and other individual specialists are located across the U.S.

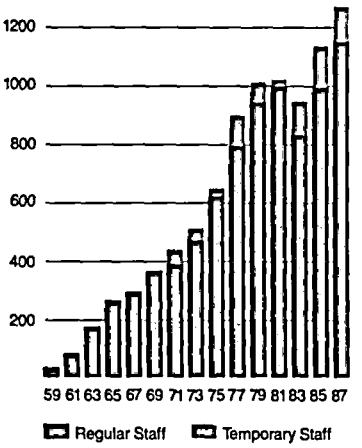
(continued on next page)

ources of Revenue



scal Year 1987

Staff



Facilities

"Facilities" is an all-encompassing word that embraces both the buildings we occupy and the equipment we use.

The most important new facility completed during 1987, the 52,000 square-foot Marcus E. Hobbs Building, is assigned primarily to research staff in the social, economic, policy, and environmental sciences.

An 8,000 square-foot addition to the Animal Research Facility has been completed largely on schedule. More good news is a $468,000 grant from the National Institutes of Health under a program designed to help upgrade animal research facilities (page 23). This grant enables us to add equipment and other items beyond our original $2.7 million budget for enhancement of the facility.

Yet even with this expansion, and with renovations of other laboratory space over the past two years, the need for new laboratories remains clear. We are, therefore, beginning to plan for additional space.

Future Years

Expectations for 1988 are based on the trends shown in the accompanying charts, on a record-setting backlog of new business already acquired, and on an innovative, resourceful and energetic staff.

The challenge to all of us (and it is a challenge to which the staff regularly responds with admirable success) is to plan, conduct, and manage research programs amid continued growth, while maintaining the quality of performance for which RTI is known.

Facilities completed in 1987 include the 52,000 square-foot Marcus E. Hobbs Building.

"Reputation"

Many factors contribute to the success that Research Triangle Institute enjoys, including a committed, extraordinarily hardworking staff, first-class facilities, and the benefits of collaboration with our parent universities.

The most important single factor, however, can be identified with one word: "Reputation." There are several fine research institutes older and larger than RTI, but none surpasses RTI's reputation for professionalism, objectivity, and the highest standards of performance and ethics.

Whenever I reminisce about RTI's early years, I am reminded that the then-new and untested RTI had two distinct advantages. First, it was identified with three major universities. Second, we recruited an initial cadre of individuals who, being recognized nationally and internationally in their respective disciplines, brought their own reputations to a new organization that had not yet started to build the institutional reputation we enjoy today.

While it would be impractical to list them all, some left legacies particularly important to the subsequent path and character of RTI. These are a few of those whom I consider RTI's trail-blazing pioneers.

Pioneers

Topping the list must be Gertrude Cox, who was recognized as the world's "First Lady" of statistics when she retired early from N.C. State University to create a Statistics Research Division as RTI's first research unit in 1959.

Soon thereafter Dr. Monroe Wall, who still is with RTI as a chief scientist, left the U.S. Department of Agriculture to establish a Natural Products Laboratory, and then build a diversified program in life sciences and chemistry.

In 1962, Dr. Anton Peterlin, from Yugoslavia via Munich, and Dr. Vivian Stannett, from Syracuse, brought their international reputations in polymer research to the new Camille Dreyfus Laboratory.

We also acknowledge the late Bill Eckerman's pioneering studies of alcohol and drug abuse among military personnel.

Semiconductor Research

I enjoy claiming credit for the initiation of semiconductor research in North Carolina. Not when I had the task of forming the highly visible Microelectronics Center of North Carolina, but rather in 1962, when I had the good fortune to recruit Dr. Robert Burger to RTI.

He built an exciting assemblage of young engineers and physicists in RTI's Solid State Laboratory. North Carolina still benefits from this team, as some of its members remain in the Institute's semiconductor research program (page 13), and some are in other research organizations. For example, Dr. Larry Monteith is now Dean of the School of Engineering at N.C. State University, and Dr. Burger himself is scientific vice president of the Semiconductor Research Corporation in the Research Triangle Park.

Impact

RTI's pioneers demanded much of themselves and built groups of young researchers who understood the importance of maintaining high standards of professional performance. The impact of these pioneers is like that of stones thrown into calm waters, sending out circles of waves that still touch the Institute and influence even newer staff members who never had the opportunity to know them.

It is for this reason that I have every confidence that RTI's future leadership and those who will pursue the inevitably exciting research targets of the 1990s will preserve and enhance that most important asset called "Reputation."

–George R. Herbert

EXECUTIVE VICE-PRESIDENT'S STATEMENT

Daniel G. Horvitz

As the research summaries in this annual report show, RTI's staff members represent many different scientific specialties, and the Institute makes substantial investments to further their professional development.

We are fortunate to work in an environment that fosters interdisciplinary teaming to address complex research issues. Our highly diverse staff is dedicated to team-based research, and our most exciting projects are those that involve a multiplicity of disciplines. RTI helps maintain this environment with policies for staff development through substantive research experience, continued education, and professional activities.

The demands of contract research provide widely varying experience for our staff members. Professionals not only must participate in forming teams and proposing research projects, but also must manage projects which include personnel from several different organizational units.

RTI's relationship with the universities of the Research Triangle also affords unique opportunities for professional development. Senior researchers often interact with university faculty through adjunct professorships, special teaching assignments, and collaborative research efforts. In addition, staff members at all levels take advantage of RTI's liberal policy for continuing education.

In 1987, members of our staff demonstrated their scientific professionalism by presenting or publishing more than 220 papers, organizing more than 20 sessions at professional meetings, taking more than 25 roles of leadership in regional and national organizations, and earning at least 15 professional honors and awards. In addition, five individuals won RTI Professional Development Awards, bringing the total number so honored since 1977 to 52.

The research environment and the professionalism of the staff help to build RTI's reputation, and are reflected in long-term programs for clients such as the National Institutes of Health, NASA, the U.S. Agency for International Development, EPA, the Department of Defense, and many private-sector enterprises.

RTI is resolved to continue its commitment to good science by further strengthening of staff and facilities. With this commitment, we can look forward to enhancing our relationships with current clients, and to beginning new relationships in government, business, and industry.

–Daniel G. Horvitz

Research Organizat

Daniel G. Horvitz
Executive Vice-Pres

James N. Brown, Jr.
Vice-President
Technology Develop

James R. Chromy
Vice-President
Survey and Computing Sciences

C. Edgar Cook
Vice-President
Chemistry and Life Sciences

Alvin M. Cruze
Vice-President
Economic and Social Systems

Ronald W. Johnson
Vice-President
Public Policy and International Devel

Forest O. Mixon
Vice-President
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Edo D. Pellizzari
Vice-President
Analytical and Chemical Sciences

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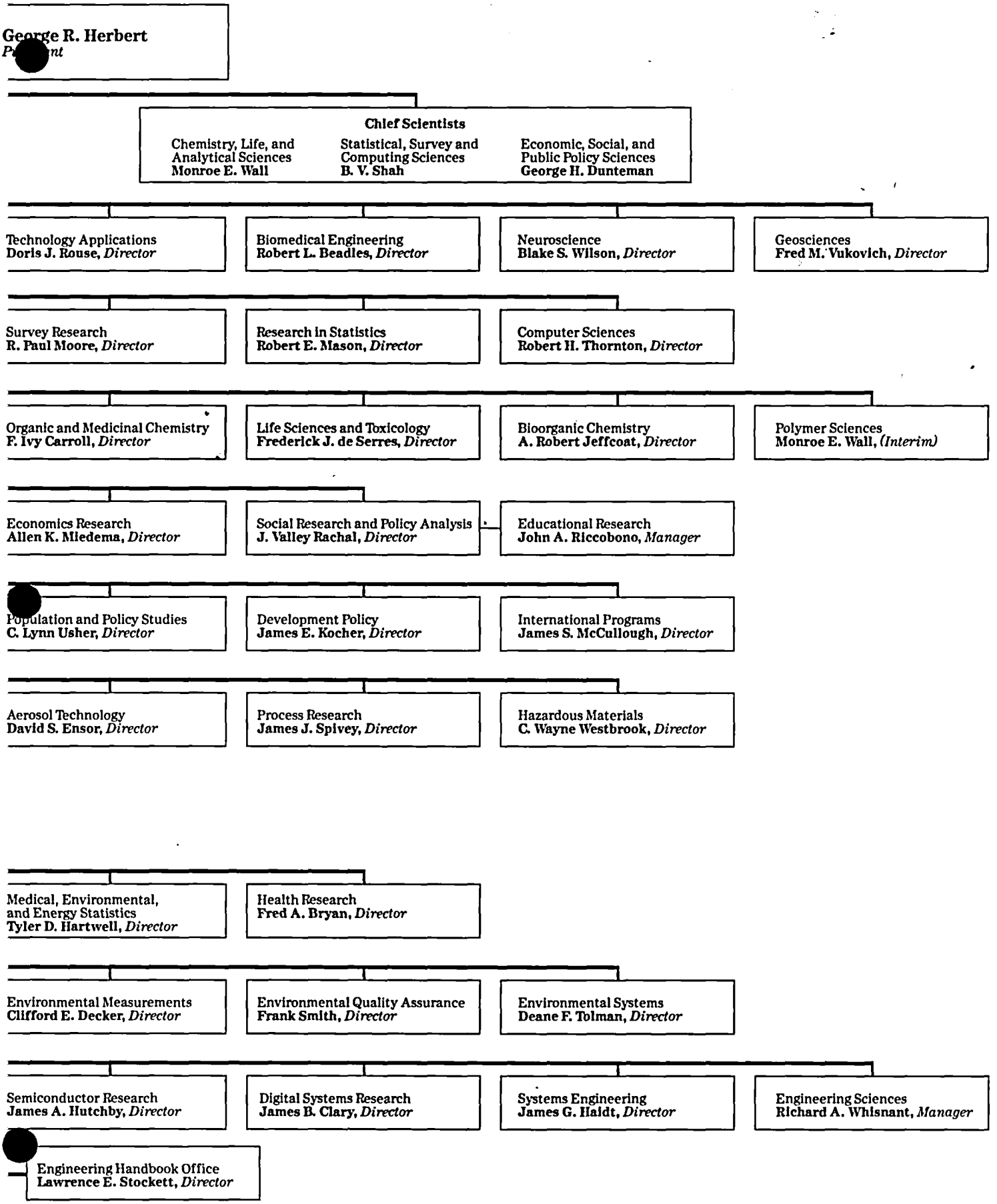
Vice-President
Statistical Methodology and Analysis

James B. Tommerdahl
Vice-President
Environmental Sciences and Engineering

F. Thomas Wooten
Vice-President
Electronics and Systems


George R. Herbert
Chief Scientists
Chemistry, Life, and Analytical Sciences
Monroe E. Wall
Statistical, Survey and Computing Sciences
B. V. Shah
Economic, Social, and Public Policy Sciences
George H. Dunteman
Technology Applications
Doris J. Rouse, Director
Biomedical Engineering
Robert L. Beadles, Director
Neuroscience
Blake S. Wilson, Director
Geosciences
Fred M. Vukovich, Director
Survey Research
R. Paul Moore, Director
Research in Statistics
Robert E. Mason, Director
Computer Sciences
Robert H. Thornton, Director
Organic and Medicinal Chemistry
F. Ivy Carroll, Director
Life Sciences and Toxicology
Frederick J. de Serres, Director
Bioorganic Chemistry
A. Robert Jeffcoat, Director
Polymer Sciences
Monroe E. Wall, (Interim)
Economics Research
Allen K. Miedema, Director
Social Research and Policy Analysis
J. Valley Rachal, Director
Educational Research
John A. Riccobono, Manager
Population and Policy Studies
C. Lynn Usher, Director
Development Policy
James E. Kocher, Director
International Programs
James S. McCullough, Director
Aerosol Technology
David S. Ensor, Director
Process Research
James J. Spivey, Director
Hazardous Materials
C. Wayne Westbrook, Director
Medical, Environmental, and Energy Statistics
Tyler D. Hartwell, Director
Health Research
Fred A. Bryan, Director
Environmental Measurements
Clifford E. Decker, Director
Environmental Quality Assurance
Frank Smith, Director
Environmental Systems
Deane F. Tolman, Director
Semiconductor Research
James A. Hutchby, Director
Digital Systems Research
James B. Clary, Director
Systems Engineering
James G. Haldt, Director
Engineering Sciences
Richard A. Whisnant, Manager
Engineering Handbook Office
Lawrence E. Stockett, Director

RESEARCH AND DEVELOPMENT

RTI research for government, business, and industry is inseparable from real-world contexts and human concerns.

In helping to meet the problem-solving, planning, and product development goals of their clients, Institute managers combine the talents and experience of RTI's staff members, thereby using professional capabilities that cut across organizational lines. As a result, most RTI programs are multidisciplinary both in purpose and execution.

The following summaries report on several of the diverse and challenging research programs that exemplify our Institute-wide commitment to attaining public and private enterprise objectives. This report also stresses the collaborative links that join RTI, its founding universities, and other Research Triangle organizations into a unique scientific community.

RTI works in research facilities at NASA's Langley Research Center. Shown here is equipment for the Advanced Flight Experiment planned for a Space Shuttle mission. RTI is developing a millimeter wave radar-like instrument to take measurements of the ionized plasma that forms when a spacecraft reenters the atmosphere. The plasma's shape, temperature, and chemical composition affect the control and durability of vehicles such as a future spacecraft that will use the atmosphere for maneuvering. RTI engineers are also developing new instrumentation to test experimental antennas and a simulator to evaluate new air traffic control systems.

Aerospace Technology

Major aerospace projects in 1987 involved cockpit displays, ault-tolerant avionics, analysis f satellite data, safety of rocket aunches, antenna research, and easuring reentry plasmas. In ddition, a new program started n 1987 to develop on-board eather radar to detect hazardous windshear.

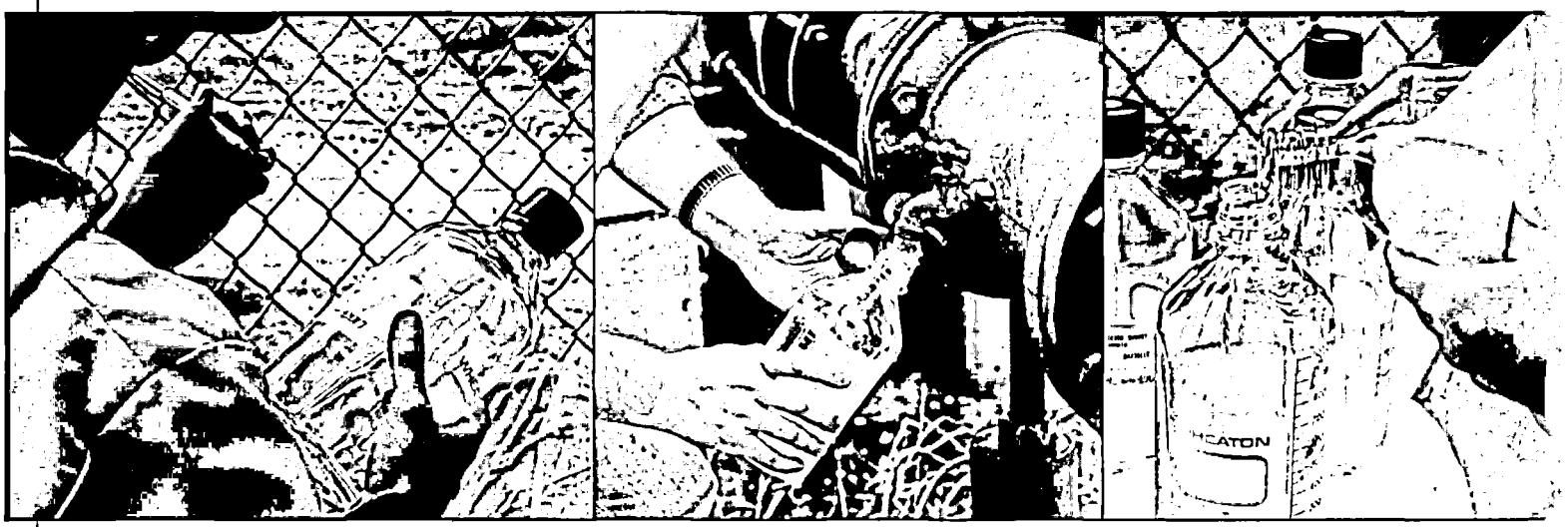
Real-time simulation and computer graphics for pplications such as cockpit displays have been the subject of research sponsored by NASA [redacted]he Air Force. In 1987, RTI [redacted]leted development of software called the Interactive Graphics Editor, which cuts the time required to design and implement a new display from several weeks to a single day. The year also saw substantial progress on three-dimensional CRT displays that have potential value for aerospace applications.

Fault tolerance has been an important topic of NASA-sponsored RTI research for more than a decade. Of particular interest is ongoing work to develop methods to design and verify highly reliable software for life-critical applications such as computers on commercial airliners. For example, RTI has developed experimental protocols to verify software and is designing combined hardware and software experiments.

RTI applies its experience in methods development to process satellite data for a variety of specific meteorological and oceanographic problems. Recent work includes studying how ground temperature and albedo distributions relate to urban climates, demonstrating the application of the Nimbus-7 Coastal Zone Color Scanner to locating schools of fish, detecting the extent of desertification in North Africa, and conducting studies related to synoptic-scale weather systems.

Analysis of fragments from rocket explosions is leading to an improved model of the damage that could be caused by an explosion near a launch pad. In addition, engineers at RTI's Florida office are working with the U.S. Department of Transportation to formulate safety policies for commercial space launches and have completed a procedures manual for the Eastern Space and Missile Center, which is one of the Air Force organizations responsible for launch safety.

Because of its success in applying statistical and hydrogeological methods to designing an EPA-sponsored survey of well-water quality, RTI has begun a similar study f[or] an agricultural chemicals company. The EPA work began with a national assessment of groundwater resources' vulnerability to pesticides. RTI uses a Geographic Information System (GIS) to produce detailed maps that combine vulnerability data with census data (example from the EPA study shown below). RTI's statisticians are using these data, plus information on



New Technology

RTI transfers knowledge from government-sponsored research to the private sector in three important ways: the NASA technology transfer program, licensing of patents, and R&D based on experience gained through government-funded projects.

Technology Transfer: NASA

For more than 20 years, the Technology Applications Team at RTI has helped NASA fulfill its mandate to transfer space technology to private-sector uses. 1987 saw important progress on a device that tracks memory-impaired persons, helping protect them from dangers involved in wandering away from a home or care center. RTI assisted in planning a demonstration of NASA-developed, high-efficiency Stirling engines in courier vehicles such as step vans. RTI/NASA efforts led to flight testing of a helicopter photographic platform for use in law enforcement, search and rescue, and moviemaking. RTI also coordinated workshops to commercialize NASA results in fields such as telerobotics and flow cytometry.

Licensing: Health Care

In 1987, RTI licensed a patented biodegradable polymer system for sustained-release delivery of selected hormonal drugs. The delivery system's first application with contraceptive agents was funded by the National Institutes of Health and entered Phase Two clinical trials last year. The system also can be licensed for other hormonal drugs.

Other licensing opportunities include antiprogestational steroids and an electrochemical biosensor for chemical analysis. R&D continues for a medical diagnostics company on an antibody-based test for marijuana, and an electronics firm is funding a new project to develop a commercial version of a wearable cardiac monitor invented at RTI.

R&D: Electronic Systems

R&D on software tools for computer-aided engineering of electronic systems began at RTI in 1980 with the Department of Defense's Very High Speed Integrated Circuits (VHSIC) program. Since then, government, industry, and RTI have invested more than $10 million in the Architecture Design and Assessment System, called ADAS.

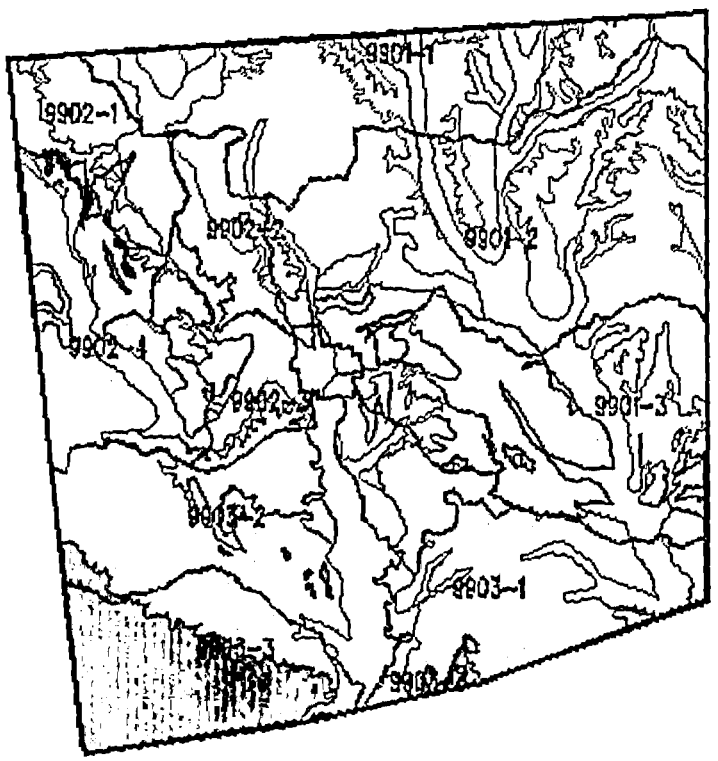
In response to industry and government requests, RTI began marketing ADAS to the electronics industry 3 years ago. For designing advanced electronic systems, more than 40 laboratories use ADAS, including TRW, Honeywell, Raytheon, RCA, the Naval Surface Weapons Center, Air Force/Wright Aeronautical Laboratories, and the Army Electronic Technology and Devices Laboratory.

More than a set of tools, ADAS is a new approach to designing highly complex electronic systems. It allows engineers to design hardware and software concurrently and to verify system performance throughout the design process.

By making ADAS available to industry, RTI also has reached new markets for other Institute R&D capabilities. In addition, RTI is able to improve the ADAS product by working closely with electronics companies to develop enhancements in response to their specific needs.

This program builds on nearly a decade of RTI experience, including funding by DOD to develop design tools, work for NASA on fault-tolerant technologies, software engineering sponsored by the EPA, research for both government and industry to design electronic syste[ms] and development of built-in-test concepts for DOD and industry clients.

pesticide usage, to plan cost-effective surveys of drinking water wells. For EPA, RTI is conducting the pilot phase of a na[illegible]al survey. For the private-sector client, RTI is surveying well-water quality in areas where the company's products are used. Shown here are RTI representatives collecting the large set of water samples that were required to develop chemistry methods and quality assurance procedures for the EPA pilot study.



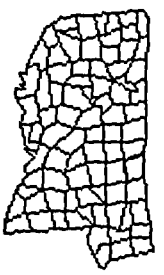
Clarke County, Mississippi

Hydrogeologic Setting:

- ☐ Unconsol./Semiconsolidated Shallow Surficial Aquifer 1 (10Ab1, Score = 100)
- ☐ Unconsol./Semiconsolidated Shallow Surficial Aquifer 2 (10Ab2, Score = 124)
- ☐ Unconsol./Semiconsolidated Shallow Surficial Aquifer 3 (10Ab3, Score = 129)
- ☐ Unconsol./Semiconsolidated Shallow Surficial Aquifer 4 (10Ab4, Score = 111)
- ☐ Unconsol./Semiconsolidated Shallow Surficial Aquifer 5 (10Ab5, Score = 127)
- ☐ River Alluvium Without Overbank Deposits (10Bb, Score = 184)
- ☐ Confined Regional Aquifers (10Aa, Score = 75)

Average Scores:

9901-1	132
9901-2	125
9901-3	117
9902-1	125
9902-2	134
9902-3	136
9902-4	114
9903-1	103
9903-2	109
9903-3	117



RTI has two enclosures for clean-room experiments. The smaller chamber, shown here, is used to measure particulate emissions from personnel and equipment. The larger chamber simulates a working clean-room environment. In addition, RTI conducts experiments in the clean room at the Microelectronics Center of North Carolina.

Clean-room Research

In an industry-funded cooperative program, RTI is exploring factors that affect the presence of particles in clean rooms, that influence particle deposition on wafer surfaces, and that improve the removal of particles from wafers.

Recent experiments in an electronics clean room have detected so-far-unpredictable bursts of particles in concentrations exceeding the room's nominal air-quality rating.

Further research is under way to identify the sources of these particle bursts and to minimize their effect on clean rooms.

RTI has research projects to:

- define limits of current particulate control practices and develop new particle control technology for submicrometer semiconductor processing
- identify and address factors affecting particle concentrations in feedstock cylinder gases
- develop instrumentation and measure particle deposition velocity both in a laboratory deposition chamber and in a full-scale clean room
- document and interpret short-term particle bursts in a state-of-the-art clean room
- test HEPA filter materials
- present a short course on particle control in semiconductor manufacturing.

Semiconductor Processing

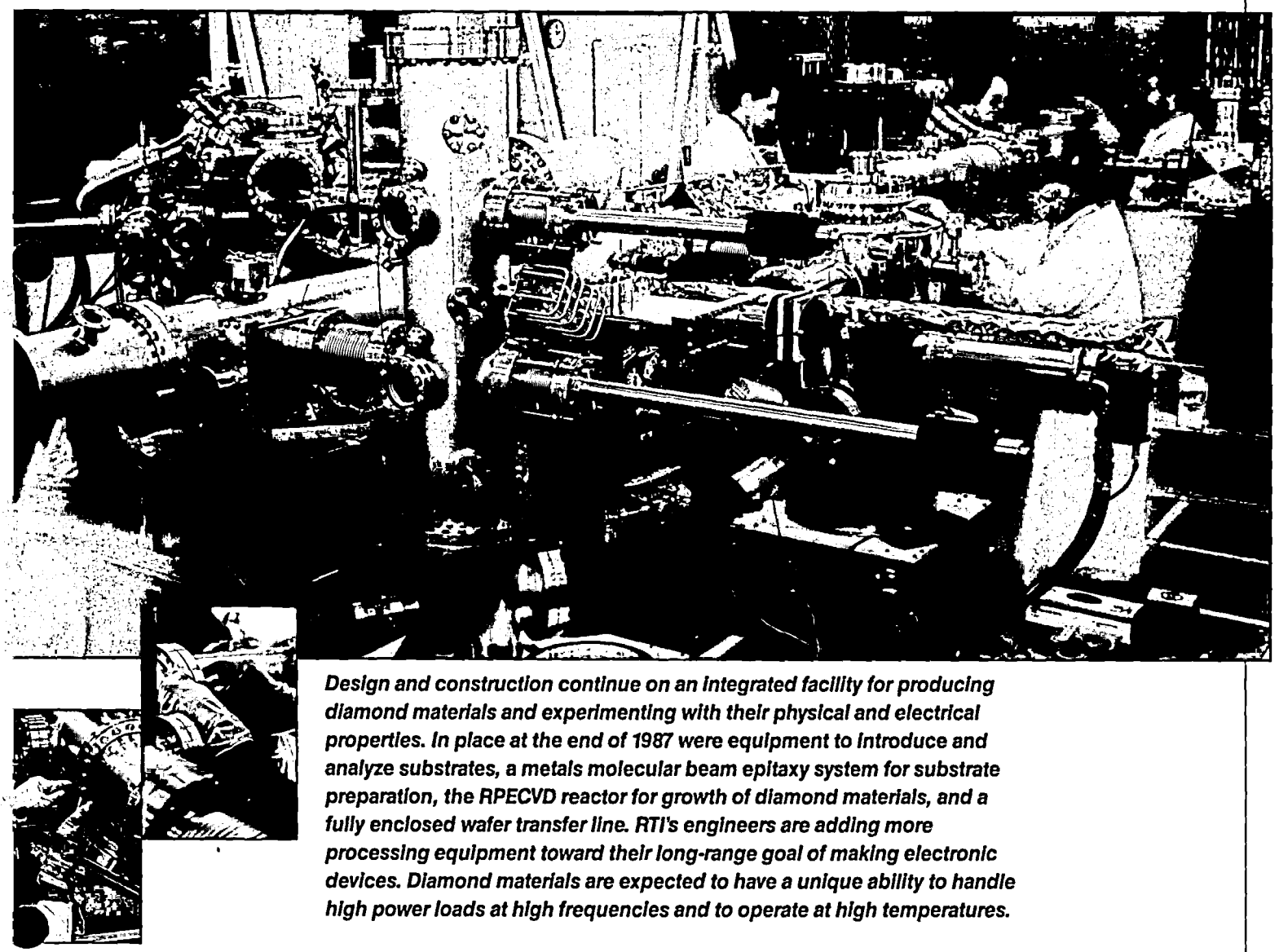
RTI engineers are developing organometallic vapor phase epitaxy (OMVPE) for producing III-V semiconductor materials and devices, and they are developing remote plasma-enhanced chemical vapor deposition (RPECVD) for processing diamond, silicon, and germanium.

Using OMVPE reactors developed and built at RTI, engineers continue to improve the electrical, optical, and physical properties of materials the process can produce. The process must meet the parameters required for devices RTI is developing with III-V materials, including heterojunction bipolar transistors, cascade solar cells, and superlattice structures for electronic and optoelectronic applications.

The OMVPE program's near-term growth will focus on exploring novel OMVPE technologies and developing reactors that provide the uniformity, reproducibility, and throughput required for commercial operation.

During 1987, RTI completed the design and construction of its third RPECVD reactor and used it to demonstrate epitaxial growth of single-crystal diamond material. The Institute's first RPECVD reactor remains dedicated to a joint program with the N.C. State University Department of Physics on low-temperature processing of silicon dielectrics. In addition, scientists at RTI have further developed RPECVD for epitaxial growth of silicon and germanium.

Another significant addition to RTI's semiconductor facility was the joint acquisition, with Duke University, of an ion implanter. Although the machine is operated by RTI, it will play an important part in each institution's research programs on both III-V and silicon semiconductors.



Design and construction continue on an integrated facility for producing diamond materials and experimenting with their physical and electrical properties. In place at the end of 1987 were equipment to introduce and analyze substrates, a metals molecular beam epitaxy system for substrate preparation, the RPECVD reactor for growth of diamond materials, and a fully enclosed wafer transfer line. RTI's engineers are adding more processing equipment toward their long-range goal of making electronic devices. Diamond materials are expected to have a unique ability to handle high power loads at high frequencies and to operate at high temperatures.

Speech Processors

Speech processor R&D has continued at RTI for 15 years with funding from sources such as the National Institutes of Health, NASA, the Veterans Administration, and private-sector sponsors.

Two important inventions for the deaf are beginning to reach the public: the Autocuer and the Cochlear Implant.

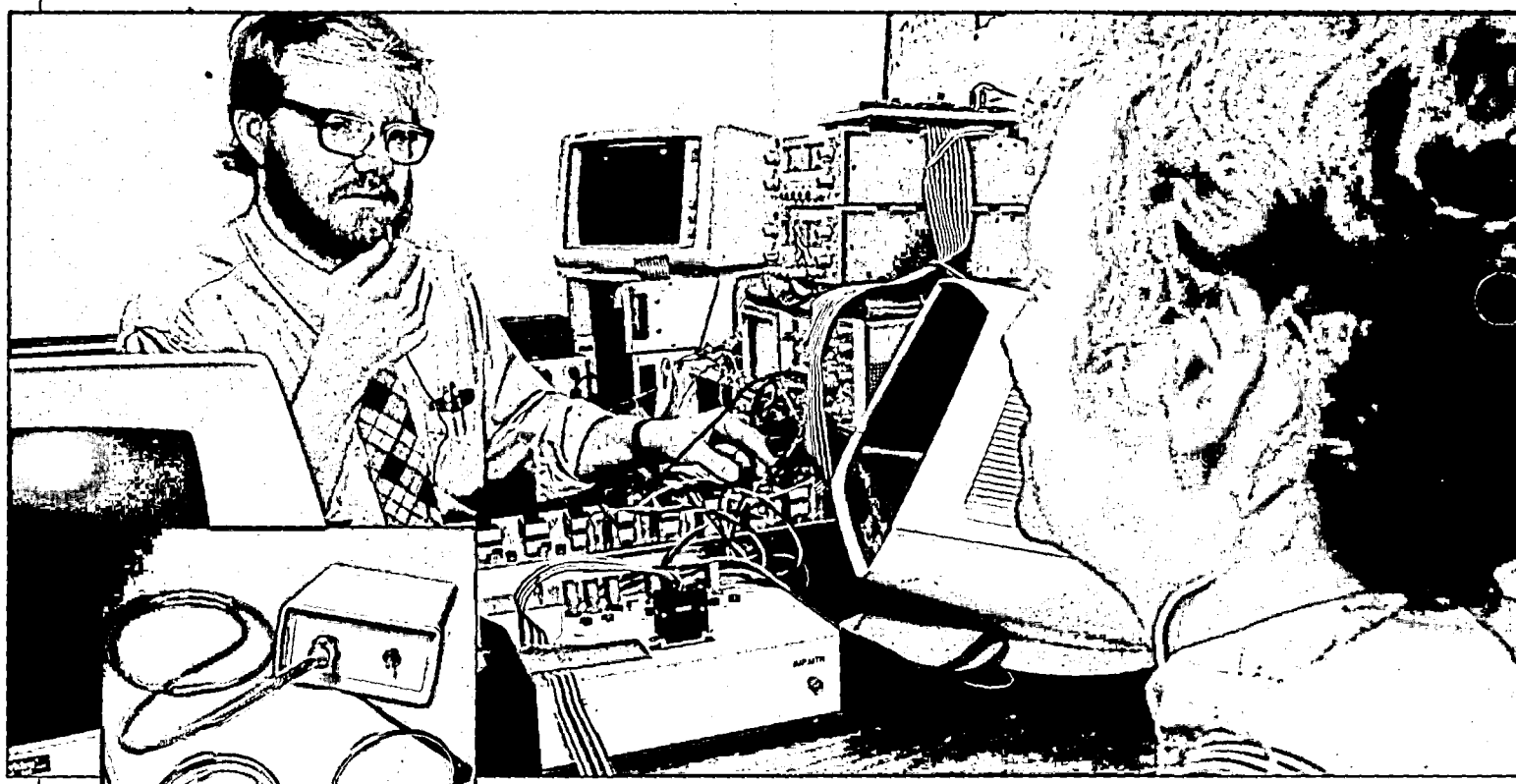
The Autocuer, jointly invented by RTI and Gallaudet University, took an important step in 1987 when Power International, Inc., acquired licensing rights and funded RTI's engineers to redesign the laboratory prototype. Field tests continue in 1988, with the design of a commercial product planned for the following year. The Autocuer processes speech and provides the deaf person with visual cues to supplement lipreading (see photo).

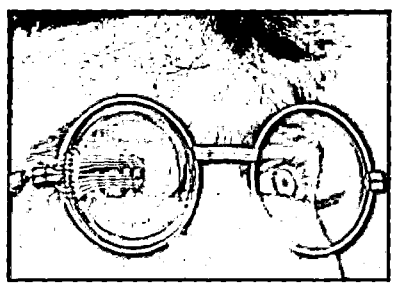
Cochlear implants use electrodes to stimulate the auditory nerves of deaf people, partially restoring hearing. RTI has developed speech processing strategies that improve the performance of implants. Surgical tests carried out at Duke University demonstrate that matching the processor to each patient's neural condition dramatically improves an individual's ability to understand speech.

In 1988, the Duke-RTI Center for the Severely Hearing Impaired will explore more processing strategies, define criteria for choosing the best processor for each patient, and expand basic studies on the neurophysiology of hearing.

RTI develops speech processors for an implanted electrode array developed by the University of California at San Francisco. Duke University medical specialists research and treat hearing impairments. An engineer at N.C. State University actively consults on the program.

Among other inventions emerging from RTI's research are hearing aids that process speech, full-speech recognition by automated acoustic and visual processing, and a concept for telephone communications by the deaf.





In a jointly managed laboratory at Duke University, RTI staff evaluate the Cochlear Implant's performance in patients treated by Duke specialists. Lipreading provides about half of the information needed to understand speech. Both the Cochlear Implant and the Autocuer provide the rest. For a significant minority of deaf people, implants can be effective. For others, the Autocuer (inset) interprets speech into visual "cues" that are electronically displayed as virtual images on an eyeglass lens. Gallaudet University developed these cues as a simple set of hand signals for communicating with deaf students.

RTI staff members collaborate with government professionals in developing countries to improve capabilities for effective economic and human development programs. RTI provides training and advanced microcomputer models to help optimize government management in these countries. Such training and computer modeling result from larger efforts in which RTI staff go to developing countries to help analyze development issues and to implement appropriate technical assistance programs.

ernational Development

More than 50 RTI staff members, with a combined working knowledge of 39 languages, are engaged in research and technical assistance in developing countries. Much of the work is in six categories: improving local government, improving education, developing women's roles in economic growth, optimizing allocation of resources, enhancing agricultural production, and improving water supply and sanitation.

As developing countries move toward decentralization, RTI provides technical assistance to strengthen local governments. RTI identifies the most successful government practices within a country and builds on them as models. The largest 1987 effort, financial training in Nepal, helped enhance local revenues and control administrative costs.

RTI and Harvard University developing methods to enable education agencies to improve the planning, monitoring, and evaluation of national education systems. RTI's System for Tracking Educational Progress (STEP) is a microcomputer package for evaluating school-age populations, enrollments, repeaters, dropouts, and graduates. STEP also assists with needs assessment and cost analysis for teachers, facilities, and equipment. Five Central American countries are using STEP, and RTI is helping the Egyptian government implement it.

Working with the U.S. Agency for International Development's (USAID) Office of Women in Development, RTI studies how women can best contribute to their nations' growth. RTI makes simulation models and prepares presentations for high-level policymakers.

To allocate resources for population growth and development, RTI collaborates with policymakers and planners from more than 50 countries. This collaboration produces economic, demographic, policy, and planning models under the Integrated Population and Development Planning project and the Resources for the Awareness of Population Impacts on Development project, both funded by USAID.

These models help policymakers optimize the allocation of their countries' resources for family planning, health care, education, employment, food and agriculture, and other human resource programs. To facilitate development and use of these and other models, RTI staff created *Host*, a versatile microcomputer system for all types of modeling.

Agricultural economists from RTI work with developing countries to improve farm productivity and food supply and distribution. The most important 1987 effort was with Mali's Institute for Rural Economy to identify, field test, and promote improved farming practices.

To improve water supply and sanitation, RTI has three tasks: to increase community involvement in clean water projects through health education and by integrating project goals with regional cultures; to offer training for financial management of water and sanitation facilities; and to train rural residents and urban managers to operate and maintain physical facilities such as wells and pumps.

Survey research on issues such as health, education, and the environment depends on collaboration among RTI's survey specialists, computer programmers, statisticians, and social scientists. These professionals build on the Institute's 29-year history of statistical research by adapting innovative cost-effective methodologies. For example, RTI integrates data management and analysis with enhanced data collection methods such as computer-assisted telephone interviewing (CATI), computer-assisted personal interviewing (CAPI), and direct data entry (DDE).

The photos show (left to right) planning a mail survey of hazardous waste management, supervisory quality control on a CATI survey on military recruiting, CAPI from a household survey on toxic exposures, and DDE from a hospital in the AIDS clinical trials.

Efficient Delivery of Services

RTI social scientists and statisticians collaborate to develop recommended policies for cost-effective delivery of services. Current work emphasizes electric utilities, government services, human services, education, and environmental protection.

Electric utilities have a strong interest in strategic planning to integrate demand-side programs, such as load management, and alternative energy sources, such as cogeneration, with conventional electric systems. RTI analyzes such technologies and programs for utilities and recommends preferred options. In 1987, utilities engaged RTI to study the value of conservation and load management; the persistence of energy savings from programs for commercial customers; responses to incentive-based conservation programs; methods to determine end-use load shapes; innovative rates for industrial customers; and new business opportunities for utility companies.

Effective government services have been the subject of policy analysis at RTI for more than a decade. Examples from 1987 include:

- RTI began an evaluation of how law enforcement authorities respond to reports of missing children
- In collaboration with other organizations, RTI applied sophisticated survey methods to help the State of Nevada objectively assess economic impacts of a proposed radioactive waste repository
- Also for state government, RTI projected the effects of economic development on groundwater resources in the Southwest.

Government policymakers call on RTI to determine cost-effective strategies for human services such as drug abuse treatment, health care, and public assistance. RTI is designing procedures to identify people likely to become long-term dependents on food stamps, and to provide them with special education and training. For the Army Research Institute, RTI researches policies for enhancing personnel retention and readiness through human services to military families.

In addition, RTI helps local and state agencies. 1987 clients included the United Way of Wake County (NC) and the General Assembly of Connecticut.

Both survey research and case studies support education policy analysis. RTI has a new project to compare categorical versus noncategorical approaches for educating handicapped children and to recommend optimum policies for state and local governments. For the National Science Foundation, RTI completed recommendations on policies for education in science and mathematics. And for state and local governments, RTI completed projects on the efficient operation of vocational education, management of local school systems, and community college curricula.

To choose among technical options for reducing discharges into the environment, EPA's policymakers consider each option's effectiveness and costs. RTI prepares microeconomic models of the affected markets and estimates how they will adjust to each option. Environmental specialists at RTI combine these results with other analyses such as risk assessment (page 21) to provide policymakers with models that summarize the overall impact of regulatory options.

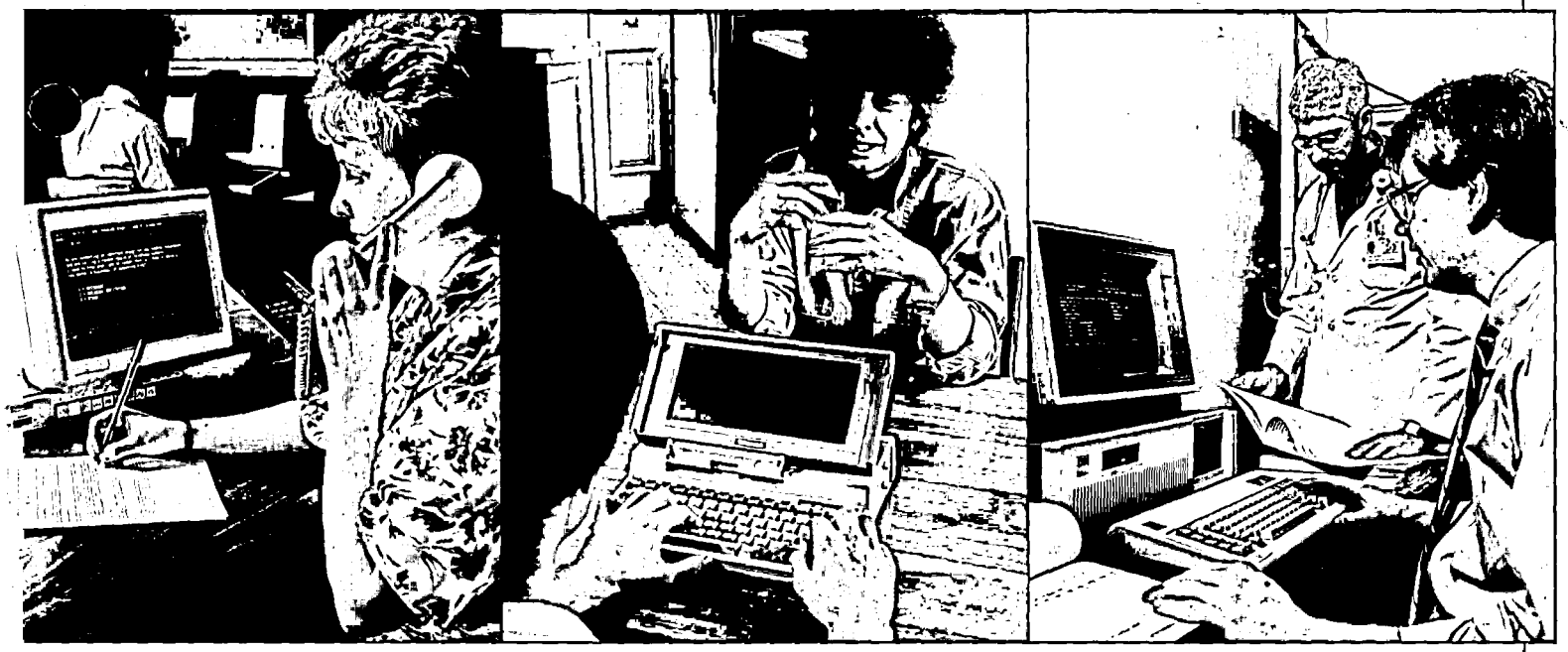
RTI economists and environmental scientists are collaborating to develop a model of the nation's facilities for managing hazardous wastes. RTI will evaluate technically feasible options for controlling emissions from these facilities. RTI also collected and analyzed data to determine how homeowners respond to information about controlling radon in households. In a new project with the Food and Drug Administration, RTI economists assess costs and benefits of food and cosmetics safety standards.

AIDS

Some scientists estimate that up to 2 million in the U.S., and up to 10 million worldwide, are infected with human immunodeficiency virus (HIV), which causes AIDS. So far there is no cure, nor is there a vaccine.

RTI researchers from a wide range of disciplines are among those seeking a way to limit the AIDS epidemic.

RTI serves as the coordinating center for AIDS clinical trials conducted for the National Institute of Allergy and Infectious Diseases. At least 30 different clinical trials



re under way at 35 medical nters, and the results are nsmitted electronically to I. Besides maintaining the ta base and monitoring data ıality, RTI staff work with nicians to interpret the of the trials. RTI also as the coordinating nter for an NIH study on ating pulmonary complica- ns of AIDS.

In a project for the National ncer Institute, RTI staff ovide support for epidemio- gical studies of retroviruses, cluding HIV. The studies cus on the transmission of troviruses in high-risk popula- ns in the U.S., the Caribbean, d Africa. For the National stitute on Drug Abuse, RTI cial scientists are examining e link between intravenous ug use and AIDS.

RTI specialists in analytical emistry have completed aracterization of an NIH- veloped compound to treat IDS. Such analysis is a neces- ry task before a new com- und can enter extensive eclinical testing.

RTI has a new task to evelop a model to estimate oject prevalence of HIV ion and the impact of travenous drug use in spread- g infection among heterosexuals. In addition, an RTI demographer has developed a microcomputer model to estimate the number of people in Africa who are, or will be, infected with the AIDS virus, and the number of infected people who will die from the disease.

Substance Abuse

RTI researchers have studied drug and alcohol abuse for more than two decades. During the past year, they began substantial new projects in chemical, social, and statistical sciences.

The National Institute on Drug Abuse (NIDA) has selected RTI to develop and implement a certification program for drug testing laboratories, and RTI continues as a leading supplier of custom-synthesized THC metabolites for pharmaceutical and drug abuse research.

1987 was the second year of a 3-year NIDA grant to replicate a landmark 1971 RTI study of the relationship between drug use and criminal activity. RTI also began the third year of a substance abuse study to assess the influence of community, school, and family factors on the effectiveness of prevention strategies aimed at high-risk urban and rural middle school students.

During 1987, social scientists continued to analyze data from the 10th year of another NIDA project — the Treatment Outcome Prospective Study (TOPS). This analysis yields information on the progress people make during and after drug abuse treatment. TOPS also provides data about social, economic, and behavioral factors that, combined with treatment, help former drug abusers develop productive lifestyles.

RTI chemists began a 3-year NIDA project to study the pharmacokinetics of psychoactive drugs, including marijuana, amphetamines, phencyclidine, ethanol, buprenorphine, maltrexone, and methadone. Chemists continued a large project NIDA has funded for almost 20 years, in which RTI provides pure, chemically characterized samples and radiolabeled samples of abused drugs, their metabolites, and analogs. In another long-term project, RTI provides radioimmunoassays of THC and its metabolites for NIDA-supported research at other institutions. NIDA also renewed RTI's contract to provide dosage forms and chemically analyze abused drugs.

RTI chemists have completed a project to develop a subdermal delivery system for narcotic antagonists and another to search for cannabinoid receptor sites in the brain.

In new research for the National Institute on Alcohol Abuse and Alcoholism, RTI is assessing the extent to which individuals' self-reports about alcohol treatment are useful in evaluating treatment outcomes. And in 1988, for the Department of Defense, RTI will conduct its third Worldwide Survey of Alcohol Use, Drug Abuse, and Health Behaviors in the Military.

An RTI criminologist has completed a study for the National Institute of Justice on the cost-effectiveness of drug treatment for criminally-involved clients. Another study, for the U.S. Drug Enforcement Administration, yielded a model for a system to retrieve information from drug evidence analyzed by state and local crime laboratories.

For two private companies, RTI is analyzing the impacts of employee assistance programs on absenteeism, accidents, and the use of medical resources.

In 1987, RTI chemists synthesized radiolabeled investigational cancer and AIDS drugs for the National Cancer Institute, preventive drugs for the Walter Reed Army Institute of Research, drugs of abuse for the National Institute on Drug Abuse, and product compounds for private-sector clients. With more than 20 years of experience, RTI supplies labeled compounds for research on how chemicals, mainly drugs in preclinical development, interact with biological systems. Shown here is tritium-labeling of cancer drugs.

Pharmaceuticals

RTI develops new pharmaceuticals for clients such as the National Institutes of Health, the U.S. Army, and health care companies. Current work includes drug synthesis, analytical chemistry, cost-benefit analysis, clinical trials, and chemical engineering.

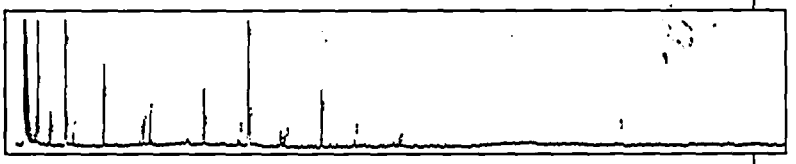
RTI is synthesizing new compounds for treating cancer; for preventive therapies against cancer, malaria, radiation exposures, and toxic exposures; and for controlling reproduction. Private-sector clients sponsor an ongoing program to create new synthetic versions of cancer-preventing retinoids, which RTI first synthesized in government-sponsored research. Another program, for the National Cancer Institute, involves isolation and synthesis of natural products with potential to prevent and treat cancer.

RTI has developed ion chromatographic analytical and quality assurance protocols for a component used in formulations by a pharmaceutical company. Another 1987 project supported a drug manufacturer by providing analytical methods related to Good Manufacturing Practices of generic products.

Also in 1987, RTI completed cost-benefit analyses of three new drugs. One of these was Burroughs Wellcome Co.'s Retrovir® (AZT), the first anti-HIV drug approved by the FDA. Such studies help establish cost-effectiveness and are needed in marketing new products.

In addition to the AIDS studies, RTI's clinical trials include treatments for vaginal infections during pregnancy and high-frequency ventilation to treat infants who have breathing difficulties. RTI statisticians are analyzing the data base from the multicenter investigation of the limitation of infarct size (MILIS), a rich source of information from an RTI-managed study on heart attack treatments. RTI started a new clinical study in 1987 on treatments of pulmonary infections associated with HIV.

In an emerging program in 1987, chemical engineers at R[illegible] completed feasibility studies [illegible] production-scale processes for making biological products.



Analytical Chemistry Methods Development

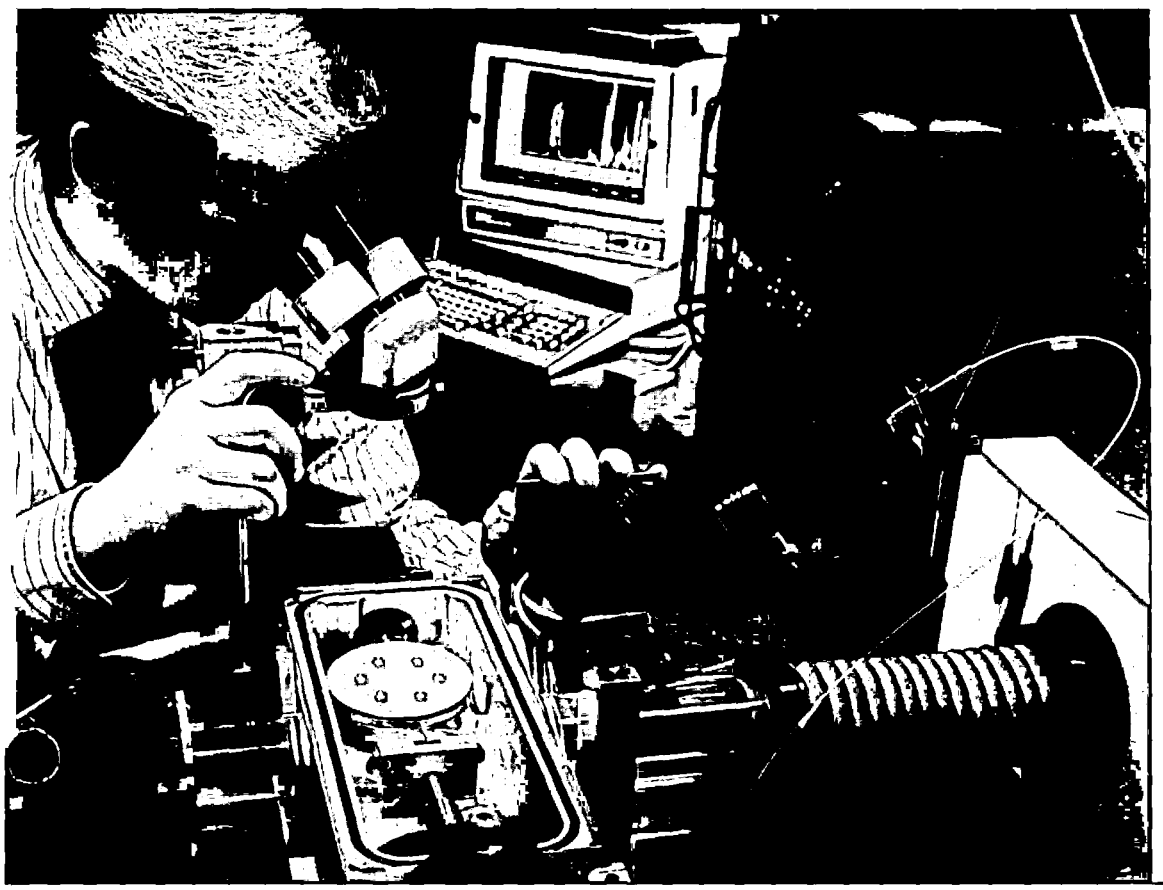
For applied research on environmental and health subjects, RTI develops state-of-the-art analytical chemistry methods using separation, spectrometry, spectroscopy, and immunoassay techniques.

In 1987, RTI received a 5-year renewal of a contract to support the National Cancer Institute's pharmaceutical research. As preclinical testing begins on a new drug, RTI uses physical and chemical techniques to characterize the compound and establish a reference standard. Then RTI develops and applies analytical protocols to ensure consistent quality of the drug at each stage of testing. As Phase One clinical trials begin, RTI develops assays and conducts analyses to ensure the quality of clinical formulations. Among the drugs currently under preclinical study is one to treat AIDS.

Each analytical method RTI develops for the EPA must be proven accurate and repeatable when applied by the variety of laboratories that analyze environmental samples. Methods development in 1987 focused on analyzing solid wastes for organic compounds, trace metals, and other hazardous materials such as cyanide. Another current effort involves methods to determine how waste samples interact with the environment by migrating from landfills to contaminate groundwater resources, or by reacting to produce toxic gas. In a new program related to mutagens, RTI is developing chemical methods that mimic the Ames *Salmonella* mutagenesis assay.

Combined chromatography and mass spectrometry (MS) are among the most important methods RTI uses for biomedical and environmental research. Work continued in 1987 to develop a single, efficient method to map prostaglandin activity related to development of new treatments for pain and inflammation. For research related to physiological disorders, the National Institute on Drug Abuse is funding RTI to develop methods for opioid peptides such as beta endorphin. Major environmental applications include analytical methods for toxic compounds not yet monitored by the EPA, including dyes and pesticides.

RTI has invested in new supercritical fluid chromatography (SFC) equipment to complement existing facilities for gas and liquid chromatography (LC), providing a complete capability for organic separations. In a project for the Food and Drug Administration, RTI is developing SFC/MS and LC/MS methods to detect antibiotic and pesticide residues in food animals and dairy products. RTI also is developing spectroscopic methods using laser excitation, such as a new concept for a fiberoptic biosensor. Among other advanced methods being developed are immobilized electrochemical and luminescent immunoassays and a new spectroelectrochemical instrument.



RTI's chemists constantly review universities' fundamental research on new analytical techniques, and they develop the most promising for applied research. In 1987, RTI combined supercritical fluid chromatography (SFC) with the new gas chromatography, Fourier-transform infrared (GC/FTIR) spectrometry system shown here to demonstrate SFC/FTIR. This innovative technique is described in a recent journal article (HRC & CC, in press), and a new project started in 1987 to optimize SFC/FTIR for environmental analyses.

Environmental Measurements and Quality Assurance

Since conducting its first environmental measurements for EPA's predecessor agencies, RTI has diversified into a complete program of methods development, field measurements, laboratory analysis, laboratory measurement proficiency testing, and quality assurance (QA).

RTI continues to develop and evaluate methods for monitoring chemical constituents in the ambient environment. This includes testing new methods, adapting existing methods to meet new needs, and developing new methods to fill gaps in environmental measurements. Current examples include chlorine compounds in fuel oil, volatile organic emissions from hazardous waste sites, and perchloroethylene, acrylonitrile, formaldehyde, nitrates, and sulfates in the ambient environment.

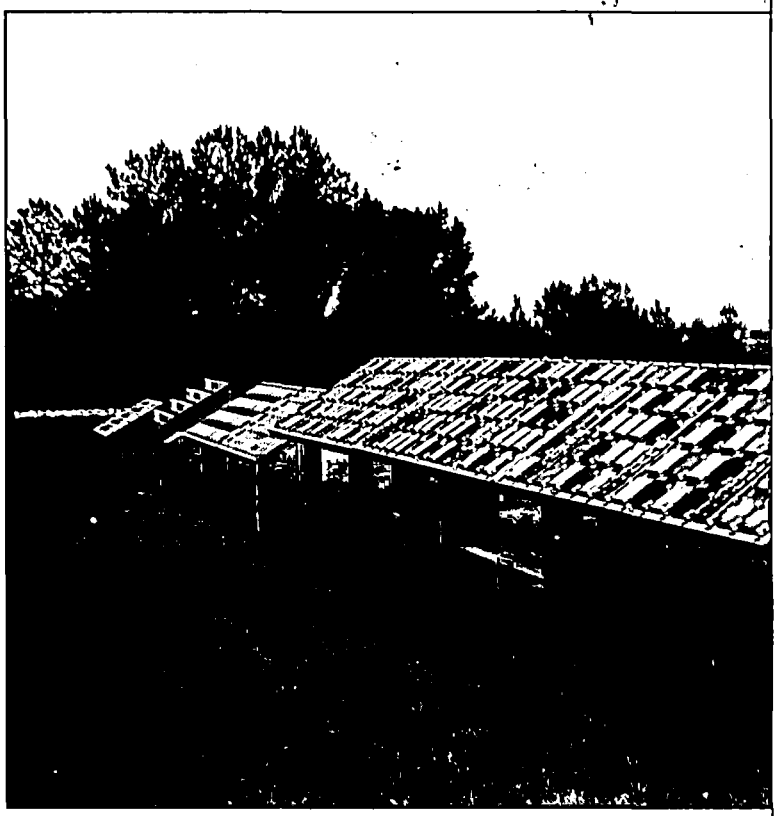
Field measurements support many research projects at RTI. Current topics include indoor air quality, radon, asbestos, occupational exposures, personal monitoring and human exposure assessment, ambient air monitoring, source measurements, acid deposition, environmental impacts on plants, groundwater quality, drinking water quality, aquatic toxicology, and hazardous waste management. In 1987, field measurements supported joint research by RTI chemists and statisticians on human exposure to organic pollutants.

New laboratory programs for the U.S. Department of Energy and the U.S. Fish and Wildlife Service began in 1987 to develop and apply analytical methods for metals contamination in migratory fish, bird, and other animal species, and to determine the movement and fate of metals in the environment. To support studies of diminishing visibility in national parks, RTI began work for the National Park Service to analyze for trace ions in particulate samples. A new project for the California Air Resources Board has RTI adapting methods and conducting experiments to determine how and why chromium in the atmosphere converts between potentially harmful and benign forms. RTI's Air and Industrial Hygiene Laboratory continued its analysis work for the National Institute of Environmental Health Sciences, private companies, and the EPA.

Recent QA projects include preparing a project plan and a data quality objectives document for the pilot phase of EPA's national survey of pesticides in drinking water wells. RTI also is assisting EPA's Quality Assurance Management Staff to design and present workshops on the data quality objectives process for the agency's senior staff.

RTI developed a QA project/test plan for EPA's integrated air-cancer project, and conducted eight related on-site performance and five systems audits. In addition, RTI conducted dozens of performance and systems audits for other epidemiological, materials degradation, crop loss assessment, and methods validation studies throughout the U.S.

In 1987, RTI won renewals of its multiyear QA contracts with EPA laboratories and began a new program with the National Bureau of Standards to develop reference materials for airborne asbestos and to certify analytical laboratories.



First photo: In its Trace Metals Laboratory, RTI develops analytical methods that regulatory agencies use to assess the health and ecological risks posed by metallic substances. In 1987, RTI began applying microwave technology for preparing samples. This technique provides better efficiency and quality control than conventional heating offers.

Second photo: RTI's Air and Industrial Hygiene Laboratory is accredited by the American Industrial Hygiene Association to develop and apply sampling and analysis methods for airborne chemicals. This research helps ensure safe working places.

Third photo: Quality assurance activities include performance audits to ensure reliable environmental data from sources such as EPA's network of acid deposition monitoring sites.

Fourth photo: A field site at RTI provides environmental data for a variety of purposes. It is a unique outdoor laboratory for research on how pollutants affect materials such as stone, coated metals, and paints. In 1987, RTI was selected as one of two U.S. sites for a worldwide materials study led by the Swedish Corrosion Institute.

Risk Assessment

RTI takes an interdisciplinary approach to develop and apply new methodologies for evaluating health and ecological risks. An integral part of this work is RTI's ability to generate most types of data for risk assessment, including toxicology, epidemiology, environmental measurements, and chemical and physical properties data. In addition, RTI uses risk assessments in its policy analysis work to support EPA decisions on environmental regulations.

Current projects focus on methods to assess risks from chemicals contained in hazardous wastes. In 1987, RTI began developing a multimedia exposure model to estimate health risks associated with hazardous waste sites. RTI also directed subchronic toxicity studies to provide data for health-based exposure levels for selected chemicals. Work continues to prepare state-of-the-art papers on critical issues such as exposures to multiple chemicals, uncertainty and sensitivity analysis, and dose-response modeling for noncarcinogens.

Another ongoing project is to develop Total Exposure Assessment Methodologies (TEAM). RTI specialists in chemistry, statistics, and environmental health are collaborating to provide applied methods that make direct measurements of individuals' exposures to hazardous pollutants.

RTI is expanding its epidemiology staff and is developing new programs to apply risk assessment to factors other than human health, such as ecological impacts. RTI's toxicology programs (page 23) and environmental monitoring programs (page 20) also are expanding their capabilities to generate data for applications such as risk assessment and regulatory support.

Several hundred chemical samples per year are sent to RTI from National Toxicology Program contractors. RTI confirms the compounds' identity and purity, describes their physical properties, and identifies the nature and amount of any impurities. Most of RTI's analytical methods are employed in these QA procedures, including gas chromatography, liquid chromatography, thin-layer chromatography, nuclear magnetic resonance, and both high and low resolution mass spectrometry. Shown here is RTI's facility for safe and reliable processing of these research materials.

Hazardous Materials Research

RTI develops improved technologies and policies for managing hazardous wastes. Work in 1987 involved chemical engineering, environmental science, chemistry, toxicology, statistics, and survey research. EPA uses these results when making policies to protect human health and the environment.

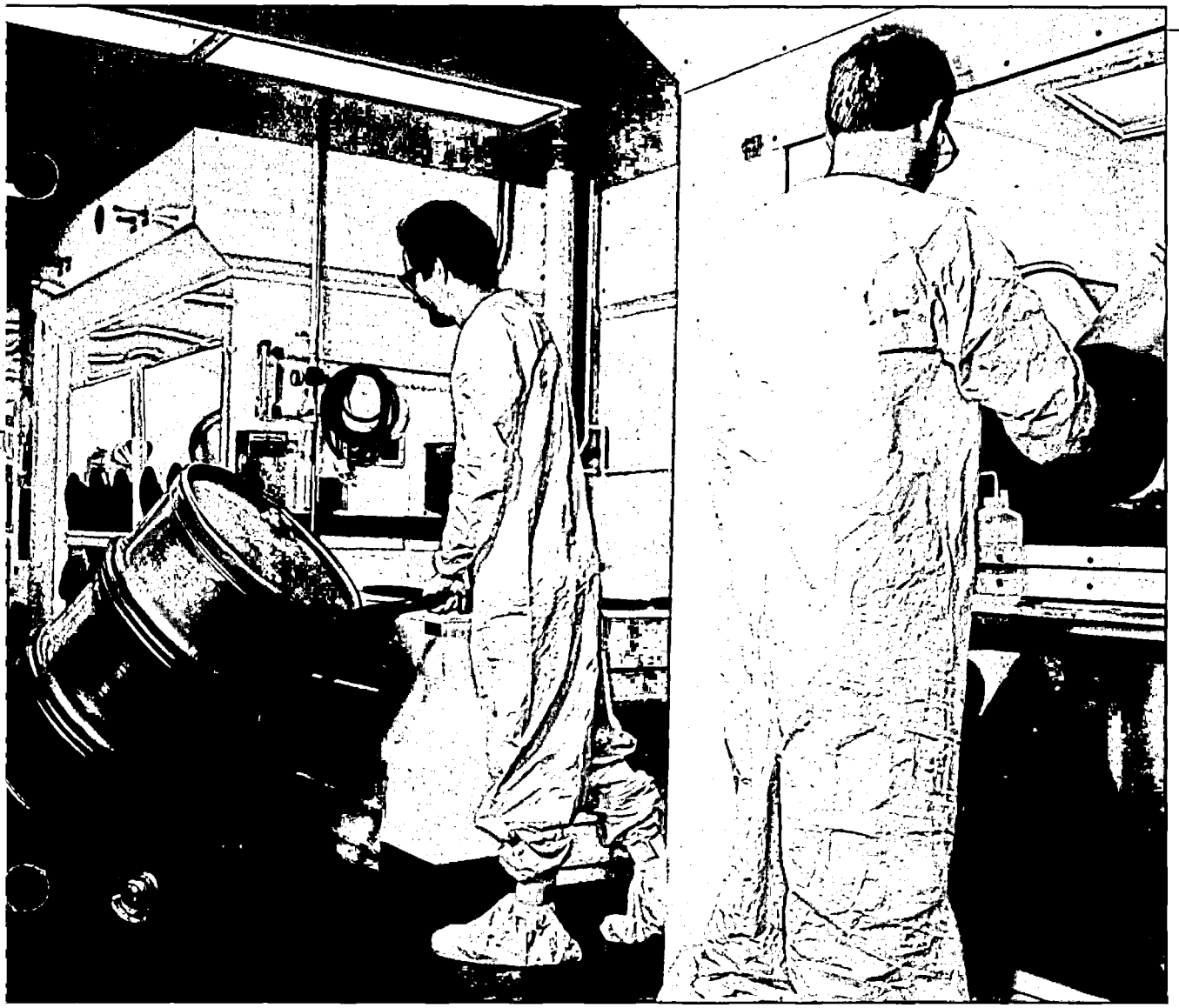
RTI provides field measurements and engineering evaluations to develop general models on managing hazardous wastes. Work in the past year has focused on surface impoundments of hazardous materials and analysis of wastes that degrade as planned and those that escape the impoundment. RTI and EPA are refining models that will point to the most effective requirements for treating and impounding hazardous wastes.

RTI has received its second renewal of an EPA program for critical review and methods development for hazardous waste analysis. Generators and disposers of wastes use these methods to determine proper management procedures. Recent work includes developing and evaluating methods related to waste oils, analyzing public comments on proposed regulations, validating chemical and statistical analysis methods, and helping businesses understand and follow regulations and methods.

Alternative technologies for waste management are the subject of engineering and cost evaluations at RTI. A current example concerns emerging technologies for treating PCB-contaminated sediments. RTI has begun a laboratory evaluation of a new technology for treating PCB-contaminated soils. RTI will develop and operate a pilot plant and will design a full-scale cleanup facility for a Superfund site.

RTI provides hydrogeology research related to managing groundwater resources and contamination. The major effort of 1987 was to produce detailed groundwater vulnerability maps of counties for well water surveys being conducted by RTI statisticians. Using a new digitizing system, RTI combines data from various sources, including that developed by RTI staff, to make detailed groundwater vulnerability maps of geographic areas of interest to clients. For government and industry clients, RTI continued assessments for siting industrial facilities and remediation planning for contaminated sites.

RTI also began a survey of more than 2,500 organizations that treat, store, dispose, and recycle hazardous wastes. A companion survey of about one-fifth of the 60,000 generators of hazardous waste begins in 1988. RTI will produce a comprehensive data base to support decisions on minimizing and managing wastes.



lational Toxicology Program

RTI provides intensive scientific research and technical ıpport services to the National Toxicology Program (NTP). ıis work helps identify chemals that need further study to revent adverse effects on uman health. NTP is a major rogram of the U.S. Department of Health and Human ervices administered through ıe National Institute of Envi-ınmental Health Sciences, and includes the National Cancer ıstitute, the Food and Drug dministration, and the ational Institute for Occupaional Safety and Health.

Extensive additions and [redacted]vements to the Institute's [redacted]cal plant are intended o qualify RTI as one of the ation's handful of laboratory facilities capable of meeting the NTP's stringent standards that govern safety and animal health and assure the validity of experimental results in toxicological and carcinogenic studies. RTI's investment of more than $2 million for new construction, equipment, and renovation has been supplemented by a grant from the National Institutes of Health. The first phases of upgrading the 21,000-square-foot facility were completed in 1987.

The broad spectrum of current research activity involving the use of animals includes:

- teratology
- metabolism and pharmacokinetics of xenobiotic materials and pharmaceutical agents
- reproductive toxicity and fertility, including assessments of chemical effects on fertility by continuous breeding programs and development of contraceptive drugs
- improved methods for drug delivery, including biodegradable polymer implants
- mutagenic effects of chemicals and X-rays in mice
- assessing germinal mutations in mice by electrophoresis
- immunological studies, including development of monoclonal and polyclonal antibodies for immunoassays.

The new capital improvements have opened the way for a significant expansion of RTI's investigations in advanced areas of:

- developmental and reproductive toxicity
- carcinogenesis
- acute, subacute, and chronic toxicity
- anticarcinogens.

A separate, 6,000-square-foot chemical preparation and holding facility was completed in 1985 for a continuing, 5-year effort to analyze potentially toxic chemical and biological samples for NTP. The analyses call for the combined talents of RTI chemists, life scientists, computer analysts, and environmental specialists.

GOVERNANCE AND CORPORATE OFFICERS

Board of Governors

Of the 28 Governors:
5 hold seats by virtue of their positions: the presidents of The University of North Carolina, Duke University, and the Research Triangle Institute, and the chancellors of N.C. State University and the University of North Carolina at Chapel Hill;
2 are specified in the By-Laws, George Watts Hill and William C. Friday;
9 are appointed annually to represent Duke University, The University of North Carolina general administration, N.C. State University, and UNC-Chapel Hill;
12 Governors are elected annually from the business and professional communities;
A separate category of Lifetime Governor recognizes retired Board members who have made extraordinary contributions to the progress and welfare of RTI. Robert T. Armstrong is the current Lifetime Governor.

Chairman:
George Watts Hill*, Chairman of the Board, Central Carolina Bank and Trust Company, Durham

Executive Committee Chairman:
Marcus E. Hobbs*, University Distinguished Service Professor Emeritus of Chemistry, Duke University

Donald S. Beilman, President, Microelectronics Center of North Carolina, Research Triangle Park

H. Keith H. Brodie, President, Duke University

Ivie L. Clayton, Business Consultant, Raleigh

Pedro Cuatrecasas, Senior Vice-President of R&D, Glaxo, Inc., Research Triangle Park

Raymond H. Dawson*, Vice-President for Academic Affairs, The University of North Carolina

Christopher C. Fordham, III, Chancellor, University of North Carolina at Chapel Hill

William C. Friday, President, William R. Kenan, Jr. Fund, Chapel Hill

Steve C. Griffith, Jr., Senior Vice-President and General Counsel, Duke Power Company, Charlotte

Phillip A. Griffiths*, Provost, Duke University

Margaret T. Harper*, President, The Stevens Agency, Southport

Franklin D. Hart*, Vice-Chancellor for Research, North Carolina State University

George R. Herbert*, President, Research Triangle Institute

Earl Johnson, Jr.*, President, Southern Industrial Constructors, Inc., Raleigh

Matthew Kuhn, Assistant Vice-President, Resource Development and Administration, BNR, Inc., Research Triangle Park

William F. Little*, University Distinguished Professor of Chemistry, University of North Carolina at Chapel Hill

Larry K. Monteith*, Dean of the School of Engineering, North Carolina State University

George E. Norman, Jr.*, Greensboro

Bruce R. Poulton, Chancellor, North Carolina State University

Charles E. Putman, Vice-Provost for Research and Development, Duke University

Thomas A. Rose, President, Blue Cross and Blue Shield of North Carolina, Durham

Patricia C. Skarulis, Vice-President for Information Systems, Duke University

C. D. Spangler, Jr., President, The University of North Carolina

Thomas J. Troup, Vice-Chairman, Burr-Brown Corporation, Tucson, Arizona

Charles B. Wade, Jr., Winston-Salem

Samuel R. Williamson, Jr.*, Provost, University of North Carolina at Chapel Hill

Phail Wynn, Jr., President, Durham Technical Community College

*Member, Executive Committee

Members of the Corporation

The Members are the equivalent of RTI shareholders. As such, they elect the Governors who represent the business and professional communities.
Of the nine Members of the Corporation:
4 are the chairmen and presidents of The University of North Carolina and Duke University;
1 is George Watts Hill, a lifetime Member of the Corporation;
4 are elected annually, two from and by the Duke University Board of Trustees, and two from and by the Board of Governors of The University of North Carolina.

Members of the Corporation representing Duke University are:
H. Keith H. Brodie, Durham
Nathan T. Garrett, Durham
Thad B. Wester, Raleigh
L. Neil Williams, Jr., Atlanta, Georgia

Members of the Corporation representing The University of North Carolina are:
Philip G. Carson, Asheville
T. Henry Redding, Asheboro
Hon. Robert W. Scott, Haw River
C.D. Spangler, Jr., Chapel Hill

Corporate Officers

RTI officers, including the research vice presidents listed on page six, are elected by the Board of Governors.

George R. Herbert, President
Daniel G. Horvitz, Executive Vice-President
William H. Perkins, Jr., Financial Vice-President
Grace C. Boddie, Vice-President-Senior Counsel
Suzanne P. Nash, Corporate Secretary
R.S. McLean, Treasurer

TI GENERAL QUALIFICATIONS

. oduction

Research Triangle Institute is not-for-profit contract research orporation located on a 150-acre ite in North Carolina's Research iangle Park. RTI was created in 1958 by joint action of the University of North Carolina at Chapel Hill, Duke University, and .C. State University.

RTI provides applied and fundamental research and technical assistance to national, state, and local governments, public rvice organizations, associations, d private-sector clients ranging rom small businesses to major orporations.

Organization and Staff

RTI's organization facilitates he formation of multidisciplinary eams to address clients' needs.

The staff of more than 1,260 ncludes approximately 60 percent rofessionally trained research rsonnel. Of these, about a third ave doctoral degrees and another ird have master's degrees. Their ackgrounds cover more than 115 e fields.

or areas of training and perience include:

ocial Sciences: economics, onometrics, benefit-cost analysis, aluation research, urban and gional planning, international velopment, health services and ealth policy research, agricultural velopment, sociology, psychology, cial psychology, education, siness administration, public ministration, municipal financial anagement, criminology, law, litical science, and the manities.

rvey Research: sample design d selection, survey planning and ecution, data collection and anagement, and research and velopment on survey method-ogy.

athematics, Statistics, and omputer Sciences: data anagement and analysis, statistical ethods development, statistical nalysis, biostatistics, clinical trials, mputer-aided engineering, AD/CAM, systems software, oftware verification, computer curity, numerical modeling, and ions research.

nmental Sciences and gineering: environmental ontrols and engineering, nvironmental chemistry, nvironmental health, industrial hygiene, hazardous materials management, hydrological and earth and mineral sciences, epidemiology, meteorology, and oceanography.

Chemical and Biological Sciences: analytical, organic, inorganic, physical, polymer, and medicinal chemistry, toxicology, pharmacology, genetics, neuroscience, biology, biochemistry, and microbiology.

Engineering and Physics: electrical, electronics, systems, computer, semiconductor, chemical, biochemical, energy, industrial, mechanical, manufacturing, materials, biomedical, aerosol, civil, petroleum, nuclear, aeronautical, and transportation engineering.

C. Laboratory and Office Facilities

RTI's 14 buildings contain 430,000 square feet of space with laboratory, computer, and other facilities for all RTI programs. RTI also has offices in Washington, DC; Newport News, VA; Cocoa Beach, FL; and at project locations in the U.S. and abroad.

D. University Relations

RTI was created as the focal point for growth in North Carolina's Research Triangle Park, a scientific center built around the resources of the area's major research universities.

RTI and its founding universities have many collaborative research programs. Additional relationships include joint staff appointments, consulting agreements, and other professional contacts. RTI participates with universities and business in the Microelectronics Center of North Carolina and the N.C. Biotechnology Center.

E. Computer Facilities

RTI has up-to-date minicomputers and microcomputers for data management and analysis, statistics, simulation, modeling, software R&D, computer-aided engineering, electronics, and laboratory management.

An important resource is the nearby Triangle Universities Computation Center, with mainframe facilities shared by North Carolina research and educational institutions.

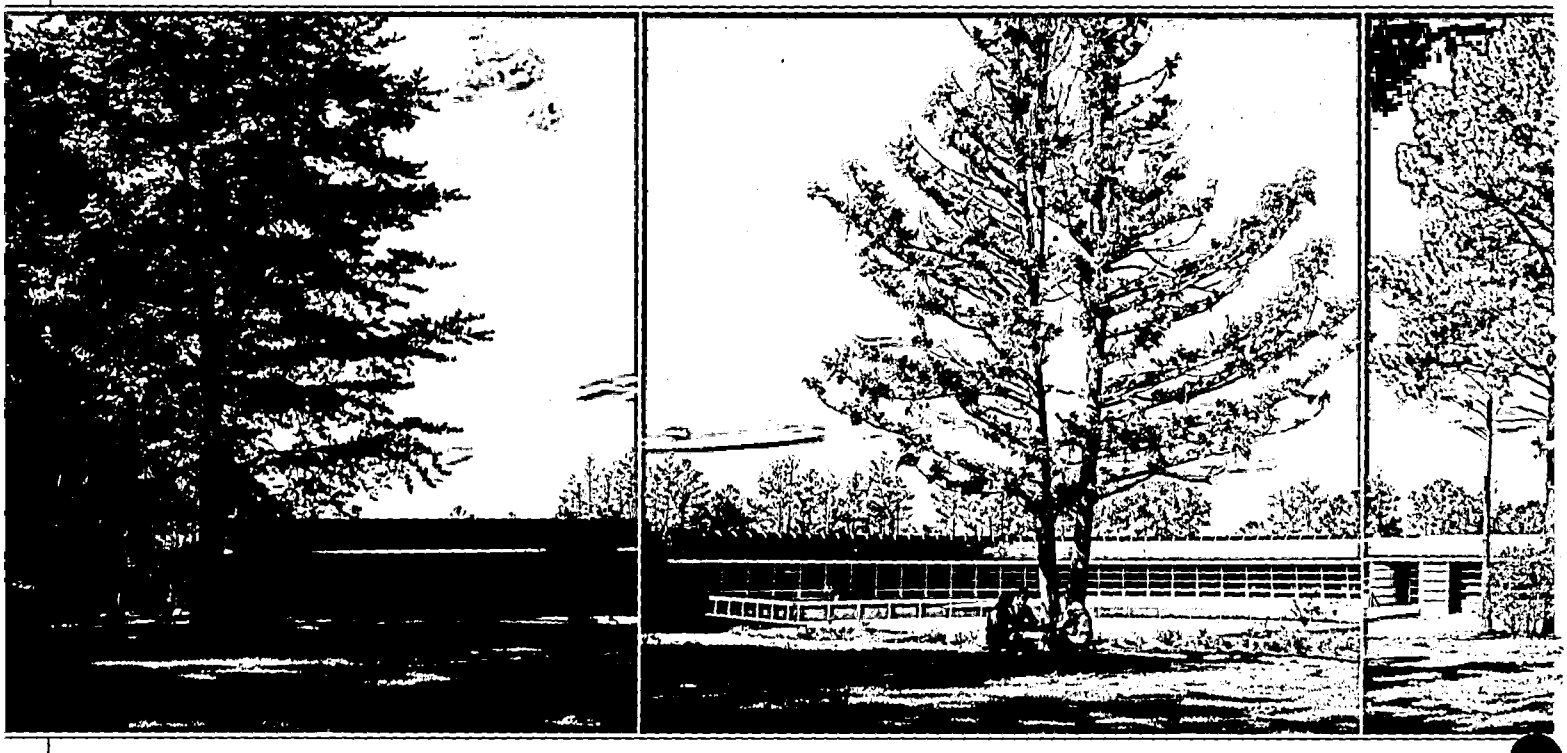
RTI has daily traffic with computer networks such as the Department of Defense Advanced Research Projects Network (ARPANET), NASA's AIRLAB research facility, the Microelectronics Center of North Carolina, COMNET, the Environmental Protection Agency, the Health Care Financing Administration, the National Institutes of Health, and the National Center for Health Statistics.

F. Library Facilities

The RTI central library provides computerized literature searches, maintains subscriptions to professional periodicals, supports satellite libraries in laboratory buildings, and provides RTI staff with full access to the local university libraries, which are cross-cataloged and shared.

RESEARCH TRIANGLE INSTITUTE
3040 Cornwallis Road PO Box 12194
Research Triangle Park NC 27709
USA

Telephone 919-541-6000
Cable RESTRINS, Raleigh, NC
Telex 802509 (RTI RTPK)
Fax 919-541-5985



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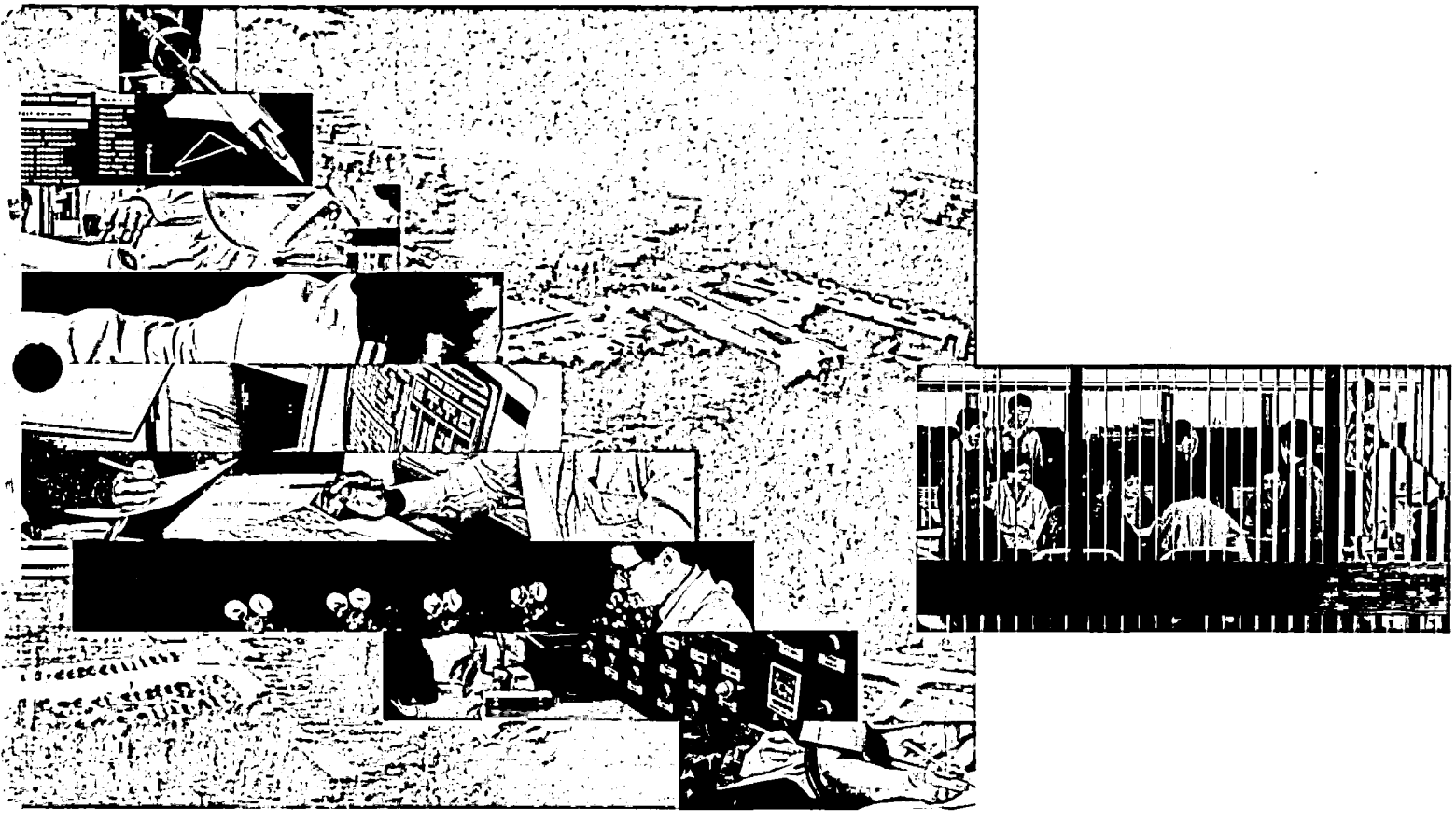
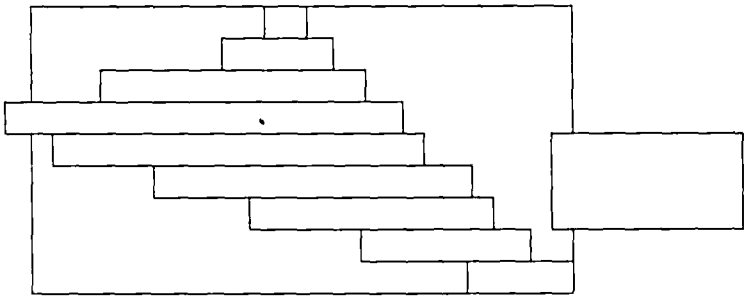
ANNUAL REPORT



RESEARCH TRIANGLE INSTITUTE



Research Triangle Institute's main facilities are in the center of North Carolina's Research Triangle Park. The cover images of this site are from photos used in this annual report.

Under contract to governmental and industrial clients, RTI conducts applied and fundamental research.

Started at the end of 1958 as the initial scientific organization in the Park, RTI has a staff of more than 1,450 and its 1988 revenues were $84.5 million.

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ANNUAL REPORT

RESEARCH TRIANGLE INSTITUTE

Its 30th year of operations, which ended September 30, 1988, was one of growth and change for Research Triangle Institute.

There was a substantial increase in revenues throughout RTI's research programs, plus a record-setting expansion in the number of regular staff members.

As the fiscal year ended, RTI's executive vice president for the past five years, Dr. Daniel G. Horvitz, affirmed his plans to return to active research in statistics. The RTI Board of Governors has elected Dr. Alvin M. Cruze, who joined RTI in 1965, to fill this position.

Corporate officers and senior members of the research staff initiated planning to prepare the Institute for the decade of the 1990s. One result has been a reorganization within some research programs.

While most of this 1988 annual report is devoted, properly, to the accomplishments of RTI's research staff, their work is clearly reflected in the year's operating results.

George R. Herbert

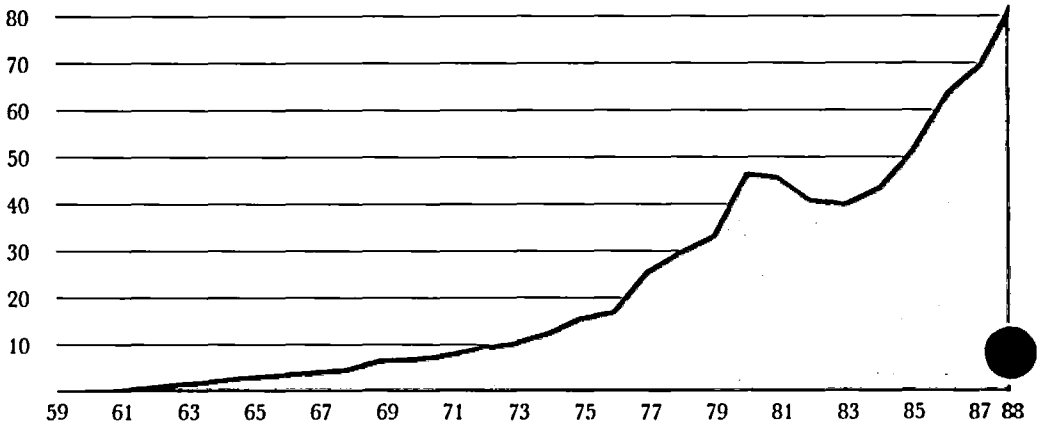
Operating Results

In fiscal year 1988, RTI's revenue rose to $84.6 million, an increase of $13.5 million over the previous year, or 19 percent. These results substantially exceed, both in dollars and rate of growth, the previous year's increase of $7.1 million.

The direct project labor portion of revenue increased by 22 percent and operating expenses rose by 12 percent, yielding an income from research operations of $2.3 million. Including depreciation, cash generated for investment in research facilities and programs totaled $5.6 million, compared with $5.1 million a year ago.

Institute growth also is reflected in a net increase of 151 in the number of regular staff members, to 1,291 at September 30. Including temporary employees, whose numbers vary with contract requirements, the total staff was 1,468 when the fiscal year ended.

Research Revenue



Sources of Revenue

In 1988 there was further growth in research funding from the US Department of Health and Human Services (from $18.4 million to $30.8 million); the US Department of Defense (from $13.4 million to $16 million); and private-sector clients (from $6.3 million to $7.6 million).

Research related to the AIDS tragedy more than doubled compared with the previous fiscal year, to $12.8 million (or 15 percent) of RTI's funding.

Continued growth in research for the private sector is particularly satisfying. More than a third of RTI's active projects in 1988 were for the private sector, up from one-quarter in the previous year. The 200 private-sector projects were for 120 different companies, including 39 in North Carolina.

New Projects

The most important factors in assuring a strong and healthy future for the Institute are the staff's success in 1) maintaining the high level of performance that warrants continued client confidence, and 2) competing for new contract awards and contract extensions.

Success in proposal competition resulted in new records for contract awards and funding allocations. Budgeted amounts for contracts and extensions signed during the year totaled $113 million, including $85.1 million already funded by September 30.

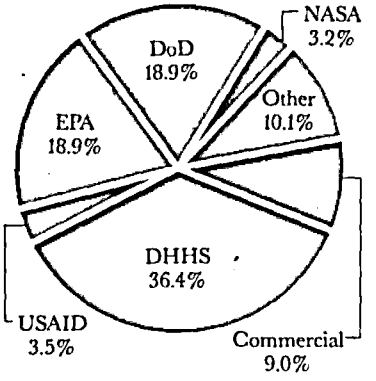
Organizational Changes

During fiscal 1988, corporate officers and senior research staff invested substantial time and thought to preparing for the decade of the 1990s.

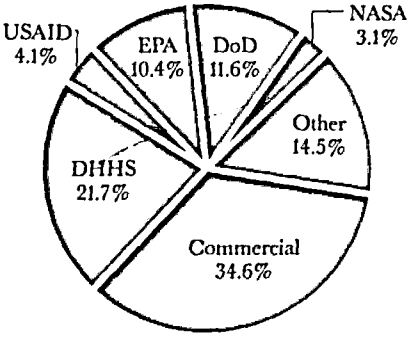
One result has been the consolidation of research programs under seven, rather than ten, vice presidents. This change, designed to maximize cooperation among all staff, enhances RTI's tradition of interdisciplinary collaboration.

While there has been significant progress in preparation for the Institute's fourth decade, planning for an even better and stronger RTI will be an ongoing process.

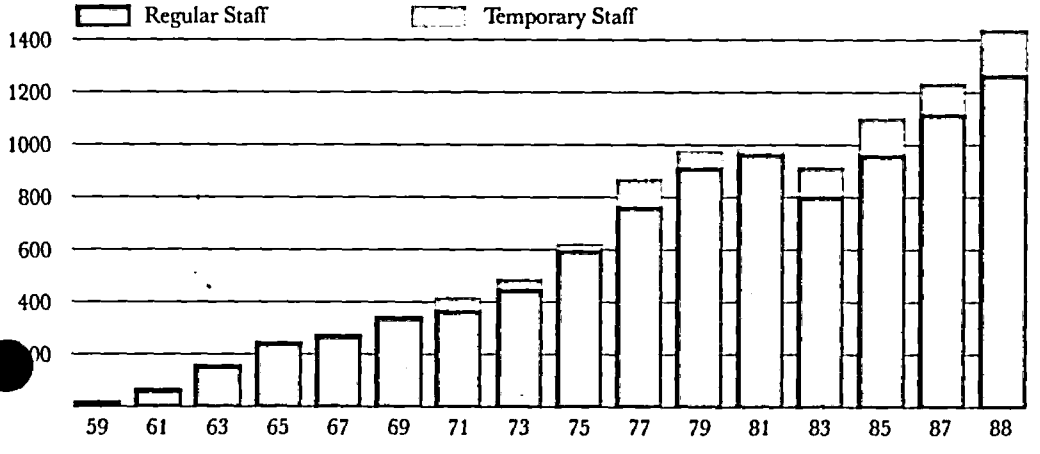
Sources of Revenue
by Contract Funds



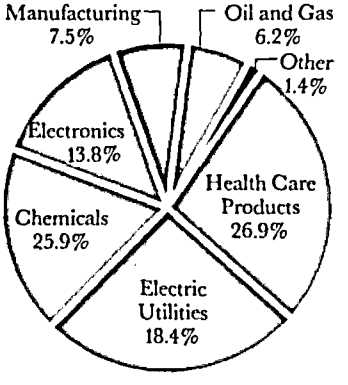
by Number of Contracts



Staff Growth



Private Sector Revenue
by Industry



EXECUTIVE VICE PRE

The executive vice president of RTI is the senior corporate officer with overall operating responsibility for the Institute's research activities.

Since becoming RTI's first executive vice president in 1983, Dr. Daniel G. Horvitz has maintained his intention of returning to statistics research. As of January 1989, he is Distinguished Institute Scientist, and will take a leading role in large, complex projects that have substantial statistical components.

RTI's Board of Governors has elected Dr. Alvin M. Cruze to be executive vice president. Dr. Cruze has held positions of ever-increasing responsibility since joining RTI in 1965. In 1983 he became vice president for economic and social systems research. He is an alumnus of the University of Tennessee, received his master's in statistics at Rutgers University, and his Ph.D. in economics at North Carolina State University.

In the following statements, Dr. Horvitz discusses some essential aspects of the RTI research environment, and Dr. Cruze discusses expectations for the 1990s.

A PRODUCTIVE ENVIRONMENT FOR RESEARCH

Daniel G. Horvitz

It has been my privilege to participate in RTI's growth and development for 25 years. The Institute's history contains important events such as initiating new scientific programs; building modern research facilities; investing in sophisticated equipment; and acquiring major research contracts with federal agencies, private companies, state governments, and others.

Through these events, RTI has become an important national resource.

How did the Institute's fine research environment develop? Undoubtedly, there were many factors.

The most obvious and essential is a remarkably capable and dedicated staff. We cannot emphasize enough the staff's focus on quality, scientific integrity, and high ethical standards in the conduct of research programs. We are fortunate to have had leadership for more than 30 years that has set the pattern for achieving these standards.

However, many other factors, while less obvious than an excellent staff, are crucial to our research environment.

Marketing Mode

While RTI is in the business of selling research, its marketing differs from that of companies with more traditional products. At RTI, development of research concepts and the marketing of them are integrated functions. It is the responsibility of the senior scientific leadership of each program to create and market ideas.

This marketing mode has nurtured a philosophy which contributes to RTI's success. In essence, each staff member has the opportunity to develop his or her own scientific interests and to market them. Projects are neither dictated nor assigned by top management. This operating mode attracts and retains capable, creative researchers.

Investment and Financial Management

The manner of using Institute capital resources has been an essential factor in RTI's success. A management philosophy that almost unstintingly supports staff needs for state-of-the-art facilities and equipment has helped to sustain an edge for RTI in the competitive world of research.

Financial management and fiscal control have been strong suits at RTI since its inception. Control of overhead costs receives the highest priority. Overhead dollars are a valuable resource for developing and

marketing research programs. RTI's policies for distributing this resource have helped create a positive environment for research.

Interdisciplinary Research

RTI's effective response to interdisciplinary research opportunities is another essential factor in its success. In the early years, research contracts were generally small, rarely requiring staff from more than one field. Today, RTI undertakes many large, interdisciplinary projects that require staff from a wide range of fields. I note with considerable pride RTI's ability to form effective teams for such projects.

RTI is able to respond to complex, interdisciplinary research opportunities for several reasons. First, in the 1960s the Institute developed a diverse set of programs, with major groupings in the chemical, life, engineering, social, and statistical sciences. Over the years, our diversity of programs, r staff skills, and our other resources ontinued to increase. Second, the need for teams of scientists working together has been of ever-increasing importance. Finally, RTI policies designed to avoid organizational barriers have fostered and encouraged interdisciplinary undertakings.

Support and Collaboration

Another essential element of RTI's research environment is administrative support to help scientists acquire research funding and carry out projects. RTI's contract, accounting, purchasing, personnel, facilities, and research services staffs' responsiveness to the needs of the technical staff is outstanding. Their dedication and willingness to work with technical staff to meet proposal and project requirements are indispensable to RTI's success.

Also, an external factor, no less important, is the environment we enjoy: The regular interaction of Institute staff with scientists at the Triangle universities has been particularly valuable to RTI and, I hope, to the universities as well.

During the past 30 years RTI has evolved into a fine research institution. As the staff addresses the scientific challenges of the 1990s, they will find ample opportunities in RTI's research environment.

GOALS, OPPORTUNITIES, AND RESPONSE

As RTI prepares for the 1990s, senior management and research staff have developed a set of guiding goals. First, we intend to continue in the mainstream of research. We will continue to focus on issues that are important to our society, and we must maintain our involvement in a diverse spectrum of scientific issues.

Our second goal is to achieve further distinction in interdisciplinary research, which has been one of our notable strengths, as well as in strong, discipline-focused studies. Recent organizational changes strengthen our capability to conduct both types of investigations.

Our third goal is to help individual staff develop to their full career potential within an environment of freedom to pursue their individual and collective scientific interests.

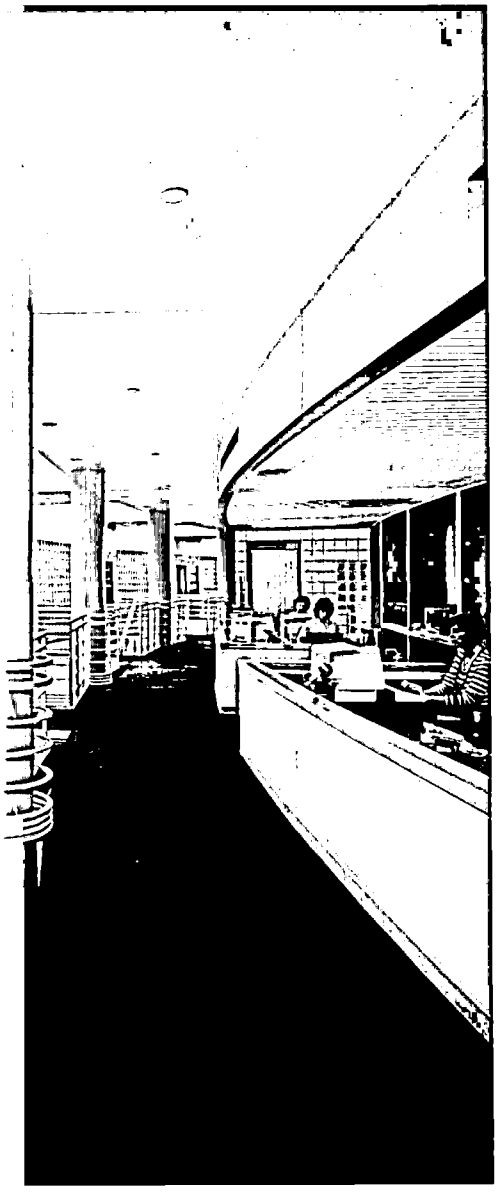
Opportunities

Although difficult over even a short- to intermediate-term future, we can identify broad trends that will affect our research.

Over the next few years, the AIDS tragedy will dominate our health and social research activities. The continued aging of our population will also have important implications.

The environment will continue to be a major concern. Our research will emphasize improved measurements of the effects of toxic substances in the human body, and effective means to minimize and manage the risks inherent in exposures to —

Alvin M. Cruze



environmental hazards.

Given the increasingly interdependent world economy, US firms will be in a continuing struggle to maintain their competitive position, particularly in the semiconductor and electronics industries. We expect expanding opportunities for RTI to develop new methods and components to improve productivity.

There will be an emphasis on effectiveness and efficiency in managing public agencies' delivery of services, not only in the US, with the anticipated continuation of moderate federal deficits, but also in developing countries that face fiscal pressures.

Finally, biotechnology provides ample opportunity to address pressing concerns, both in human health and in agriculture.

We must also remain alert to funding sources that support research on these issues. Driven in part by the need to maintain America's competitive position, both public and private-sector support for research will increase. However, there will be shifts of funding, such as a shift in federal research from defense to non-defense agencies. We will also see a trend toward larger research efforts to respond to problems that require complex, interdisciplinary investigations.

Strategies

Given these goals and opportunities, we must assure the continued growth and vitality of our research operations.

First and foremost, our overall operating philosophy will remain unchanged — that is, we will provide the resources and the environment in which our staff can generate and pursue their individual and collective research interests. This philosophy allows us to attract and retain bright, creative staff, the most critical factor in meeting each of our research goals.

Second, we must maintain balance across the various scientific disciplines. This provides a foundation for rapid response to new research challenges and is a cushion against shifts in funding sources.

Third, we must maintain excellence in critical research capabilities in which RTI holds a position of leadership. To do this, we will support the staff's needs in such technologies as survey research, computing, semiconductor design and fabrication, environmental measurement, analytical chemistry, and chemical synthesis.

Fourth, through transfer of knowledge and capabilities developed under government funding, we are pursuing more opportunities in the private sector. We must develop effective approaches to market these services and to make businesses aware of our capabilities.

Finally, we will see an increase in collaborative research across many institutions. Building on our history of close ties with our parent universities, we are in an excellent position to form additional innovative organizational structures with shared responsibilities to develop areas of specialization and to manage the risks inherent in large-scale research activities.

Conclusion

It is an Institute conviction that in the future, as in the past, the key to our continued success is our staff. Successful conduct of challenging and complex research efforts requires well-trained, experienced, and imaginative people who are willing to learn and to explore new ideas and approaches, and who are committed to excellence.

I am convinced that we have that staff.

Research Organization

Board of Governors
Executive Committee

George R. Herbert, President

Alvin M. Cruze, Executive Vice President
Distinguished Institute Scientist: Daniel G. Horvitz

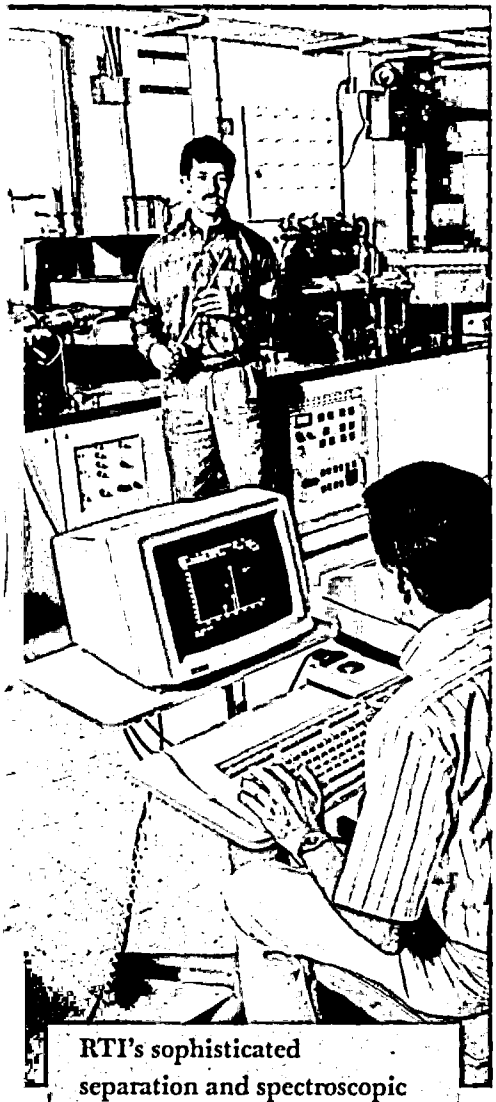
Research Vice Presidents	Research Centers and Programs
James R. Chromy Statistical Sciences	Computer Science, Robert H. Thornton, director Ragland Computer Center, James C. Wright, director Research in Statistics, Robert E. Mason, director Survey Research, R. Paul Moore, director *Chief Scientist:* Ralph E. Folsom
C. Edgar Cook Chemistry and Life Sciences	Organic and Medicinal Chemistry, F. Ivy Carroll, director Bioorganic Chemistry, A. Robert Jeffcoat, director Life Sciences and Toxicology, Frederick J. de Serres, director Polymer Sciences, Vivian T. Stannett, Camille Dreyfus Scientist *Chief Scientist:* Monroe E. Wall
Ronald W. Johnson Social Sciences and International Development	International Programs, James S. McCullough, director Policy Studies, C. Lynn Usher, director Development Policy, James E. Kocher, director Social Research and Policy Analysis, J. Valley Rachal, director Economics Research, Allen K. Miedema, director Educational Studies, John A. Riccobono, senior program director *Chief Scientist:* George H. Dunteman
Edo D. Pellizzari Analytical and Chemical Sciences	Methods Development and Applications Systems Development and Measurements Mass Spectrometry
W. Kenneth Poole Biometrics Research	Epidemiologic and Medical Studies, Fred A. Bryan, director Medical, Environmental and Energy Statistics, Tyler D. Hartwell, director *Chief Scientist:* B. V. Shah
James B. Tommerdahl Environmental Sciences and Engineering	Environmental Measurements, Clifford E. Decker, director Environmental Quality Assurance, Frank Smith, director Environmental Systems, Deane F. Tolman, director Hazardous Materials Research, C. Wayne Westbrook, director Aerosol Technology, David S. Ensor, director Process Research, James J. Spivey, director Geosciences, Fred M. Vukovich, senior program director *Chief Scientist:* Forest O. Mixon
F. Thomas Wooten Electronics and Systems	Digital Systems Research, James B. Clary, director Systems Engineering, James G. Haidt, director Semiconductor Research, James A. Hutchby, director Technology Applications, Doris J. Rouse, director Biomedical Engineering, Robert L. Beadles, senior program director Neuroscience, Blake S. Wilson, senior program director *Chief Scientist:* James N. Brown, Jr.

Synthetic and analytical chemists at RTI are making significant contributions to public health while advancing basic research techniques.

Drug development at RTI began 28 years ago with a program in natural products chemistry to identify compounds with anticancer activity. Synthesis programs on many different drug topics followed. These efforts have been greatly augmented by computer-aided drug design, which helps researchers to discover new drugs to combat cancer, drug abuse, dermatological problems, Alzheimer's disease, and many other illnesses.

Separation chemistry, spectrometry, spectroscopy and immunoassay have yielded new methods for pharmaceutical research and hazardous waste analysis.

These capabilities have made RTI a source for reproducible analytical methods, new drugs and drug analogs for biological studies, and certifications for laboratory quality control.



RTI's sophisticated separation and spectroscopic laboratories, represented here by the mass spectrometry facility, offer complete analysis, which staff are using to develop analytical methods for environmental and pharmaceutical research.

FOLLOWING THE TRAIL OF DRUGS

How does the body break down a drug once it's administered? Does it store or excrete the active ingredients? How well is the drug absorbed? How can a new drug be followed to the site of its activity in the body?

Those are key questions; to answer them, a way of tracking the drug through the body is needed. Chemists at RTI provide the answer by preparing isotopically labeled forms of compounds being considered for disease treatment. AIDS drugs were the focus of new labeling projects in 1988, and work continues with anticancer drugs, as well as abused drugs.

Labeled compounds also allow researchers to study drug receptors by providing a means to monitor interactions of drugs with specific molecules in the body. Such studies can lead to more specific drugs with fewer side effects.

DEVELOPING NEW DRUGS

Medicinal chemists are investigating new methods in computer-aided drug design (CADD), a recently-introduced tool.

CADD helps chemists to generate structures and statistical models consistent with previous experiments, and to suggest new experiments that will have the most chance of success. CADD has great potential for reducing the cost of developing new drugs.

BREAKING DOWN DRUGS

When the body metabolizes therapeutic drugs, it may create ineffective or toxic compounds or, occasionally, compounds that are even more potent than the original dru To understand the pharmacological activiti of these metabolites, RTI scientists measure the amounts of each of them in body tissue and fluids. They then purify small amounts of the metabolites and determine their chemical identity. Finally, chemists produce larger quantities of the metabolites synthetically. A metabolite can then be studied to determine both its contribution to therapeutic goals and side effects.

ENVIRONMENTAL TROUBLE-SHOOTING

Before federal regulations concerning harmful substances can be invoked, precise measurements are needed. RTI chemists are studying methods to detect and measure carcinogenic substances, such as benzene, in samples with complex components. In some cases, a method for sampling and analysis of a specific compound must be developed; in others, the source of pollutants must be identified.

Examples of current studies include measuring tetrachloroethylene exposures in homes when freshly drycleaned clothes we brought in, and developing methods to detect chemical residues in milk.

Other RTI scientists determine the rates and extent of absorption of specific environmental chemicals following oral, dermal or inhalation exposure. The distribution of these chemicals among different body tissues and the rates and routes of their elimination are often key to these studies. Still other scientists investigate the effects of the chemicals on reproduction and development of laboratory animals. The results of these studies help regulatory agencies assess the toxic potential of the chemicals.

DEVELOPING METHODS IN ANALYTICAL CHEMISTRY

Chemists in search of a particular compound seldom find it standing alone, waiting to be analyzed. Analytical capabilities make RTI a strong partner in endeavors ranging from environmental monitoring to chemical analysis of potential cancer drugs.

Imagine trying to separate and identify flour, sugar, baking powder, yeast, and milk after they are blended into a batter. Chemists work on the chemical version of that problem, developing analytical methods to isolate and characterize chemical contaminants in solid waste disposal sites. One answer is laboratory methods that create "miniature waste sites" that mimic the chemical reactions of real situations.

Before a drug can be given to a patient, its chemical properties and composition must be thoroughly understood. Purity must be defined and degradation products identified. For the National Cancer Institute, RTI chemists conduct chemical tests on drugs being investigated for anticancer potential as well as supplying accurate standard reference compounds for cancer studies at other laboratories.

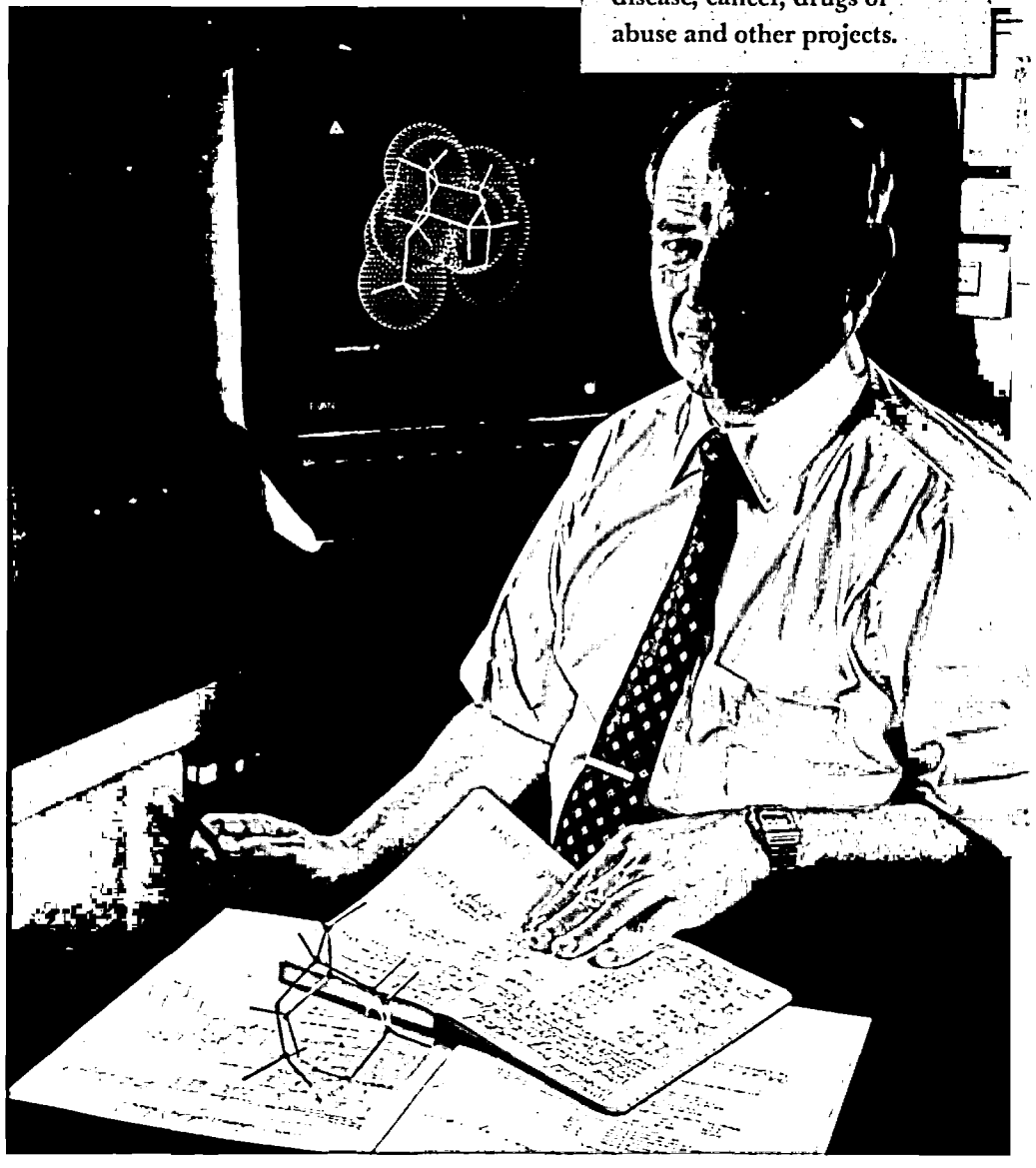
ANALYZING ANALYSIS' FUTURE

Future analytical chemical problems will require new techniques and approaches. RTI chemists get a head start by reviewing fundamental research results with an eye to their potential applications.

By perfecting equipment and training staff in the early stages of a technology or a methodology, RTI not only makes timely use of new techniques, but also contributes to their development and application.

For example, research is now under way in spectroelectrochemistry, a combination of techniques from two areas of analytical chemistry.

Chemists use computer-assisted drug design (CADD) to check hypotheses about drug mechanisms of action. CADD helps researchers reduce the number of compounds targeted for synthesis, saving time and money. In 1988, CADD was used in research on Alzheimer's disease, cancer, drugs of abuse and other projects.



Whether it's a machine to test automobile parts quickly and accurately during production, or a method of keeping particle contamination away from highly sensitive semiconductor wafers, manufacturers are benefiting from RTI's expertise in process and manufacturing engineering.

Engineers work on a full range of concepts, from designing more efficient processes to assembling equipment. Projects in 1988 included fundamental research on particle physics, pollution control techniques for coal-fired power plants, process simulation, and cost analysis for assembly lines.

An RTI staff member consults with a Weber USA employee about a quality-control cell, which the Institute developed for a fuel pump assembly line. For clients in a variety of fields, RTI analyzes, designs, fabricates and installs one-of-a-kind equipment to improve manufacturing productivity.

FULL-SERVICE MACHINE DESIGN

Fuel pumps. Circuit boards. Plastic pitcher lips. With the right machines, these items can be automatically produced, loaded, formed, and checked for quality. RTI's engineering design program produces such machines from concept to on-line operation. Coupling a computer-aided design system with a knowledge of hardware, assembly, and components, RTI engineers produce effective pieces of equipment for industrial clients seeking improved productivity.

One example is a quality-control test stand, designed and built for a fuel pump manufacturer. The device not only had to quickly measure flow and pressure in the pumps, it also had to fit into an existing production line. Other current production technology designs include robotics, automatic test equipment, manufacturing cells, and control systems. A current project will provide software to simulate a semiconductor production line and will allow chip cost analysis to define the value of process improvements.

WAREHOUSE AUTOMATION

Up-to-the-minute inventory information is one of the features of a real-time, on-line transaction processing system RTI helped install in a Warner-Robins Air Force Base warehouse with 320,000 square feet of floor space and 190,000 storage locations.

The fully-automated system records the receipt, storage, and issuance of materials. Computers guide vehicles with on-board micro-computers to bins to store and retrieve cargo. The system fills orders accurately and keeps track of inventory.

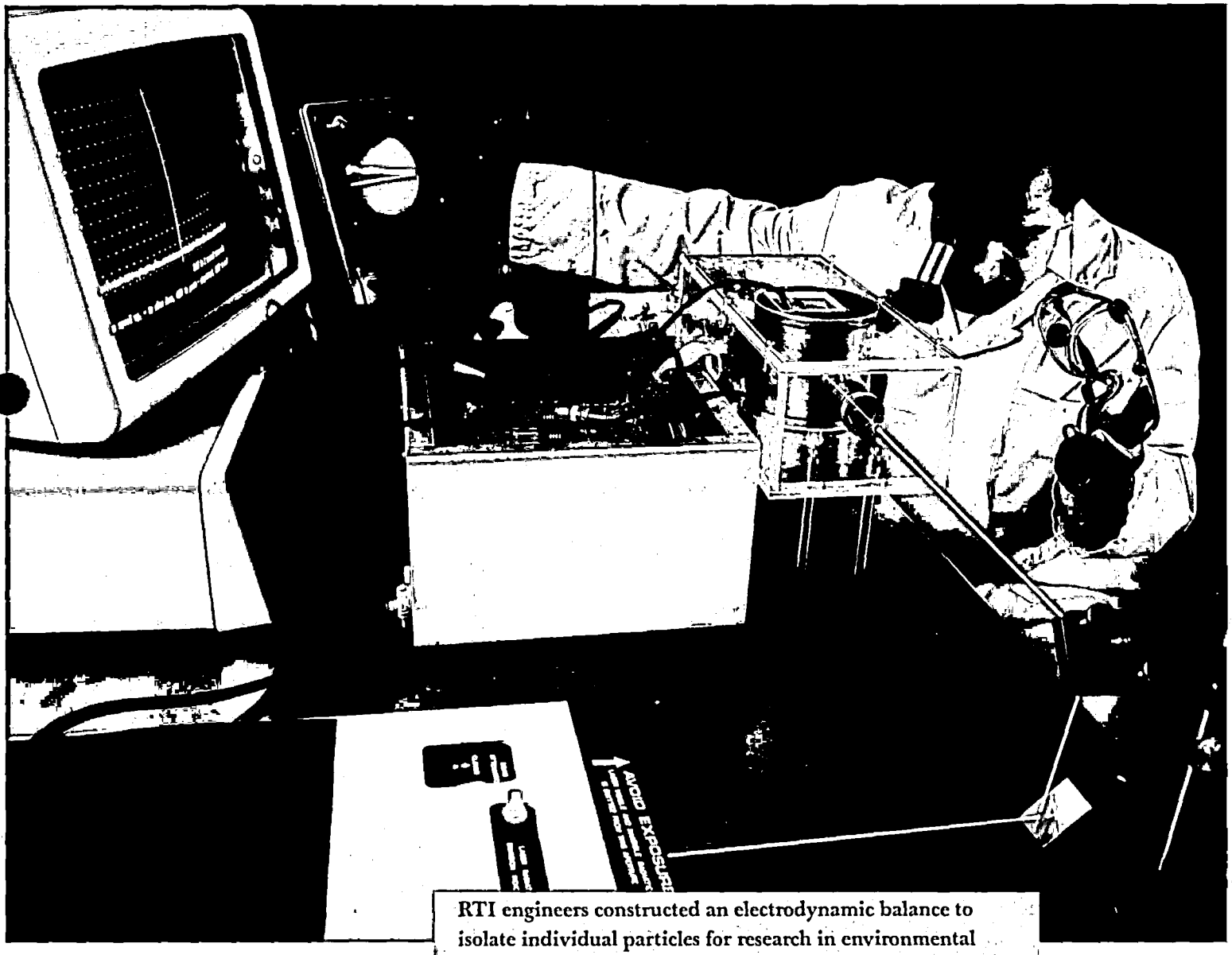
THE PHYSICS OF PARTICLES

Submicron airborne particles can cause major problems in a clean room used to manufacture semiconductor wafers. Several 1988 projects addressed those production problems.

RTI researchers showed that an increase in particle concentration in air outside a clean room can cause a detectable increase in the concentration inside the room when operations are not in progress. In oth research to help identify the sources of particles generated within the room, researchers designed and built an electro-dynamic balance that levitates a single particle to a predetermined position, allowing physical and chemical properties to be studied in detail.

Measuring particle chemical characteristics is becoming more important in both semiconductor and pharmaceutical clean rooms. RTI researchers have identified promising techniques for measuring chemical and biological properties of particles in near-real time.

Particle physics in process liquids is another area of investigation at RTI. Work concentrates on understanding mechanisms of particle transport from liquids to a wafer surface and on methods of cleaning particles from wafer surfaces.



RTI engineers constructed an electrodynamic balance to isolate individual particles for research in environmental emissions and cleanroom technology. With the balance, individual particles are captured and levitated; thus their chemical properties, weight and size can be measured accurately.

The Army, Navy and computer design. Asbestos regulations and imported foods. NASA's Viking spacecraft and diabetes treatment. These combinations, which are making vital contributions to health care and private industry, are examples of technology transfer at RTI, which works to ensure that knowledge and technology developed in government research programs have wide application in private-sector enterprises.

A personal heart monitor was developed for EPA to test the effects of pollutants on cardiac function. The technology has been transferred to use in medical diagnostics and licensed to Power International, Inc.

24-HOUR HEART WATCH

A device that entered clinical trials in 1988 enables physicians to collect cardiac measurements over an extended time. The wearable heart monitor is one of two advanced technologies developed at RTI, and now is licensed to a company that is bringing the devices to market.

Originally adapted for an EPA study on the cardio-pulmonary effects of polluted air, the monitor is being developed for marketing by Power International, a Maryland health care products firm. RTI's prototypes of the device use impedance cardiography, a method of recording physiological heart responses noninvasively. If clinical evaluations are successful, the device could prove invaluable to physicians, fitness devotees, athletes, and trainers.

Power International's other license from RTI is for the Autocuer, a device that helps hearing-impaired people distinguish similar-looking syllables when lipreading.

HARDWARE AND SOFTWARE DESIGN

In 1988, RTI continued to market its Architecture Design and Assessment System (ADAS), a computer-aided engineering (CAE) system for designing complex, special-purpose computer systems (see page 15).

Largely used to design computer architectures for military and industrial applications, ADAS is the only available CAE system that allows engineers to develop both hardware and software simultaneously. This is a particular advantage for custom-designed special-purpose systems, such as a multi-processor RTI has constructed for computer modeling of acid rain.

RTI developed ADAS based on technology developed for the Department

of Defense, NASA, and clients in the electronics industry. The Institute has marketed ADAS for more than three years, and uses it in electronics design projects for government and industry clients.

VALUATION OF HEALTH RISKS

Experience RTI gained through work with the EPA is now translating into improved methods of valuing the health benefits of preventing consumption of foods that violate quality standards. Related experience in helping EPA communicate risk also can be transferred.

Putting a dollar value on preventing air contaminants such as asbestos from causing adverse health effects, and comparing such a benefit with the costs of regulating those contaminants, calls for sophisticated economic analysis. RTI's economists have developed techniques to make such comparisons, providing EPA with information necessary to develop cost-effective regulatory strategies.

RTI is transferring these techniques to a similar effort by the Food and Drug Administration to cost-effectively regulate imported food. Economists at RTI are estimating the dollar value of eliminating such problems as contamination in imported foods. To determine the costs and benefits of proposed regulations, RTI's results will be compared with the impact additional monitoring would have on food prices.

Businesses and government agencies are also becoming interested in how to communicate risk information effectively. The challenge with issues such as radon in homes is to motivate people to make sound decisions on protecting their health.

In 1988 RTI completed a series of studies for EPA using survey-based techniques to track the impact of efforts to communicate radon risk, and to test various approaches to see which work best. For these studies, RTI not only developed promotional materials such as brochures and advertisements, but also a general methodology that can be used to prepare effective communication of risk information on other subjects.

NASA's SPACE-AGE MATCHMAKING

Problems in industry and medicine are matched with space-age solutions in RTI's 22-year-old project for NASA's Technology Utilization Program.

During this long tenure, RTI has helped NASA develop the program into its present form, including market analysis, technology assessment, R&D planning, test and evaluation, and commercialization.

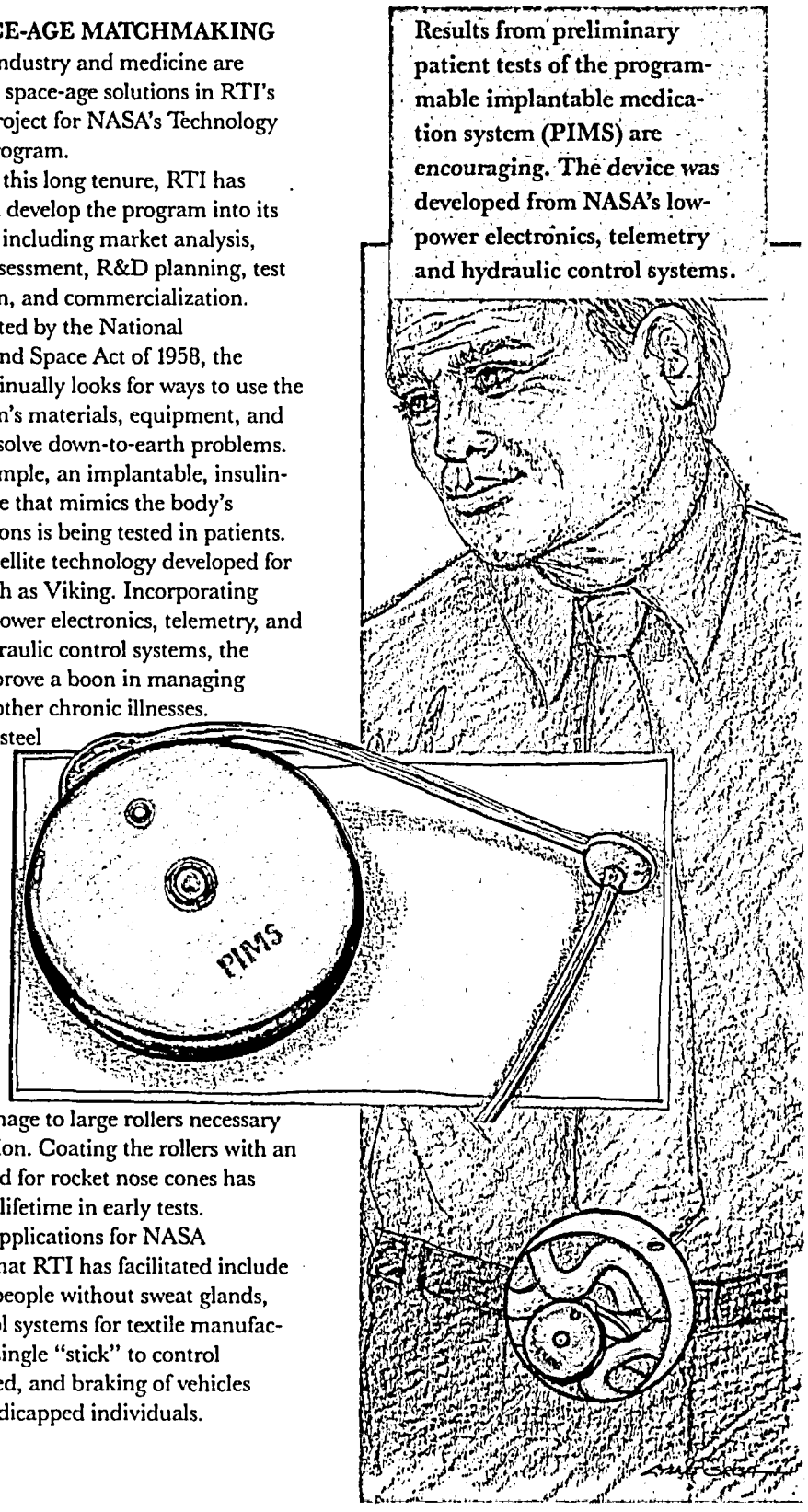
Mandated by the National Aeronautics and Space Act of 1958, the program continually looks for ways to use the space program's materials, equipment, and know-how to solve down-to-earth problems.

For example, an implantable, insulin-delivery device that mimics the body's natural functions is being tested in patients. It employs satellite technology developed for spacecraft such as Viking. Incorporating NASA's low-power electronics, telemetry, and advanced hydraulic control systems, the device could prove a boon in managing diabetes and other chronic illnesses.

For the steel industry, RTI suggested a hard-nosed approach to a problem. High temperatures in a process known as continuous casting caused expensive damage to large rollers necessary for the operation. Coating the rollers with an alloy developed for rocket nose cones has doubled their lifetime in early tests.

Other applications for NASA technologies that RTI has facilitated include cool suits for people without sweat glands, process control systems for textile manufacturers, and a single "stick" to control direction, speed, and braking of vehicles driven by handicapped individuals.

Results from preliminary patient tests of the programmable implantable medication system (PIMS) are encouraging. The device was developed from NASA's low-power electronics, telemetry and hydraulic control systems.



How best to provide services for Army families? How best to design highly reliable computers? How to ensure that drug abuse tests are accurate? How to reduce plastic wastes from Navy ships?

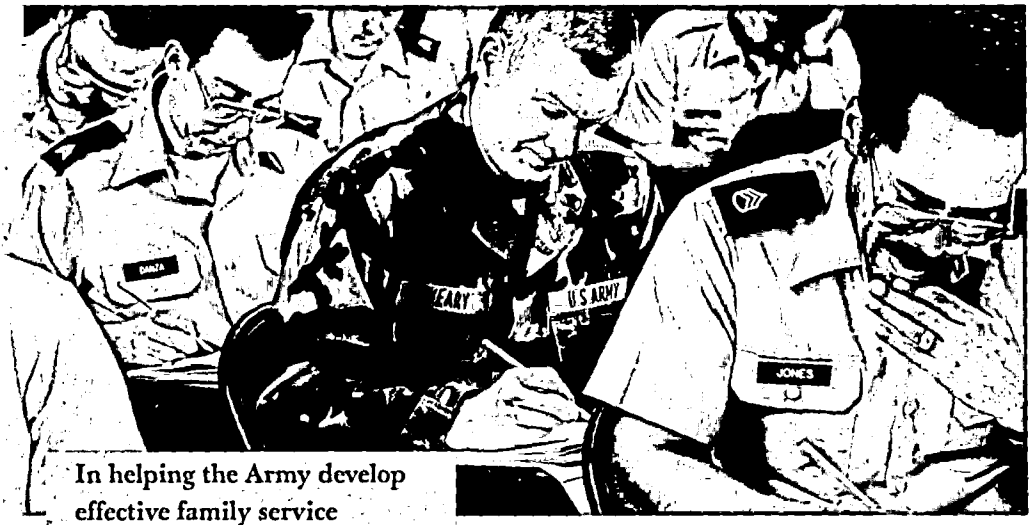
These questions, addressed in RTI's research for the US Department of Defense (DOD), reflect the range of interests among RTI's multidisciplinary staff.

The social and statistical sciences represent the largest volume of work in 1988, followed by electronics, medical research and environmental research and consulting.

SOCIAL SCIENCE

Family life, substance abuse, and recruiting are the three main topics of RTI's current social science research for the military.

For the Army Research Institute for the Behavioral and Social Sciences, RTI is conducting a series of surveys and policy analyses to determine how family life affects the career decisions of military personnel.



In helping the Army develop effective family service programs to increase retention, RTI is conducting nationwide surveys of enlisted personnel.

The study, now entering the third of its five years, produces specific recommendations on improved services for spouses and families of military personnel. For example, job placement assistance for civilian spouses is one of the more cost-effective ways to enhance a family's satisfaction with a military career, which in turn leads to increased retention of military personnel.

In 1988, RTI continued its decade-long series of statistical efforts related to substance abuse in the military. Social science and statistical specialists at RTI began their third worldwide survey of substance abuse and health behaviors among military personnel. The studies are designed to determine the extent to which substance abuse affects the health and performance of military personnel. Among the findings of previous studies is a decline in drug abuse.

MEDICAL R&D

RTI's programs in synthetic and analytical chemistry assist DOD clients to combat substance abuse, disease, and chemical warfare threats to military personnel.

RTI works with the Army and Navy to ensure the quality of drug abuse tests performed at military hospitals. In addition, RTI is nearing completion of a three-year program to develop an electrochemical biosensor for real-time analysis of chemicals.

RTI also synthesizes compounds designed to protect the body from chemical warfare agents such as nerve gases.

ENVIRONMENTAL RESEARCH

RTI scientists and engineers work for DOD to help reduce environmental impacts of military installations and activities.

The US Navy is prominent among RTI's clients for development of biodegradable plastics. Such materials would help the Navy reduce the environmental impacts of refuse from its ships.

RTI also assists the Navy with tests for the presence of carcinogenic asbestos on bases and ships.

For the Air Force, RTI helps evaluate hazardous waste sites, and develops methods to project the extent to which volatile organic compounds enter the atmosphere.

ELECTRONICS

Semiconductors, microelectronic systems and chip designs, computer graphics, and reliability of computer systems continue to dominate RTI's research and engineering for the military.

Semiconductor research ranges from development of specific electronic devices — such as heterojunction bipolar transistors and high-efficiency cascade solar cells — to development of processes for advanced semiconductor materials such as diamond, gallium arsenide and low-temperature silicon.

In microelectronics, RTI continues to develop its computer-aided engineering tool, the Architecture Design and Assessment System (see page 12). ADAS is unique in allowing engineers to concurrently develop both hardware and software for special-purpose computer systems. Using ADAS and other tools, RTI is designing systems for real-time computer graphics, interpretation of remote-sensing data, and fault-tolerant applications such as aircraft computers.

To develop reliable computer systems requires new engineering approaches to build in reliability, plus new experimental validation techniques to assess the quality of software and hardware. For computer hardware, RTI emphasizes CAE tools to improve the pre-prototype evaluation of designs, and also the built-in test concept to help ensure long-term performance. For software, Computer-Aided Software Engineering (CASE) is an important aspect of ADAS and other tools. RTI continues to develop innovative concepts to validate the performance of software as it is being written.

Computer-generated graphics displays in the cockpits of modern aircraft reflect a trend away from conventional instrumentation. As this trend continues, increasingly complex computer systems must be designed to generate the displays.

Specialists in human factors design these new displays, and they need better computer-aided design tools to help them optimize the images. Of equal importance, they also need automated tools to develop the software that implements the images.

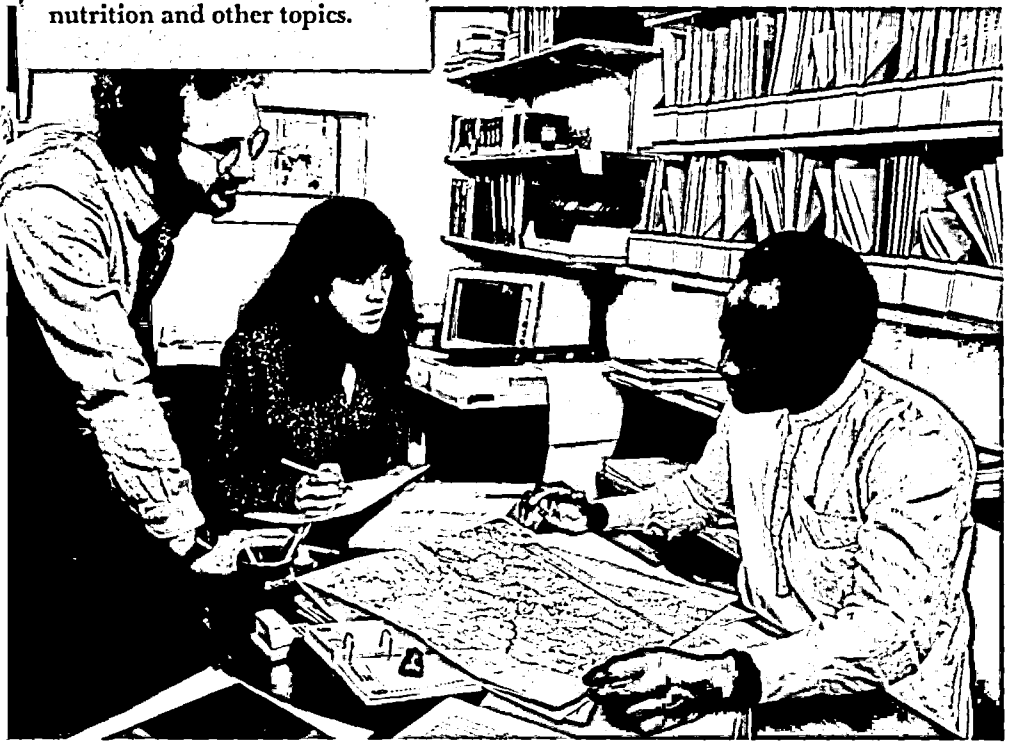
In an ongoing project for the Air Force, RTI is developing such a tool, called the Airborne Graphics Software Support System. AGSSS is a software system that supports interactive and pictorial development of cockpit displays and their dynamic specifications, creates display codes automatically, and compiles the resulting programs to run in airborne processors.

Other electronics-related work includes a program with the Air Force to develop automated warehousing and materials handling methods for manufacturing.

To reduce the time needed to develop computer-generated cockpit displays that are replacing traditional instrumentation, RTI engineers have designed a system for creating the displays and automatically generating the software required to run them. The work was done for NASA and the Air Force Systems Command.

Whether in Washington or Kathmandu, governments face a similar situation – what public policies best help the farmer, businessman, impoverished mother, drug abuser, dropout or gifted scholar while advancing the country's goals? Setting effective policy requires three kinds of knowledge: the behavior of individuals for whom the policy is designed, their social and economic context, and the problems governments face in implementing the policy. In the United States and abroad, RTI staff are addressing all three sets of issues to help mold strong economic and social policies.

Projects in international development call for RTI staff to travel worldwide and for officials from other countries to visit the campus. Institute staff have assisted with projects in population, agriculture, education, housing, urban development, energy, nutrition and other topics.



INTERNATIONAL DEVELOPMENT

What does a baby boom this year mean for a nation's economy 20 years from now? What do those high birth rates mean for mothers' and children's health? Answers to such questions are provided by economic computer models RTI designs and applies in many developing countries.

Examples of this work from 1988 include: a model for Lesotho to demonstrate the national economic benefits of increasing the formal participation of women in economic activities; a microcomputer-based system for managing data and making projections on educational systems for more than 50 countries; and a model to assist the government of India in planning health services.

LEARNING EXPERIENCE

In 1988, RTI embarked on a series of new projects for the US Department of Education to research education issues and evaluate education programs. The research focuses on students with special needs, as well as on management of drug abuse in schools.

RTI is establishing a center to study the inclusion of students with handicaps in regular educational settings. In a related study, RTI will analyze services needed by students with handicaps as they leave school. (Ongoing studies in 1988 gathered information on the effectiveness of selected categorical and noncategorical approaches to educating students with handicaps.)

RTI also conducts a descriptive study of the "Chapter 1" education program for children of migrant workers. Effectiveness of services for language-minority, limited-English-proficiency students is the subject of a project to analyze and report data for national longitudinal evaluations.

In yet another new project, RTI will study the impacts of the Drug-Free Schools and Communities Act.

For the National Science Foundation, RTI began a followup study to determine the amount of class time devoted to science and mathematics, as well as student and teacher attitudes about these subjects.

Abroad, RTI's System for Tracking Educational Progress (STEP) helps school systems evaluate school-age populations, enrollments, repeaters, dropouts and graduates. STEP also assists with needs assessment and cost analysis.

HEALTH AND WELFARE

Examining the performance of health care plans helps determine directions for future programs and policies. In 1988, *The American Journal of Clinical Nutrition* published a special 130-page supplement entitled *The National WIC Evaluation: Evaluation of the Special Supplemental Food Program for Women, Infants, and Children.* The publication highlights six years of RTI work to evaluate the WIC program. This RTI study was the first attempt to measure the nationwide impact of WIC, which is administered at the state and local levels.

Researchers determined the WIC program's effect on child growth, behavior, vocabulary, memory, dietary intake and use of preventive health care. The study also evaluated WIC's impact on concerns such as birth weight, preterm delivery, and food expenditure patterns.

RTI's work related to long-term care continued to expand in 1988, including a new project for the Health Care Financing Administration to develop a system nursing homes will use to determine the needs of their residents and the most appropriate services. RTI also will evaluate the impact this system has on the quality of care provided in nursing homes.

Health researchers also began studies of population demographics and state agency performance in services to the elderly.

DRUG ABUSE

In 1988, RTI researchers continued an almost 20-year tradition of studies on the problem of drug abuse. RTI is conducting the triennial national household survey of drug abuse, and is evaluating the national drug-free schools program.

Work was completed on a book, to be published by the University of North Carolina Press, that summarizes 10-years' work on evaluation of drug abuse treatment programs. A study was begun this year to examine ways to increase the capacity of methadone maintenance programs, part of effort to reduce heroin addiction, the sharing of needles and the spread of AIDS.

With a local school system in North Carolina, RTI designed and is evaluating the effectiveness of an alcohol and drug abuse prevention program aimed at sixth, seventh and eighth graders. If found to be effective, the program could serve as a model for school systems nationwide.

Another project is investigating the quality and utility of self-reporting of alcohol use by those who have been through a treatment program. RTI administers a Washington, DC, clearinghouse for information on the relationship between drug abuse and crime.

Also, work has begun on computer simulation models that will estimate the number of heroin addicts and the spread of AIDS through IV drug use.

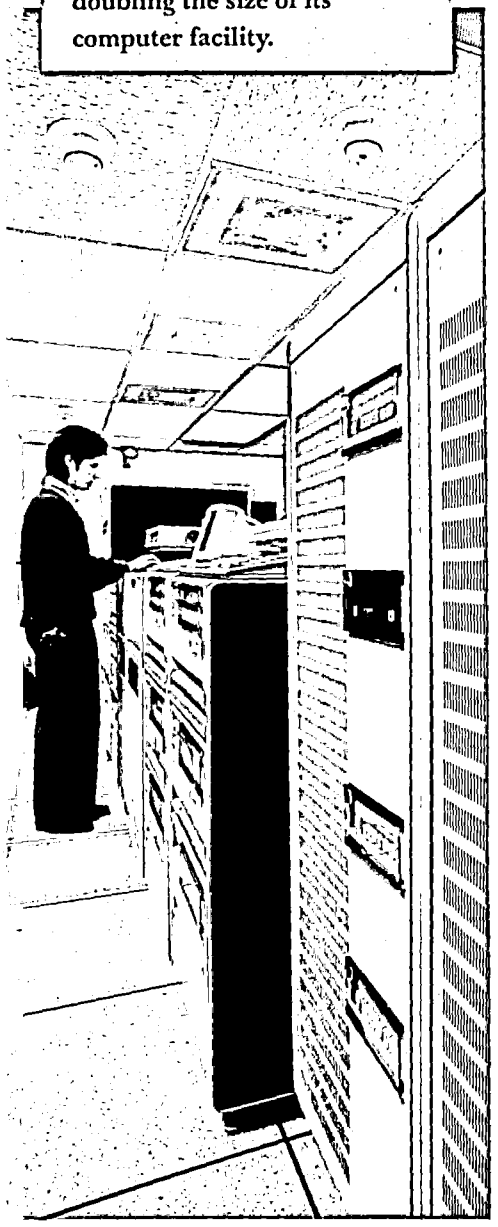
Work on drug abuse encompasses many of RTI's centers, from life sciences to sophisticated statistical analysis and surveys, and emphasizes the strength of the interdisciplinary make-up of the Institute.

RTI conducts statistical and policy analysis research in ways to combat drug abuse. Here, researchers check pharmaceutical inventories against cards developed to help survey participants identify drugs of abuse.

Starting with an address up to 20 years out of date, find an individual. In interviews, assess his or her mental health. Extract information from multiple other sources for thousands of similar individuals. Tabulate the information by age, race and sex. Find other groups that match these demographics for comparison.

Such assignments are formidable.

However, with an interdisciplinary blend of substantive and analytical capability, data collection skills, survey design experience and data-processing computer technology, RTI specializes in large, complex survey research.



An in-house computer center supports survey research and statistical analysis. Assisted by a donation of computer room equipment from General Electric, RTI is doubling the size of its computer facility.

FINDING WHERE THE WAR STILL RAGES

For some Vietnam veterans the war continues even after 20 years at home. In response to a congressional mandate, RTI conducted what has been called "perhaps the most far-reaching and ambitious national mental health epidemiologic study ever attempted on any population."

Relying on experience gained in other complicated studies, RTI staff managed every phase of the four-year National Vietnam Veterans Readjustment Study. To properly assess whether a veteran suffered post-traumatic stress disorder, a multi-dimensional assessment package was developed, including adaptations of both clinical methods and standard survey tools. More than 140 survey specialists and 30 mental-health professionals conducted interviews throughout the nation.

More than 3,000 interviews were conducted with Vietnam theater veterans and comparison groups of other veterans of the same time period, as well as nonveterans.

Data from the thousands of interview questions were compiled, evaluated, verified and summarized at RTI in preparation for testimony before Congress. The large survey tapped the full range of RTI's survey, statistical, analytical, and substantive capabilities.

TAMING LOGISTICAL NIGHTMARES

Review 50,000 x-rays. Search 2,815 medical records. Follow-up with 1,409 patients. Persuade them to return to a clinic they visited years ago or to have an x-ray made and sent to the clinic.

Managing such logistical tangles can be a vital part of valid epidemiologic and health care studies. To determine effects of frequent x-raying of pre-pubescent females with scoliosis, RTI researchers coordinated these activities. Such complicated data collection, in this case to determine if there was a correlation with breast cancer, is a specialty of RTI.

This year saw studies of HIV infecti in mothers and newborns, hemophiliacs a their sexual partners, and laboratory and clinical staff of the National Institutes of Health and its contractors; studies of HIV and HTLV-I infection in populations in the Caribbean; a follow-up of 28,000 patients in the US and England treated for hyperthyroidism; and other studies in the US and abroad for the National Cancer Institute.

RTI works through hospitals, health departments and physicians' offices to collect epidemiologic data. Survey research, sampling statistics and one or more of the physical, social or life sciences units are often involved in epidemiologic studies.

COMPUTER-AIDED SURVEY RESEARCH

The US Army faces crucial questions about the impact of its different family programs on family well-being, soldier readiness, and retention, particularly in a period of static or shrinking budgets and increasing competition for resources.

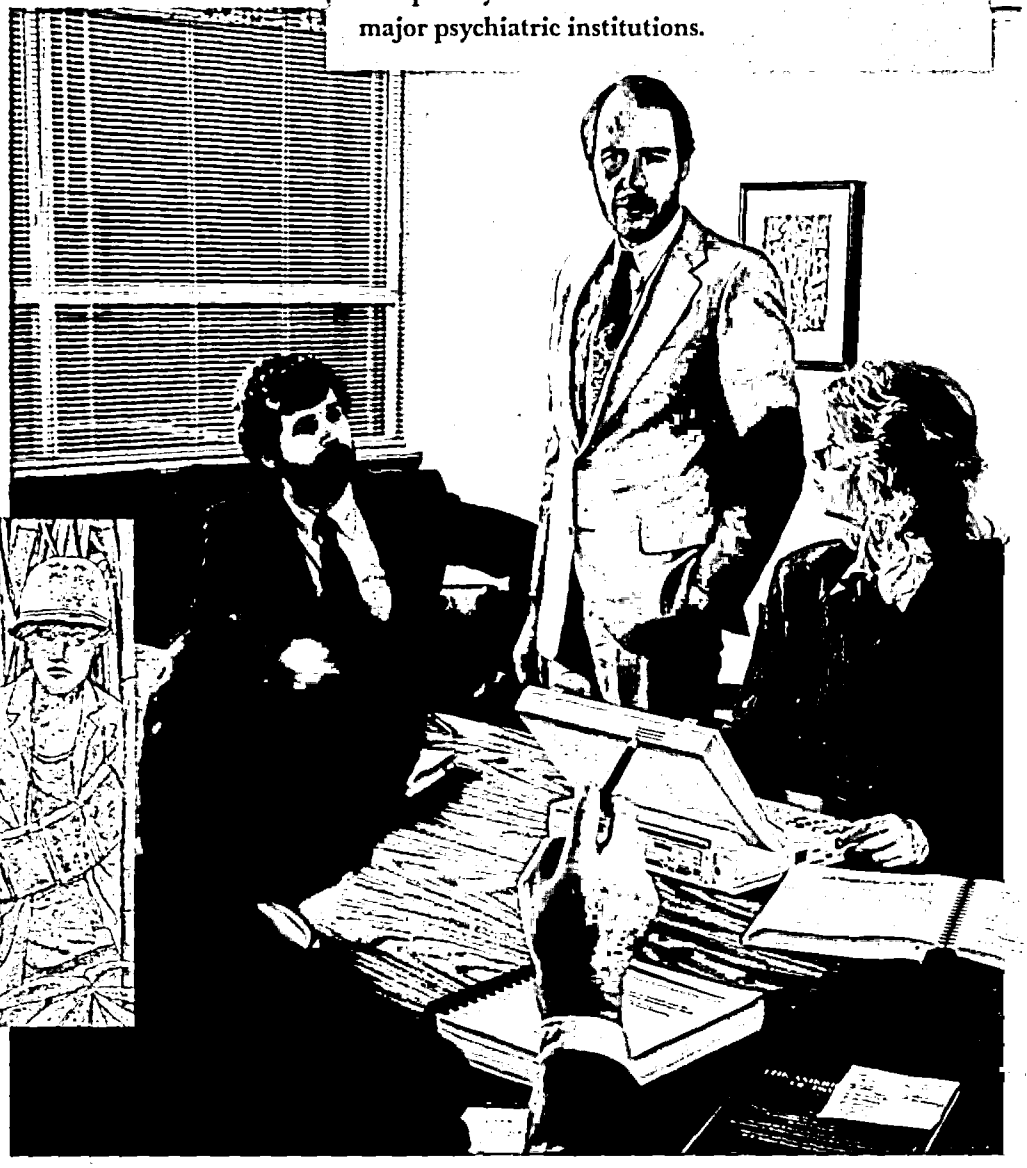
To help answer these questions, RTI has begun a new project to design and implement an efficient and versatile sample survey program called the Army Computer-

Aided Telephone Interview (ACATI) system. Based on RTI's experience with computer-enhanced data collection, the system will include all phases of survey design, implementation, analysis and reporting.

RTI will use ACATI for surveys to assess Army programs and policies and to examine the climate within the Army and its families for programs and policies related to readiness, retention, and family well-being.

In the first year, it is anticipated that the Army will request one in-depth survey of about 1,600 respondents (Army personnel or family members), two quick-response surveys of about 400 respondents, and a pulsing survey designed to monitor trends over time.

This year RTI completed a study for Congress on the prevalance of post-traumatic stress disorder among Vietnam-era veterans. Staff members designed and executed the study with an inter-disciplinary team that included researchers from major psychiatric institutions.



Research on health care, including statistics, policy analysis, chemistry, life sciences, and biomedical engineering, is a major theme of RTI's research efforts.

In 1988, AIDS came into sharp focus as the dominant topic of RTI's health care research. From statistical innovations that have made complex, but urgent, clinical trials possible, to rapid synthesis of experimental drugs for pharmacology research, RTI's wide-ranging experience has helped advance both treatments and understanding of this epidemic.

Supercritical fluid chromatography is one of the advanced analytical techniques that RTI chemists use for development and study of a variety of compounds, including new drugs.

THE CHEMISTRY OF THE DRUG

As new therapeutic drugs are developed, specialists in analytical and synthetic chemistry must contribute to exacting studies that precede clinical trials.

For the National Cancer Institute, RTI develops the analytical procedures that ensure consistent quality of experimental anti-cancer drugs. These procedures, based on the sophisticated chemistry facilities here (see page 8), also provide necessary information about the physical and chemical characteristics of drugs.

Similar studies are under way for pharmaceutical companies for a variety of new chemical entities.

Synthetic chemistry not only contributes new compounds, but also provides materials necessary for pharmacology studies that reveal how a new drug interacts with the body's metabolism. This information leads to decisions on dosing regimens for the initial stage of clinical studies.

For such studies, RTI synthesizes isotopically labeled versions of experimental drugs. In 1988, a laboratory at RTI was dedicated to synthesizing labeled versions of new AIDS drugs. Ongoing programs include cancer drugs, drugs of abuse, and a variety of other compounds.

MULTI-CENTER STUDIES

Statisticians at RTI have worked for many years to hone their skills to manage and analyze data from large, multi-center clinical trials. In 1988, the Institute's statistical, computer, and data management professionals were active in no less than seven trials on a wide variety of medical subjects.

In the coming year, RTI will complete a clinical trial on the use of ventilators to assist premature infants with lung problems. Meanwhile, in an ongoing study involving 15,000 women, RTI will assess the extent to which timely treatment of gestational genitourinary infections will prevent premature births.

Nearing completion is a study on the effectiveness of diagnostic ultrasound to detect and quantify atherosclerotic lesions in carotid arteries. RTI is assisting the Bowman Gray School of Medicine with a new clinical trial on drug therapy to retard the progression of atherosclerotic plaques in carotid arteries.

In an AIDS-related study, RTI is gathering data on the development of pulmonary complications experienced by people with HIV infection.

The AIDS clinical trials for the National Institute of Allergy and Infectious Diseases (NIAID) present unique challenges. The program is large (34 clinical centers), complex (more than 80 simultaneous clinical studies), and urgent.

The program has grown from its original handful of clinical centers, and is now poised to move from a phase of solving unprecedented data management problems to a phase of generating vital statistics on AIDS treatments.

RTI has developed a unique distributed data collection system for the study. Each clinic is part of a nationwide computer network, entering data every day. At night, computers transfer the data to RTI, where the laborious process of quality assurance and data analysis begins. This distributed system is also being used for several of RTI's other ongoing multi-center clinical studies.

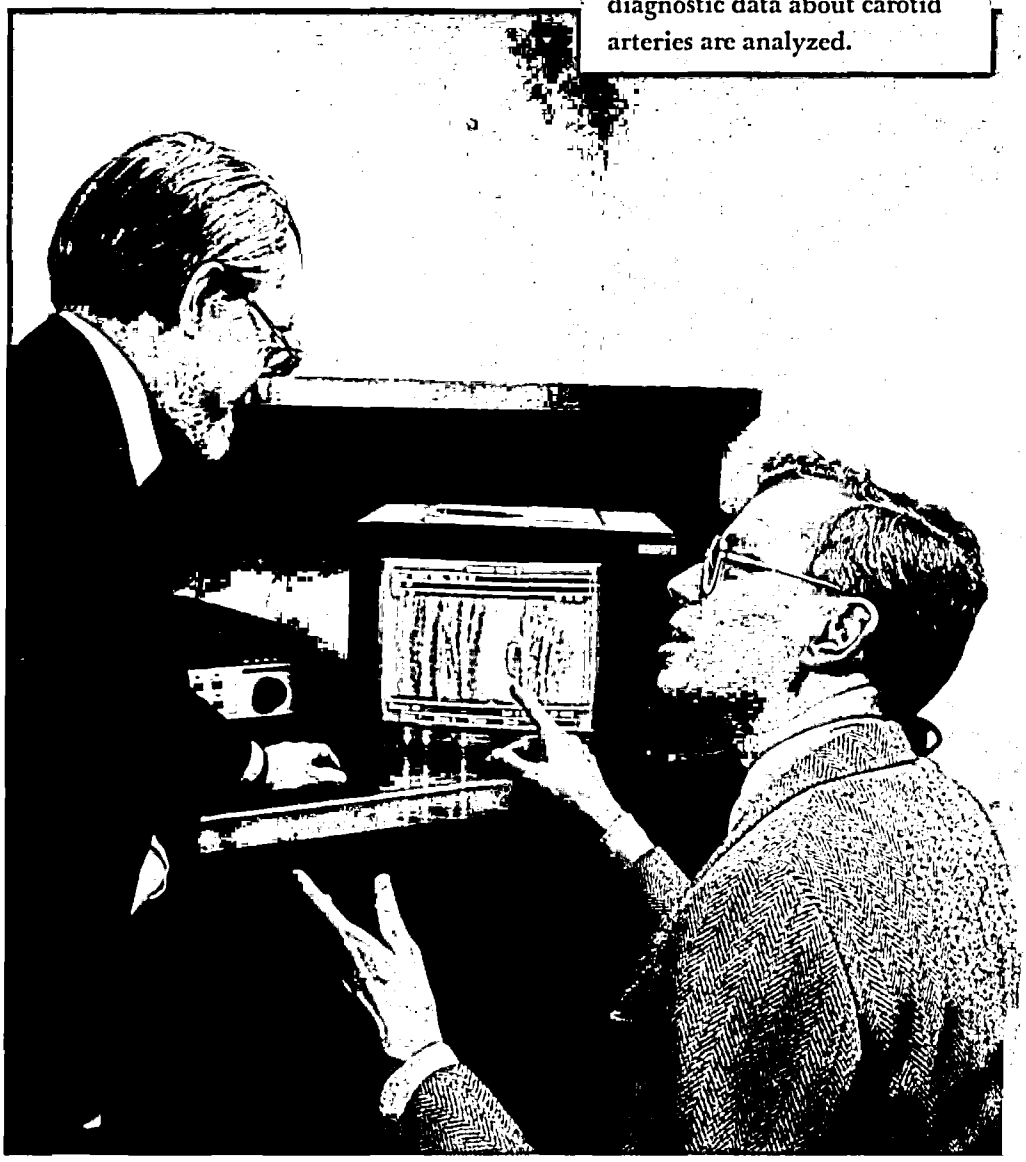
BIOMEDICAL ENGINEERING

Through technology transfer (see page 12) and engineering, RTI develops new diagnostic and prosthetic technologies.

1988 was largely a year for continued development of technologies such as speech processors for hearing prostheses, compact data systems for portable diagnostics, and materials applications within the NASA technology transfer program.

An emerging program, however, involves the reliability of software in biomedical devices. For nearly a decade, RTI has been working with NASA to create procedures to develop and validate highly-reliable software for life-critical applications. While the original emphasis was on electronic systems in aircraft, RTI has been called upon by both industry and government to assess how these procedures could apply to biomedical software.

RTI and the Bowman Gray School of Medicine began a study in 1988 of warfarin and lovastatin as they are used to combat atherosclerosis. Shown here is a facility in Winston-Salem, NC, where diagnostic data about carotid arteries are analyzed.

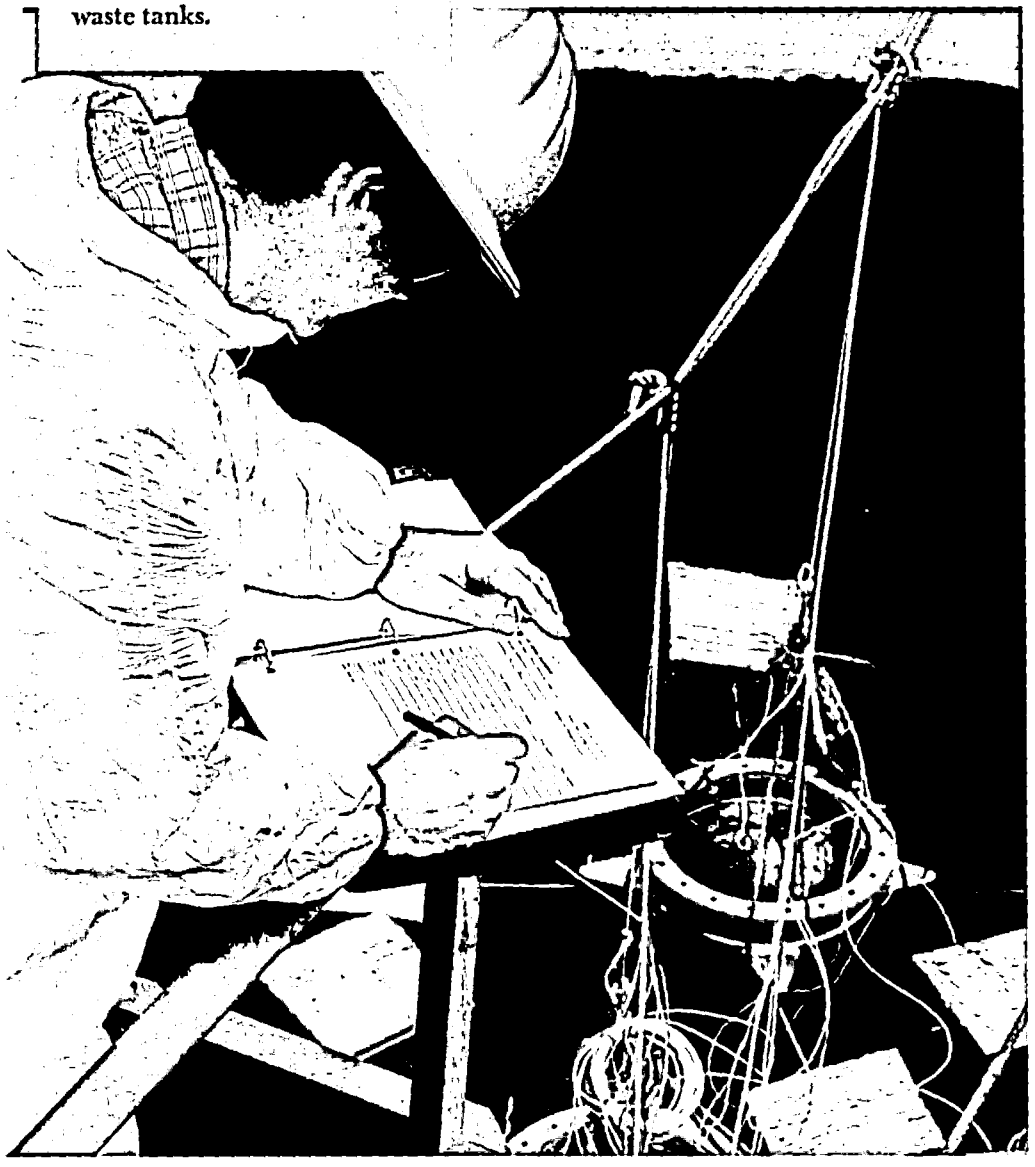


Much of RTI's work, involving nearly every scientific and engineering discipline at the Institute, concerns the effects that pollutants are having in our environment and in the bodies of animals and humans.

Perhaps more than any other field of investigation, environmental research draws on the broad range of expertise that RTI comprises. While chemists and biological investigators use sophisticated technologies to probe the problems on the molecular level, economists evaluate the benefits and costs of proposed environmental regulations at the national level.

The range of disciplines at RTI has made the Institute a valuable partner in the critical work of protecting our environment and ourselves.

Flux chambers, adapted at RTI to measure volatile organic emissions from hazardous waste sites, provide critical information about what is being released into the air. Here, RTI staff use flux chambers to collect samples from large chemical waste tanks.



FIELD AND LABORATORY

Researchers must often begin environmental work by developing a method of collecting the pollutant in the field. Work in 1988 produced such methods for chromium VI, the carcinogen benzene, and the dry deposition portion of acid rain. Laboratory analysis of samples, which requires the separation of compound components, presents a variety of challenges. For example, chemists combined supercritical liquid chromatography with high performance liquid chromatography to investigate pesticides in milk.

In related work, standard testing samples were developed for auditing laboratories that conduct testing for the EPA.

TOXICOLOGY

RTI's toxicology program focuses on the impacts of chemicals, particularly those in the environment, on human health. The program includes both *in vivo* and *in vitro* techniques.

The year's most important events centered on completion of a two-year project to enlarge the facility for *in vivo* research. This has doubled the size of the behavioral toxicology facility, created a functional histology laboratory, and expanded and upgraded all other aspects of the facility.

The National Toxicology Program continues funding research on birth defects and the effects of chemical exposures on reproductive capability.

RTI's main *in vitro* laboratory continued to use the Ames assay and mammalian cell cultures to assess the muta-

genicity of chemicals for clients in industry and government. In 1988 an important new relationship was developed with a company in the health care products industry.

Another *in vitro* laboratory is for electrophoretic detection of mutations. Work in 1988 included studies of mutations in male mouse germ cells caused by ethylene oxide (an industrial pollutant) and X-rays.

The toxicology program expanded in 1988 to included development of molecular methods, such as DNA sequencing, which permits direct analysis of changes in genetic material. One current project is a study of the fidelity of the AIDS virus DNA polymerase in phage DNA.

BENEFITS AND COSTS

How much is unpolluted water in a stream worth? If forced to make a decision, would people rather have cleaner air and higher gasoline prices, or current levels of air quality and prices?

The evaluation of non-market goods, such as the environment, is a complex science that occupied researchers in several 1988 projects. Economists have devised ways to put dollar values on non-market goods so that they can be compared to costs of regulation.

In one study, researchers estimated the value of losses in a bay and wetlands caused by an oil leak. Another project looked at the value of changes in employment opportunities caused by environmental regulation.

Other 1988 projects examined regulatory alternatives, looking at environmental standards, equipment and methods available, and their costs. In particular, researchers studied alternatives for hazardous waste site regulation.

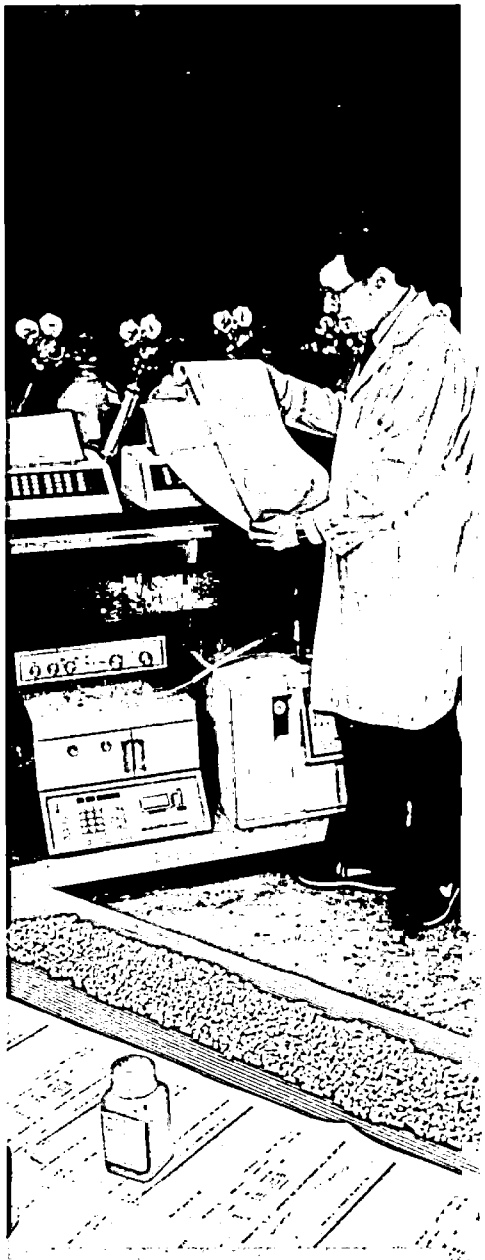
CONTROL TECHNOLOGY

Clearing the air was a priority for RTI's chemical engineers in 1988. Projects included methods development for both industrial and home use.

Electrostatic precipitators clean pollutants from vapors being released by industrial smokestacks. Engineers finished work on a computer model for designing precipitators that allow for variations in ash content, temperatures, sizes of ash particles and other factors. Engineers also worked on mathematical models to predict the increase of precipitator efficiency through the use of cold pipe prechargers.

To help clean up coal's reputation as a dirty fuel, other control technology work focused on methods of getting pollutants out of the hot gas produced by coal-burning power plants.

In projects for improving the quality of indoor air, staff members evaluated the efficiency of fibrous filters and electronic air cleaners for ventilation systems. They also began work on a simulator to predict air-quality for specific rooms. This system would help designers specify ventilation systems to improve indoor air quality, and would aid investigators in trouble-shooting "sick building" problems in existing structures.



Pellets developed for sorbent beds offer a promising, cost-effective method to remove coal-gas chemicals that, in advanced power-generation systems, would contribute to acid rain. The sorbent beds are being tested in a unique bench-scale system developed by RTI engineers.

State and local governments call upon RTI's experience with environmental, educational, economic, and social policies.

Studies range from atmospheric chemistry to community college curricula, and from water resources to prevention of substance abuse.

A municipal drinking water system in North Carolina is enjoying significant cost-saving as a result of an RTI project to optimize pumping schedules and use. The software package developed for the program makes the most of varying time-of-day electric rates and each pump's capacity.

ENVIRONMENTAL ISSUES

An important new study in 1988 is the evaluation of existing environmental management and resource protection programs for the Albemarle and Pamlico Sounds. RTI is working with the NC Department of Natural Resources in this study of the state's two largest sounds, which are part of the EPA's national estuaries studies program.

Ongoing projects for the California Air Resources Board include studies of atmospheric chromium, comparisons of indoor and outdoor pollution, and quality assurance for environmental measurements.

Other environmental studies for state and local governments in 1988 include work on air emissions from hazardous waste sites in North Carolina, measurements and modeling of toxic air pollutants in New Jersey and analysis of water extracts in Florida.

EDUCATION

RTI helps community colleges plan curricula for anticipated industrial development. Studies in 1988 included estimating the training needs of a college near a new automobile plant, and analyzing employers' needs for skills related to electro-optic technologies.

Local school systems benefit from RTI's capabilities to develop plans for school system mergers and analyze their potential impacts. Studies in 1988 included systems in North Carolina and Ohio.

ECONOMIC DEVELOPMENT

RTI helps state and local governments plan and evaluate economic development initiatives.

One 1988 study, funded by an electric utility, resulted in a program that offers rate incentives to retain industrial customers. RTI developed a computer program to evaluate applications submitted by these customers to qualify for the rate incentive. Other recent studies include a labor market needs analysis and population and employment projections.

Also related to economic development is management of water resources. Ongoing projects in 1988 included regional water supply and demand analyses in central North Carolina and in New Mexico.

In a new water resources program, RTI developed a computer model to help water systems get maximum benefits from time-of-use electricity rates. The first application, in Raleigh, NC, allowed the city to significantly reduce the costs of pumping water.

SOCIAL POLICY

RTI provides needs assessments for state and local social services agencies, and technical assistance in planning services programs.

RTI is assisting a county social services agency to plan and execute a substance abuse prevention program in schools. In a new project, RTI is evaluating a statewide alcohol and drug abuse service system in one of the nation's largest states.

ELECTRIC UTILITIES

Electric utilities are among the most important categories of private-sector clients for RTI. Services to these companies include benefit-cost and market analyses, integrated resource planning, market analyses of technologies and business plans, load research, and design and evaluation of innovative rates and services.

Additional work for utilities is related to environmental responsibility.

DEMAND-SIDE PROGRAMS

Demand-side management includes activities designed to change the ways customers use electricity to benefit both the customers and the utility. RTI's studies help utilities plan and execute effective programs in both conservation and load management.

In 1988 RTI continued a multi-year project with a large northeastern utility to identify how rebates encourage energy-efficient appliances, and to forecast customer acceptance of other demand-side programs.

IMPACTS OF NEW TECHNOLOGIES

Anticipating the market potential and rate of market penetration for end-use technologies, such as ground-coupled heat pumps, helps utilities improve their long-range demand forecasts, guides their resource planning, and points to marketing plans that will promote technologies to help achieve load-shape goals.

In 1988 RTI designed and developed a set of market forecasting models for a large utility on the east coast. The utility uses these models to anticipate customer acceptance of demand-side programs that include specific end-use technologies.

RTI also has begun a multi-year project for the Electric Power Research Institute to design, develop, and test a complete system of forecasting tools to help utilities forecast market potential and penetration of new end-use technologies.

MARKET AND BUSINESS ASSESSMENTS

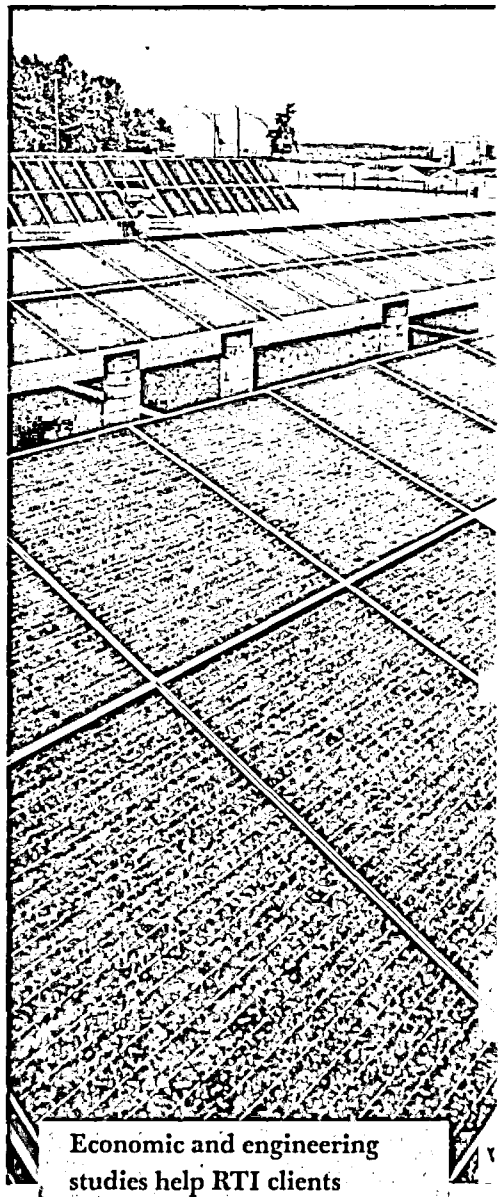
Many electric utilities are looking for ways to broaden their business opportunities by using their knowledge of energy production and marketing. In 1988 RTI conducted market and business assessments for various options its clients are exploring.

RTI assessed opportunities in power conditioning equipment, small cogeneration systems, and photovoltaics. In each study, RTI made 10-year estimates of market potential and assessed possible business roles for the utility company in these markets.

ENVIRONMENT

RTI conducts fundamental and applied research on particulate control technologies such as electrostatic precipitators, filtration, and electrically-enhanced filtration.

Another important focus has been innovative technology to cost-effectively recover sulfur from fossil fuels.



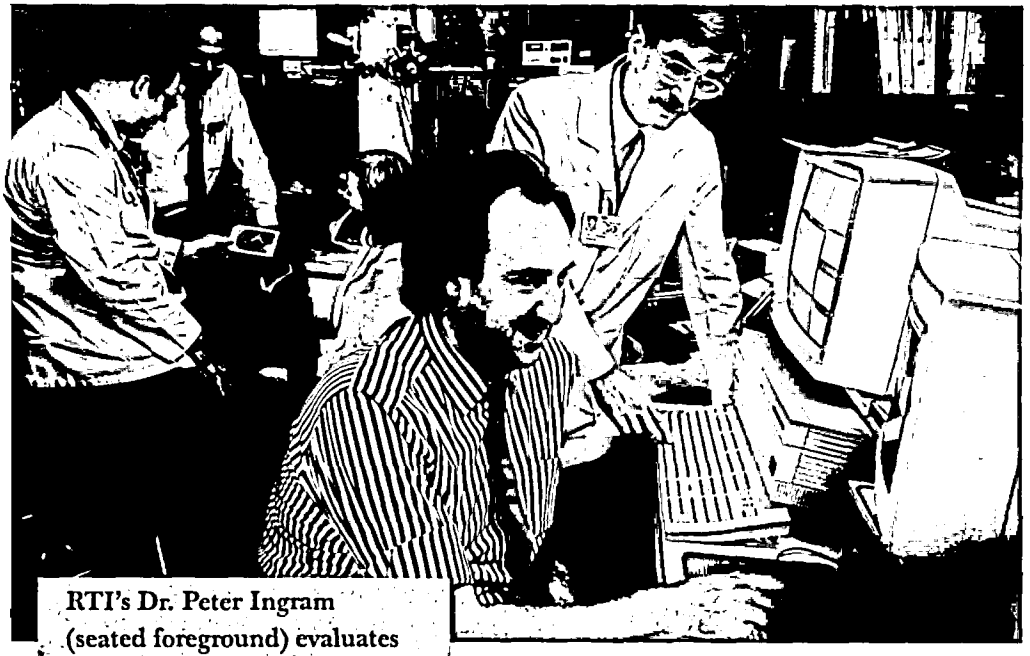
Economic and engineering studies help RTI clients develop effective conservation, load management, operating and capacity expansion strategies. Shown here is a photovoltaics station at a utility company, one of the Institute's clients.

When scientific institutions of North Carolina take on interdisciplinary research programs and projects, they look to each other for collaborative relationships. For three decades, these relationships have extended the multi-institutional research community on which the Research Triangle concept was based.

RTI participates in this community as a leader in its own projects, as an associate through subcontracting relationships, and as a colleague in joint development of new programs and capabilities.

On these pages are examples of collaborative efforts with each of the research topics covered in this annual report.

RTI's chemistry staff works in collaboration with Duke University on NCI-funded research on cancer preventive compounds, assists with development of platinum anticancer drugs at the University of North Carolina at Chapel Hill (UNC-CH), and provides analytical support for industrial studies at NC State University (NCSU).



RTI's Dr. Peter Ingram (seated foreground) evaluates electron microscopy images with medical researchers at Duke University Medical Center.

Semiconductor researcher Gill Fountain (seated) works with graduate students at North Carolina State University's plasma enhanced chemical vapor deposition facility.

RTI works through the Microelectronics Center of North Carolina on industry-funded research to improve contamination control in clean-room settings. NCSU is a collaborator in this program of fundamental and applied research.

Technology development and transfer includes applied research on speech processors for auditory prostheses, which are evaluated in the Duke-RTI Center for the Severely Hearing Impaired. In addition, RTI, Duke, and UNC-CH are collaborating to develop and test physiological monitors based on impedance cardiography.

The NCSU Department of Physics and RTI's Semiconductor Research Center collaborated to develop a new plasma deposition process to make exotic semicon-

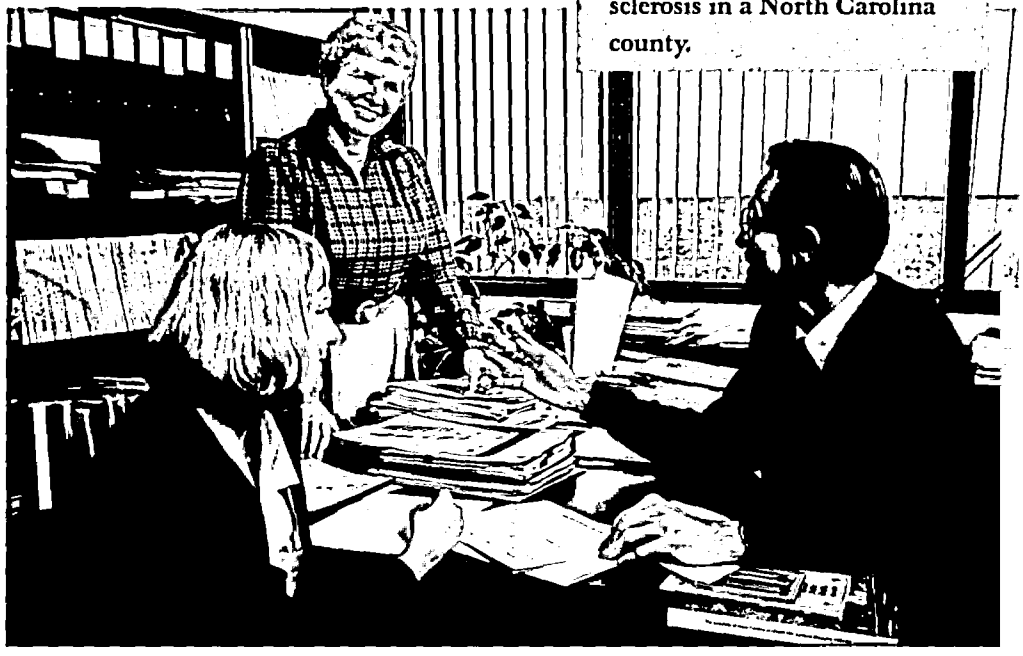
Bowman Gray School of Medicine at Wake Forest University. The two institutions are assessing lovastatin and aspirin to treat atherosclerosis.

NCSU has been assisting with an RTI project for the Gas Research Institute in which improved technologies are being developed to reduce base gas requirements in underground natural gas storage facilities.

RTI is assisting the NC Department of Natural Resources with an EPA project on an issue of state and local impact in North Carolina: environmental management and resource protection programs in the Albemarle and Pamlico sounds.

A petroleum engineer and an economist from NCSU collaborated with RTI to analyze trends in the East Coast market for natural gas. RTI's client, an electric utility, used this information in planning its approach to gas-fired cogeneration systems.

RTI staff members Ann Toledo (seated) and Dr. Jane Bergsten consult with University of North Carolina professor of epidemiology Dr. Gerardo Heiss on a study of the prevalence of atherosclerosis in a North Carolina county.



ductor materials. While each institution has developed its own research focus, collaboration remains important.

Continuing a long-term collaborative effort in the social sciences, UNC-CH researchers are working with RTI on two new studies on educating children with handicaps. Another UNC-CH team is working with RTI on an NIH project regarding factors that influence timing and variation of the end of childbearing.

RTI's survey research and data collection abilities are crucial to Duke's epidemiology research on mental health, and to a new Duke survey on dental health among older people.

A new clinical trials project in 1988 involves RTI as a subcontractor to the

GOVERNANCE AND CORPORATE OFFICERS

Board of Governors

Of the 27 Governors:
five hold seats by virtue of their positions: the presidents of The University of North Carolina, Duke University, and the Research Triangle Institute, and the chancellors of NC State University and the University of North Carolina at Chapel Hill; two are specified in the By-Laws: George Watts Hill and William C. Friday; nine are appointed annually to represent Duke University, The University of North Carolina general administration, NC State University, and UNC-Chapel Hill; 11 Governors are elected from the business and professional communities: A separate category of Lifetime Governor recognizes retired Board members who have made extraordinary contributions to the progress and welfare of RTI. Robert T. Armstrong is the current Lifetime Governor.

Chairman:
George Watts Hill*, Chairman of the Board, Central Carolina Bank and Trust Company, Durham

Executive Committee Chairman:
Marcus E. Hobbs*, University Distinguished Service Professor Emeritus of Chemistry, Duke University

H. Keith H. Brodie, President, Duke University

Ivie L. Clayton, Business Consultant, Raleigh

Pedro Cuatrecasas, Senior Vice President of R&D, Glaxo, Inc., Research Triangle Park

Raymond H. Dawson*, Senior Vice President and Vice President for Academic Affairs, The University of North Carolina

William C. Friday, President, William R. Kenan, Jr. Fund, Chapel Hill

Steve C. Griffith, Jr., Senior Vice President and General Counsel, Duke Power Company, Charlotte

Phillip A. Griffiths*, Provost, Duke University

Paul Hardin, III
Chancellor
University of North Carolina at Chapel Hill

Margaret T. Harper*, President, The Stevens Agency, Southport

Franklin D. Hart*, Vice Chancellor for Research, North Carolina State University

George R. Herbert*, President, Research Triangle Institute

Earl Johnson, Jr.*, President, Southern Industrial Constructors, Inc., Raleigh

Matthew Kuhn, Assistant Vice President, Resource Development and Administration, BNR, Inc., Research Triangle Park

William F. Little*, University Distinguished Professor of Chemistry, University of North Carolina at Chapel Hill

Larry K. Monteith*, Dean of the College of Engineering, North Carolina State University

George E. Norman, Jr.*, Greensboro

J. Dennis O'Connor*
Vice Chancellor for Academic Affairs and Provost, University of North Carolina at Chapel Hill

Bruce R. Poulton, Chancellor, North Carolina State University

Charles E. Putman, Vice Provost for Research and Development, Duke University

Thomas A. Rose, President, Blue Cross and Blue Shield of North Carolina, Durham

Patricia C. Skarulis, Vice President for Information Systems, Duke University

C. D. Spangler, Jr., President, The University of North Carolina

Thomas J. Troup, Vice Chairman, Burr-Brown Corporation, Tucson, Arizona

Charles B. Wade, Jr., Winston-Salem

Phail Wynn, Jr., President, Durham Technical Community College

*Member, Executive Committee

Members of the Corporation

The Members are the equivalent of RTI shareholders. As such, they elect the Governors who represent the business and professional communities.
Of the nine Members of the Corporation:
four are the chairmen and presidents of The University of North Carolina and Duke University;
one is George Watts Hill, a lifetime Member of the Corporation;
four are elected annually, two from and by the Duke University Board of Trustees, and two from and by the Board of Governors of The University of North Carolina.

Members of the Corporation representing Duke University are:
H. Keith H. Brodie, Durham
Nathan T. Garrett, Durham
Fitzgerald S. Hudson, Charlotte
Thad B. Wester, Raleigh

Members of the Corporation representing The University of North Carolina are:
Robert L. Jones, Raleigh
T. Henry Redding, Asheboro
Hon. Robert W. Scott, Haw River
C.D. Spangler, Jr., Chapel Hill

Corporate Officers

RTI officers, including the research vice presidents listed on page 7, are elected by the Board of Governors.

George R. Herbert, President
Alvin M. Cruze, Executive Vice President
William H. Perkins, Jr., Financial Vice President
Grace C. Boddie, Vice President-Senior Counsel
Suzanne P. Nash, Corporate Secretary
R.S. McLean, Treasurer and Assistant Corporate Secretary

AN OVERVIEW OF RTI

A. Introduction

Research Triangle Institute (RTI) is a not-for-profit contract research corporation located on a 180-acre campus in the center of North Carolina's Research Triangle Park. RTI was established in 1958 by the University of North Carolina at Chapel Hill, Duke University, and NC State University.

RTI conducts applied and basic research and provides technical services in the United States and abroad for private-sector clients, national, state, and local governments, and public service organizations.

B. Organization and Staff

RTI's organization supports the formation of interdisciplinary teams to address complex research issues.

The staff of more than 1,450 includes approximately 60 percent professionally trained research personnel. Of these, about 30 percent have doctoral degrees and another 30 percent have master's degrees. The backgrounds of this staff cover more than 115 degree fields.

Major areas of training and experience include:

Social Sciences: economics, econometrics, benefit-cost analysis, evaluation research, urban and regional planning, international development, health services and health policy research, agricultural development, sociology, psychology, social psychology, education, business administration, public administration, municipal financial management, criminology, law, political science, and the humanities.

Survey Research: sample design and selection, survey planning and execution, data collection and management, and research and development on survey methodology.

Mathematics, Statistics, and Computer Sciences: data management and analysis, statistical methods development, statistical analysis, biostatistics, clinical trials, epidemiology, computer-aided engineering, CAD/CAM, systems software, software verification, computer security, numerical modeling, and operations research.

Environmental Sciences and Engineering: environmental controls and engineering, environmental chemistry, environmental health, industrial hygiene, hazardous materials management, hydrogeological and earth and mineral sciences, meteorology, and oceanography

Chemical and Biological Sciences: analytical, organic, inorganic, physical, polymer, and medicinal chemistry, toxicology, pharmacology, genetics, neuroscience, biology, biochemistry, and microbiology.

Engineering and Physics: electrical, electronics, systems, computer, semiconductors, chemical, biochemical, energy, industrial, mechanical, manufacturing, materials, biomedical, aerosol, civil, petroleum, nuclear, aeronautical, and transportation engineering.

C. University Affiliations

RTI was created as the focal point for growth in North Carolina's Research Triangle Park, an industrial and governmental scientific center built around the resources of the area's three major research universities.

RTI's capabilites are greatly expanded by frequent collaboration with university scientists. Additional relationships include joint staff appointments, cooperative research programs, and other professional contacts. RTI participates with universities and business in the Microelectronics Center of North Carolina and the North Carolina Biotechnology Center.

D. Laboratory and Office Facilities

RTI's 16 buildings contain more than 400,000 square feet of space, including laboratory, computer, and related facilities for all RTI programs. RTI also maintains research offices in Washington, DC; Newport News, VA; Cocoa Beach, FL; and at various project locations in the US and abroad.

E. Computer Facilities

In-house facilities for data management and analysis, statistics, simulation, modeling, software R&D, computer-aided engineering, electronics, and laboratory management include minicomputers, microcomputers, and a mini-supercomputer.

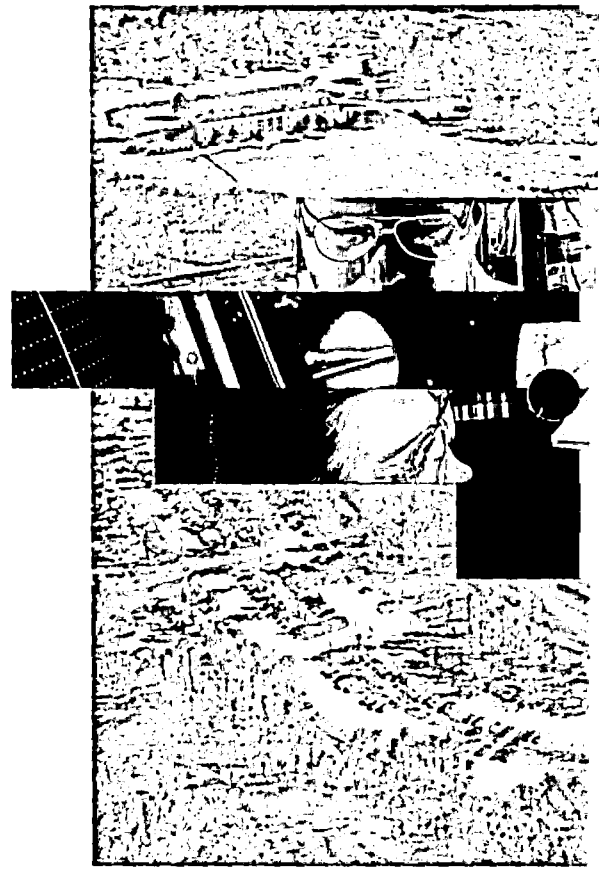
RTI also has daily traffic with computer networks such as those of the Department of Defense Advanced Research Projects Network (ARPANET), NASA's AIRLAB research facility, the Microelectronics Center of North Carolina, COMNET, the Environmental Protection Agency, the Health Care Financing Administration, the National Institutes of Health, and the National Center for Health Statistics.

F. Library Facilities

The RTI Technical Information Center provides on-line computerized literature searches via more than 300 data bases relevant to RTI research programs. The Center maintains subscriptions to more than 1,035 professional periodicals. Specialized libraries are maintained in RTI research buildings.

RTI staff have full access to the combined libraries of the nearby universities, which have been cross-cataloged and shared since 1934. Access is facilitated by computerized catalog links and daily truck service.

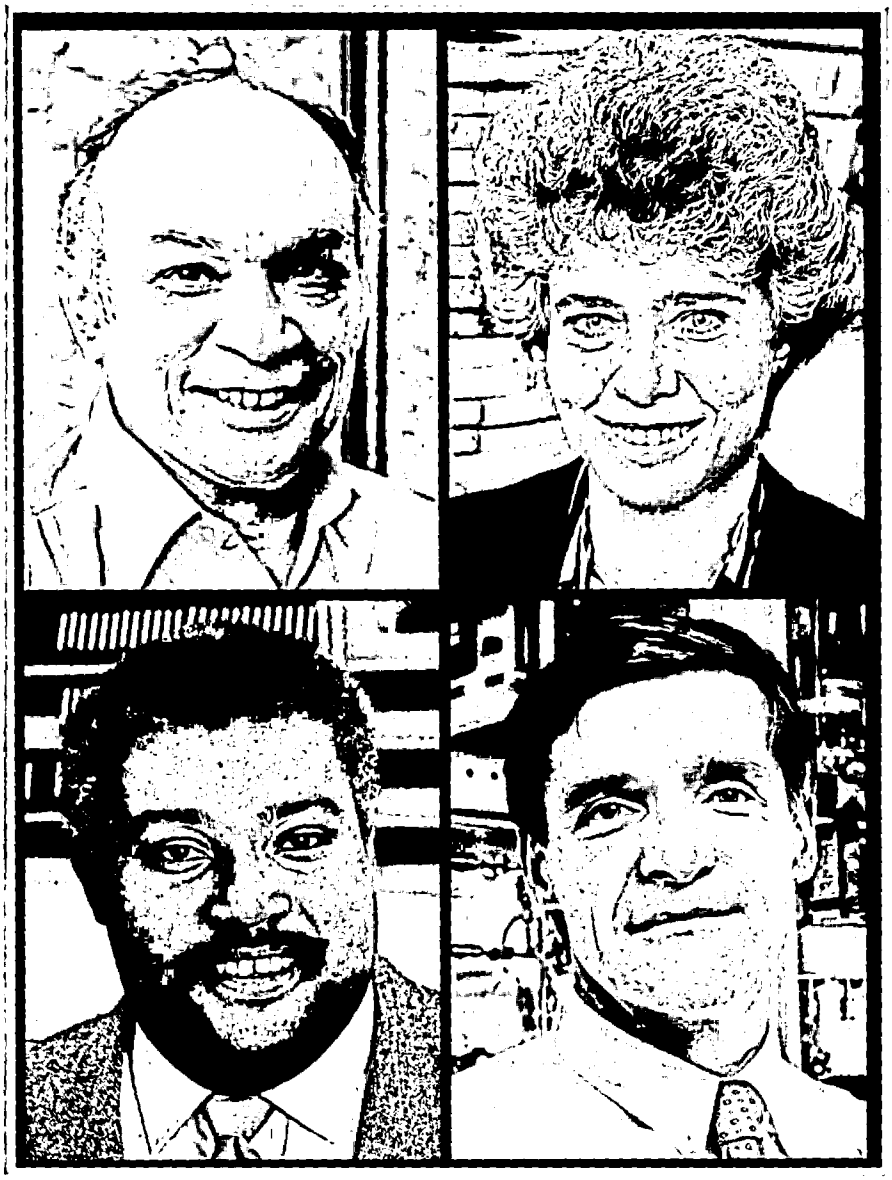
The combined university collections include more than 7 million bound volumes, 80,000 current serials and periodicals, 4.5 million microforms, and 14 million manuscripts. The UNC-Chapel Hill library is the regional repository for US Government documents.



RESEARCH TRIANGLE INSTITUTE
3040 Cornwallis Road PO Box 12194
Research Triangle Park NC 27709
USA

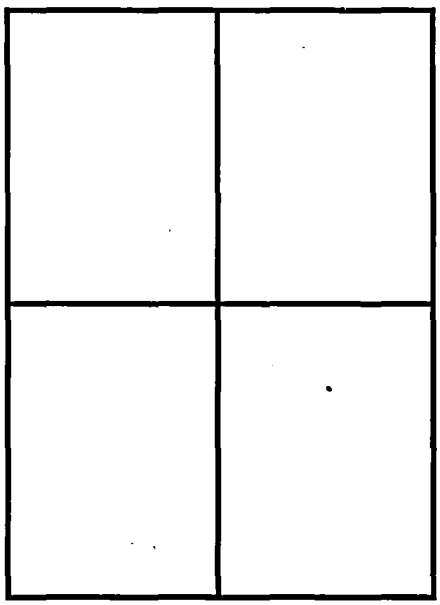
Telephone 919-541-6000
Cable RESTRINS, Raleigh, NC
Telex 802509 (RTI RTPK)
Fax 919-541-5985

RESEARCH TRIANGLE INSTITUTE



1989

ANNUAL REPORT

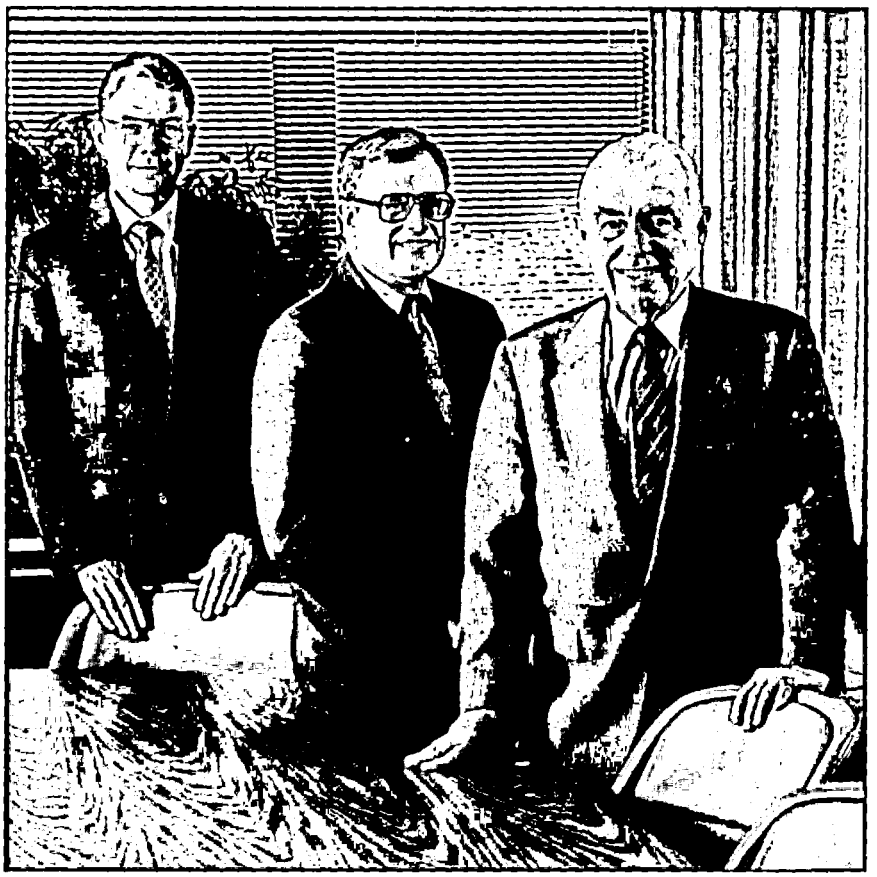


Founded in 1958 with a staff of one, RTI now employs nearly 1500 people, with nationally recognized specialists in chemistry, social sciences, engineering, international development, statistics and many other fields.

Under contract to governmental and industrial clients, RTI conducts applied and fundamental research, with 1989 revenues totaling $88.3 million.

RESEARCH TRIANGLE INSTITUTE
1989 ANNUAL REPORT

RTI Names New Senior Executives



F. Thomas Wooten, President
Alvin M. Cruze, Executive Vice President
George R. Herbert, Vice Chairman and President Emeritus

In 1989, RTI made a successful transition to a second generation of senior management. In January, Alvin M. Cruze became executive vice president, with overall responsibility for research operations. In July, RTI's Board of Governors elected F. Thomas Wooten to become president at the end of the fiscal year. George R. Herbert, president since RTI's founding in December 1958, had announced in June his intention to pass the presidency to a successor. He continues at RTI as vice chairman and president emeritus.

Dr. Wooten, who joined RTI in 1966, has served in a variety of administrative and technical positions, most recently as vice president of Electronics and Systems since 1983.

Dr. Cruze joined RTI in 1965 and has directed numerous social science research programs. From 1983 through 1988 he was vice president of Economic and Social Systems.

My confidence in RTI's future is based on two precious assets that have been built carefully over 31 years — our staff and our reputation. The interests, experience, and entrepreneurial spirit of RTI's technical staff, combined with a strong core of scientific and support capabilities, allow RTI to respond to emerging societal needs for research and scientific development. This annual report focuses — as it should — on the diverse accomplishments of RTI's staff.

F. Thomas Wooten

1989 Research Highlights

The following pages summarize the scientific accomplishments of RTI's technical staff. Their work reflects diversity, technical capability, interdisciplinary collaboration, and responsiveness to societal needs for research and scientific development.

Examples of current RTI research include new analytical chemistry methods in both medical and environmental research; educational planning in Egypt; new semiconductor materials and devices; the effectiveness of drug abuse treatment; pharmaceutical research and development; epidemiologic studies of AIDS; new technology for pollution control; and survey research on health and the environment.

These and other examples are presented in 12 sections:

- A Chemical Solution
- Information Arms Policy-makers
- Multiple Assaults on Pollution
- Chemistry Drives Drug Research
- Reliability in Data Collection
- A World of Experience
- Basic Chemistry for Complicated Problems
- Collecting Information to Battle Diseases
- Minute Measurements for Big Problems
- Solving Semiconductor Problems
- Vital Information Gained in Complex Surveys
- Software Engineers Design Solutions

RTI'S RESEARCH PROGRAMS

Statistical Sciences
Designs and conducts scientific sample surveys. Manages and statistically analyzes survey data and other scientific data bases. Collaborates with other research units on surveys, statistics, mathematical modeling, and data base management.

Electronics and Systems
Develops electronic and semiconductor technology, and applications in aerospace, manufacturing, medicine, and defense. Works in semiconductors, reliable computer systems, computer graphics, communications, automation, and medical technology.

Chemistry and Life Sciences.
Designs, makes and assesses chemicals. Performs research in synthetic and bioorganic chemistry, metabolism, toxicology and polymers. Work includes pharmaceuticals, abused drugs, and agricultural, industrial and environmental chemicals.

Social Sciences and International Development
Uses economic, sociological, demographic, and psychological methods to assess and recommend policies for governments and companies. Studies issues such as economic development, education, health care, mental illness, homelessness, substance abuse, crime, public utilities, and environmental protection.

Analytical and Chemical Sciences
Develops fundamental chemical analysis techniques and applies them in research on pharmaceuticals, pollutants, toxicology, and industrial processes.

Biometrics Research
Uses statistics and data management to produce information on health care, the environment, and energy management. Conducts clinical trials of medical treatments and diagnostics, epidemiologic studies of diseases such as AIDS and cancer, surveys on pollution, and statistical analyses of energy use.

Environmental Sciences and Engineering
Develops basic information, regulatory strategies, and new technologies for environmental protection. Works on environmental measurements, quality assurance of environmental data, risk assessment, waste minimization and treatment, geosciences, and chemical engineering.

DR. MARGARET MARTIN-GOLDBERG
RESEARCH ANALYTICAL CHEMIST

"What I find most satisfying about RTI is the emphasis placed on high quality creative thinking. RTI encourages its scientists to explore new research ideas and supports the development of unique, state-of-the-science technologies, such as solvatochromic probe spectroscopy."

A Chemical Solution

Chemists and other scientists at RTI are applying their skills to a range of projects both in basic research and in the field.

Where Soil Meets Water

Modern farmers apply many substances to their fields to get the most and best yield. Some things, like fertilizer, they want to stay around, and some, like pesticides, they want to do the job and wash away. Researchers at RTI are using high-tech laboratory procedures to further the understanding of solid-liquid interfaces, which could have an application to the farmers' situation.

Chemists are developing a unique methodology, solvatochromic probe spectroscopy, that will recognize substances stuck to solid surfaces by shape rather than concentrations. This is a new analytical technique that, when perfected, will be applicable to many areas of study.

Indoor Air

In a study for the California Air Resources Board, RTI chemists are collecting air samples and analyzing them to determine people's exposure to pollutants. The researchers are performing a probability-based personal exposure and residential indoor air study for a set of very volatile, volatile and semivolatile organic chemicals.

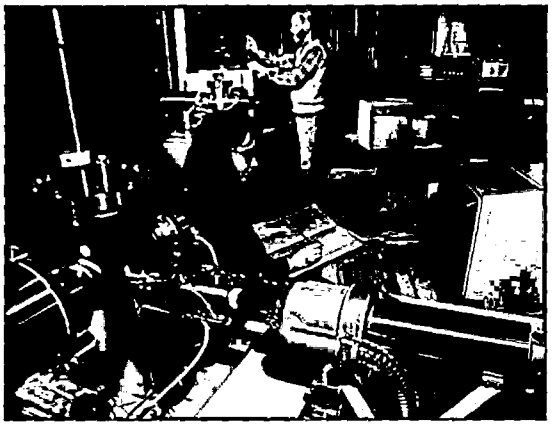
A probability sample provides results that are representative of a larger study population. Households and people in this study are monitored for a 24-hour period, and a questionnaire is completed at the end of the monitoring to get information on activity patterns and potential pollutant sources.

TEAM

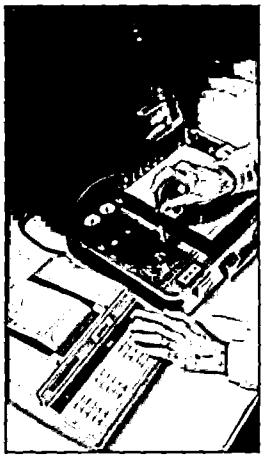
For more than a decade, RTI has been involved in Total Exposure and Assessment Methodology (TEAM) studies sponsored by the Environmental Protection Agency. The studies' goals are to determine personal exposure to a variety of potentially harmful agents. TEAM studies are now being planned to monitor exposure to particles and acid aerosols.

Experimental Drugs

Getting a new drug ready for market is a sophisticated series of exacting studies, requiring specialists in analytical and synthetic chemistry. RTI is developing analytical procedures that ensure consistent quality of experimental anti-cancer drugs. Similar studies are under way for pharmaceutical companies for a variety of new chemical entities.



RTI also synthesizes isotopically labeled versions of experimental drugs to help reveal how such drugs interact with the body's metabolism.



Far left:
Supercritical fluid chromatography allows health and environmental researchers at RTI to examine complex chemical compounds.
Left:
RTI's mass spectrometry facility is used for analysis in a variety of projects.
Above:
Researchers in a study of indoor air quality use portable air-monitoring equipment to collect samples.

Information Arms Policy-makers

Before federal, state and local governments can decide how they will respond to issues such as drug abuse, the high school dropout rate or long-term care for the elderly, they must arm themselves with information. Research specialists from a variety of fields gather this much-needed information for government agencies.

Golden Years?

Never before have so many people lived so long. While that is a positive trend, it strains many of society's institutions.

For the Health Care Financing Administration, RTI researchers are working to improve one of these institutions, long-term care facilities. The researchers are developing a resident assessment and care planning system to focus attention on residents' perspectives and preferences.

The assessment system focuses on a resident's ability to function, considering health, psychological and social abilities and needs. The assessment system also will give regulators and the nursing home industry standards with which to evaluate facility performance.

Treatment Pays

It pays to provide drug addicts with treatment. That was the finding of a national study conducted by RTI of more than 10,000 addicts.

Treatment sharply reduces regular drug use and criminal activity by addicts supporting their habits. The savings more than pay back society's investment in treatment, the study concludes.

The findings of the study were used in a speech by President George Bush when he revealed his national drug strategy.

Drug Abuse Treatment: A National Study of Effectiveness, published in 1989 by the University of North Carolina Press, presents the complete findings of the study.

Educational Information

Often special educational programs are needed to reach students with particular needs. But how do educational officials and government funding agencies know if the programs are working or how they might be improved?

In a project begun this year, RTI is studying grants to post-secondary institutions that train teachers and other education professionals who work with students who have limited English proficiency (LEP). The researchers are determining how many LEP trainees are graduating, whether graduates get jobs in the field and how long they remain

in those jobs, as well as gathering other information.

In another of the center's various projects, researchers will study how state vocational rehabilitation agencies serve their clients.

Right:
In 1989, researchers completed a long-term study of drug abuse and reported the results in a new book.
Far right:
RTI's research projects are enhanced by good working relationships with local administrators.

DR. ROBERT HUBBARD
PROGRAM DIRECTOR FOR ALCOHOL & DRUG ABUSE

"RTI offers the opportunity to conduct research on complex social problems such as alcohol and drug abuse. Many of the findings can be directly applied to improve both individual programs and national policies."

DANA GREENWOOD
ENVIRONMENTAL CHEMIST

"Americans spend about 90 percent of their time indoors, which makes the issue of indoor air quality more important than many people realize. Projects like our recent one to explore the health risks associated with common building materials and other sources of indoor air pollution could have significant meaning to a large number of people."

Multiple Assaults on Pollution

Pollutants enter our environment from a variety of sources. Projects at RTI are as varied as those sources and approach the problem from several angles. .

Defining the Risk

Radon. Benzene. Formaldehyde. What is the risk of exposure to these indoor air pollutants?

Scientists here completed a study this year charged with finding ways to answer that question. The objective of the study was to develop specific risk characterization methods so that results of risk studies will be readily available, technically defensible and understandable to the wide spectrum of people concerned with indoor air quality.

The researchers developed a risk characterization framework that illustrates the large number of factors that must be considered in risk studies and plots mathematically an approach for assessing the risk. The aim of this framework is to improve the understandability of a complex technical area by separating it into key components and to explicitly state assumptions.

Medical Throwaways

When syringes, vials of blood and other medical waste washed onto beaches, the nation was alerted to the problem of disposing of medical waste. Legislation resulting from concern about this problem required that a series of reports to Congress be made to evaluate methods of tracking and managing medical waste.

Researchers have already made the first report on medical waste treatment techniques. The report discusses the efficacy of different types of waste treatment.

Clean Coal

Burning coal for electricity production is a two-edged sword. While coal is plentiful and relatively inexpensive, the sulfur impurity in the fuel is linked to acid rain, a major global pollution problem.

Researchers in process research worked in 1989 to develop methods that are both environmentally safe and cost-effective in converting coal to electricity. For one project, researchers developed sorbent beds to capture sulfur gases in hot, pressurized coal gas. The sorbent beds can be regenerated, saving on costs for power plants.

Chemical engineers continue to work in this area and are testing a bench-scale model of this cleaning process.

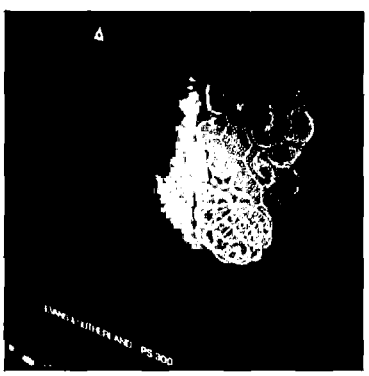
Upper left:
RTI develops and applies environmental monitoring methods such as these flux chambers for measuring volatile organic emissions.
Left:
RTI engineers develop technology for pollution control such as these sorbent pellets for trapping sulfur from coal gas.

Chemistry Drives Drug Research

Change one atom of a molecule, and you can potentially change the way the molecule behaves. Attach a radioactive atom, and you can follow a molecule through biological processes. At RTI, work at the molecular level drives studies of new drugs, drug abuse and disease mechanisms.

Computer-Aided Drug Design

In ancient cultures, a sibyl was thought to have the power of prophecy. Chemists at RTI are using a computer-based molecular modeling program, called SYBYL, to sift through the enormous number of possible molecular structures and make some prediction as to which ones would be most useful as potential new drugs.



The program allows research chemists to generate, store, examine and compare the millions of possible shapes of flexible molecules. Computer-aided design is the beginning of the synthesis process in which chemists take readily available starting compounds through a carefully planned sequence to make new compounds that may exhibit improved drug activity.

Cocaine Mechanisms

The craving is so strong that addicts have been known to stop taking cocaine only when they collapse from physical exhaustion. Yet scientists aren't certain how cocaine triggers such powerful physical hunger.

At RTI, molecular modeling and synthetic chemistry techniques are being used to understand the biochemical mechanisms of cocaine abuse and toxicity. RTI is designing cocaine analogs to provide information about the biochemical mechanisms associated with the addictive or reinforcing properties of the drug.

Bioequivalency

When a pharmaceutical company wants to change or develop an alternative drug formulation, it must prove to the FDA that the new compound is equivalent to the old one. "Whether it's to increase shelf-life or solubility or for any other reason, the drug concentration profile reached in the blood must remain equivalent," said Dr. Ellen Cheung.

Researchers at RTI develop methods for bioequivalency testing as well as doing the analysis of blood and other tissue to determine drug concentrations. "Pharmaceutical companies also use our capability to prove equivalency when they are making generic versions of drugs," Dr. Cheung said.

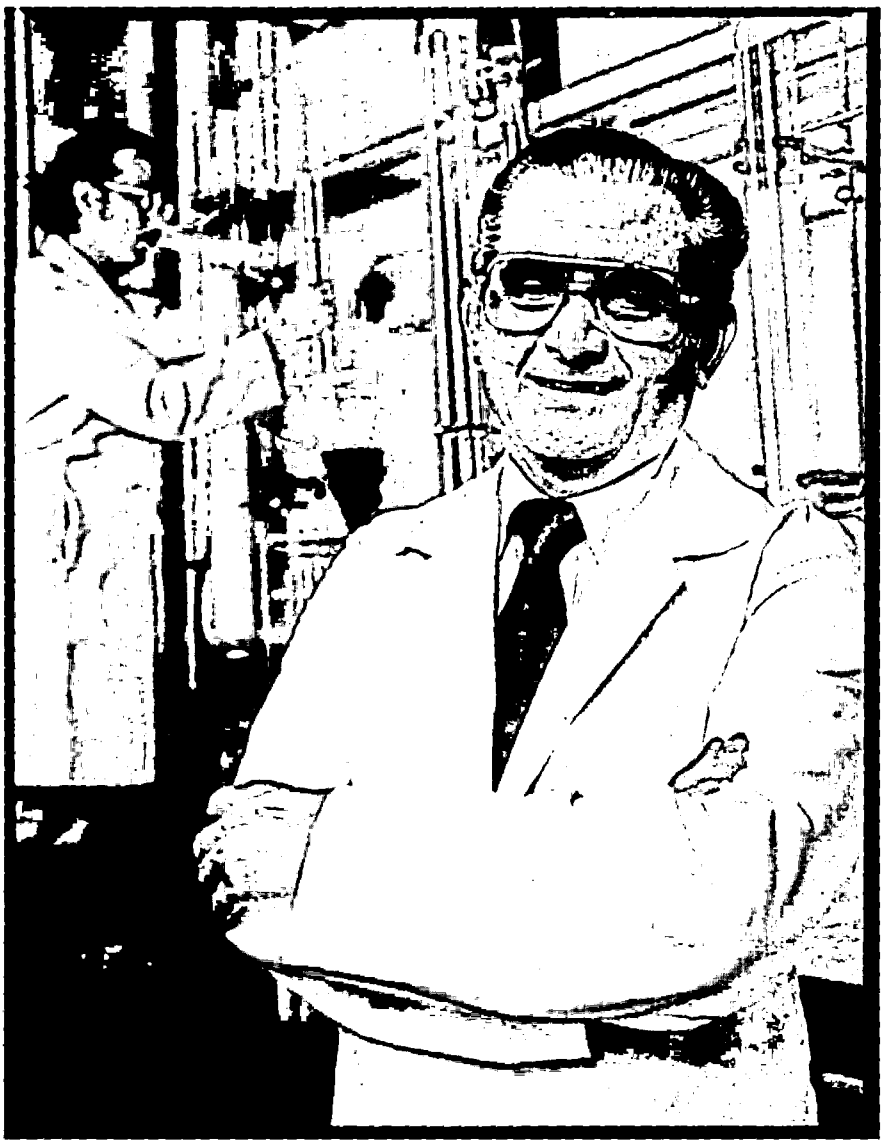
Radioactive Labeling

Chemicals labeled with radioactive atoms are important tools of medicinal chemistry, biochemistry and pharmacology. Design and preparation of radiolabeled compounds are significant aspects of the synthetic chemistry work done at RTI.

RTI now has radiosynthesis programs sponsored by government agencies such as the National Cancer Institute, the National Institute on Drug Abuse and the US Army, as well as programs sponsored by private-sector organizations. The compounds prepared in these programs are used in the development of new drugs to treat cancer, AIDS and malaria and for protection against neurotoxins. Also, they are tools used in research on drug abuse.

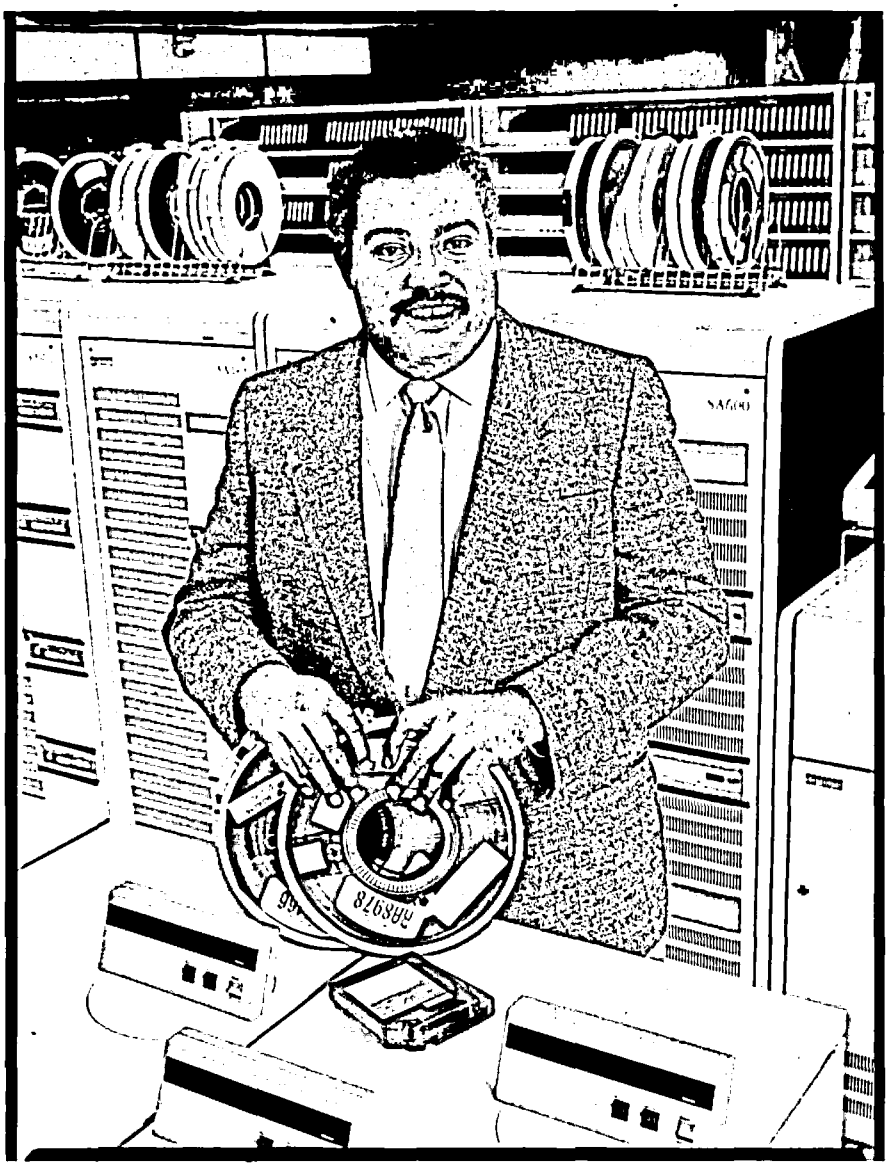
Above:
RTI synthesizes isotopically labeled compounds in support of pharmaceutical and environmental research.
Right:
RTI researches and develops new pharmaceutical compounds, relying on its organic synthesis experience and computer-aided drug design.

DR. M. C. WANI
RESEARCH CHEMIST



"We are exploring the chemistry of natural products that have potential as antitumor agents, and we have just seen promising results with one of our compounds. It is exciting to pursue chemical science that has a possibility to benefit those who are ill."

PAUL BALDWIN
COMPUTER TAPE OPERATOR



"We have upgraded this equipment almost every six months for the last several years. We realize how important these data are, so we stress backup and security because we can't afford to lose any of this information."

Reliability in Data Collection

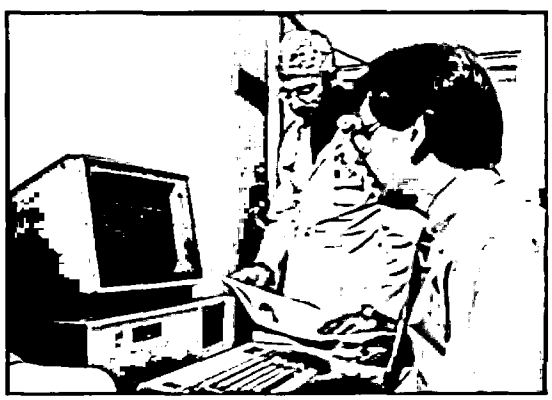
With years of experience in complex data collection, RTI takes a variety of measures to ensure that collection is done in the most up-to-date, cost-effective way.

Designing Surveys

The task is to find out what the drug use habits are of the general US population. Both in collecting the data and in the sensitivity of the subject, it's a formidable task.

The first step to successfully completing such a survey is to carefully design the survey and collection methods, say statisticians at RTI who have been designing and implementing complicated surveys almost since the Institute was founded. "You have to determine what population you want to survey, then you identify where that population is and how best to reach them," said Dr. Robert Mason, director of the Center for Research in Statistics.

RTI has built an experienced staff capable of sampling design, data collection and management and statistical analysis. National surveys conducted this year have included work on radon concentrations, hazardous waste generators, the attitudes of young people toward military service, drug use, economic concerns in the operation of water treatment plants and many others.



Computer Center Grows

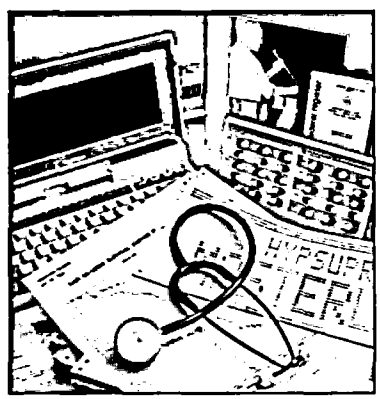
The computer center at RTI nearly doubled its size with renovations completed in 1989. "The staff has come to depend on the reliability of our system," said computer center director James Wright. "We back up every disk nightly so that if there is a total hardware failure you would only lose a day's work."

The computer system not only handles the demands of spreadsheets and computer-assisted telephone interviewing, but also links the Institute to many other government, university and private industry sites.

Tracking Data

RTI employs several techniques to keep track of and ensure the quality of the data collected for its projects. For a series of clinical trials, a system was developed that allows a computer at RTI to poll field computers at more than 40 locations each night. Once a week, changes in protocols or other instructions can be sent from the RTI computer to the field units.

Managing complex clinical trials requires several levels of data tracking. Protocol monitors and regional monitors in the field follow all information. In addition, monitors answer questions fieldworkers have, check data for accuracy by comparing it to source documents and clean data as it arrives.



Far left:
Survey researchers develop software and procedures to collect, track and analyze data from complex surveys and clinical trials. For one series of trials, software was designed to automatically poll field computers for data.
Left:
A range of methods is used to follow and manage information that surveys generate.

A World of Experience

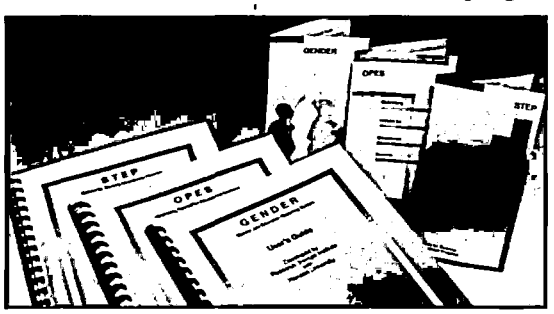
For some RTI staff, the points of the Research Triangle are far-flung—for instance, Kathmandu, Cairo and Jakarta. For more than 25 years and in more than 20 countries, RTI has worked with government officials on studies of population growth, urbanization, agriculture, education, health and other topics.

Growing Pains

Unchecked population growth can put serious limits on a country's progress. With several projects and a variety of microcomputer-based models, RTI is raising leaders' awareness of population growth problems and providing assistance to manage those problems.

Big City

The fastest growing cities in the world are in countries least equipped to handle such expansion. In 1989, RTI reviewed Agency for International Development projects to determine what effect urbanization would have on these programs. RTI has numerous other studies under way that examine from several angles the urban problems in developing countries.



While cities are growing, many central governments are shifting the responsiblity for services onto localities. Researchers at RTI are working with local governments on methods of raising the revenues needed to carry out these services.

One concept for bridging rural and urban communities is market towns. RTI personnel have presented seminars on this idea, generating strong interest among officials from Nepal, Pakistan and Indonesia.

On the Farm

When agricultural officials in one country had results of new research that would help farmers, they got the men together to present the findings. RTI researchers found out, however, that the officials were talking to the wrong people.

The researchers found that the women of the area ran the farms while their husbands were away, working in mines. Through this and other projects, researchers here are helping developing countries improve their farming efficiency.

Homework

For too many children in developing countries, homework is actual physical labor needed to sustain the family. These children often fail to get even a basic education.

Recognizing the need to educate their populations, several countries have contracted RTI to help improve their school systems. With projects and innovative software, RTI is helping more children get the education they need.

Right:
RTI researchers examine pressing problems in developing countries such as the lack of basic education and the increasing populations of urban centers.
Below:
Staff in international programs develop software that helps decision-makers formulate and implement plans to enhance social and economic development.
Far right:
International development staff work with officials from developing countries both at RTI's campus and abroad.

DR. LUIS CROUCH
RESEARCH DEVELOPMENT ECONOMIST

"Our approach to upgrading decision support systems in developing countries is based on a strategic vision of the role of information technology in the policy process. Several decades of international development work have taught us to start by determining a country's real information needs."

Basic Chemistry for Complicated Problems

Chemists and other researchers in the basic sciences are at work in RTI's laboratories on health and environmental problems that are in the nation's streets, businesses and homes. While these scientists may be working on the molecular level, the results often have large implications.

Catalytic Antibodies

"Essentially, this work, if successful, would increase the body's repertoire for handling toxins," said senior research immunologist Dr. Carol Whisnant. She is describing work on catalytic antibodies, agents that bind with chemicals and catalyze their reactions. This could render toxins harmless. Research is just beginning in this new field at RTI.

Catalytic antibodies could have direct application to the treatment of drug addiction, Dr. Whisnant pointed out. "If an addict were given a catalytic antibody designed for the drug he was abusing, then the drug would not have its usual effect on the body."

Such antibodies could alsobe used with poisonings and other cases in which dangerous substances are introduced in the body.

Fresh Fruit

Pesticides and other chemicals are used to produce the flawless fruit we've come to expect in grocery stores. However, those chemicals may leave harmful residues. The Environmental Protection Agency has established limits on the amount of pesticide residues that can be considered safe. There is an urgent need to develop simple, rapid methods to detect and measure residues. Under FDA sponsorship, RTI worked in 1989 on the development of enzyme immunoassays for that purpose.

Using a sophisticated process involving proteins, enzymes and antibodies, researchers are able to produce a test that changes color in the presence of pesticide. The intensity of color is related to the amount of pesticide present.

Degradation Tests

When a dairy cow is sick, a veterinarian prescribes drugs to get it back to producing. But what happens to those drugs when they are eliminated from the cow's body?

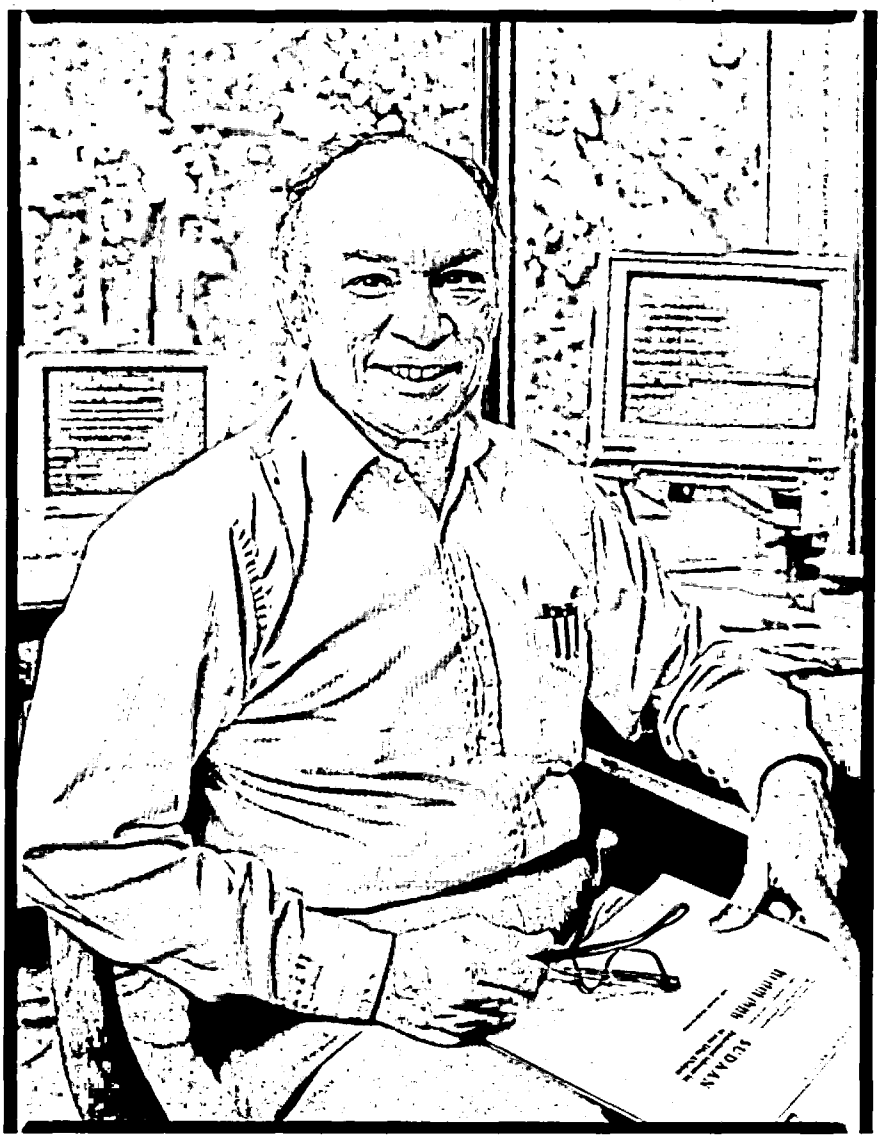
For a private company, RTI has conducted degradation tests to see what happens to certain drugs in soil. The tests were conducted in three different types of soil samples, which had various properties that might influence degradation. RTI researchers used radiolabeled compounds to track degradation. "FDA regulations are beginning to require companies to do degradation tests," said research environmental scientist Dr. Karen Hendry. "The test apparatus we have set up could be used for all kinds of different degradation tests."

Right:
RTI researches the fate of chemicals in environmental media — here, a bench scale experiment on chemicals' degradation in soil.
Far right:
Antibody research requires laboratory capability to produce monoclonal antibodies.

DR. CAROL WHISNANT
SENIOR RESEARCH IMMUNOLOGIST

"Scientists like to see their work have a direct impact on a problem such as drug abuse or food contamination. Here, with a mix of basic science and applied research, I get to see my work affect real-world issues."

DR. BABU SHAH
BIOMETRICS CHIEF SCIENTIST



"Before SUDAAN, there was no general purpose software package that could analyze complex survey data. I took the name from the first two letters of 'survey data analysis,' but I liked it because in Sanskrit it means beautiful gift."

Collecting Information to Battle Diseases

In the fight against illness, we often picture doctors and nurses as the warriors. However, many other professionals—such as statisticians, computer scientists, data monitors and analysts—contribute to advances in drug therapies and treatment techniques.

Beautiful Gift

Before any new drug is made available to the public, it is thoroughly tested, and the results must be carefully collected and analyzed. Software has been available to analyze simple random sample surveys; however, the complex data collection often required in clinical trials and other sophisticated surveys could not be handled by this software.

"Our work has been aimed at developing programs to make it easier for statisticians to analyze complex survey data," said biometrics research chief scientist Dr. Babu Shah. Under sponsorship from the National Center for Health Statistics, Dr. Shah and his colleagues have developed professional software for survey data analysis (SUDAAN).

Clinical Trials

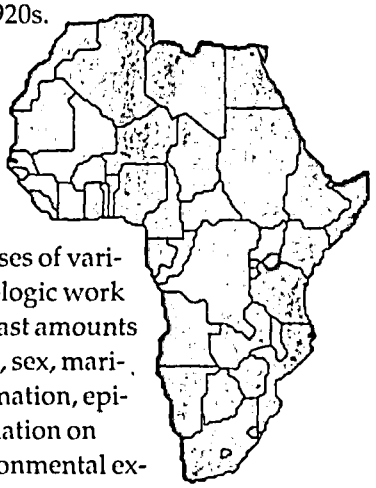
Heart disease is one of our major predators; almost half of all deaths in the US have a cardiovascular cause. Researchers at RTI began a clinical trial this year of two drugs that may help to stave off this killer.

"The Multicenter Asymptomatic Carotid Artery Plaque Study is representative of many of our clinical trials," said director of medical, environmental and energy statistics Dr. Tyler Hartwell.

"It is a double-blind, placebo-controlled trial employing a factorial design to determine whether either of two active interventions, lovastatin and warfarin, retard the development of atherosclerotic plaques in carotid arteries," said Dr. Hartwell.

Looking for the Causes of Diseases

Surveying food handlers in Africa. Checking medical records from the 1920s. Studying children who received chloride-deficient formula as infants.



All of these activities are part of epidemiologic studies RTI researchers are carrying out to find the causes of various diseases. The epidemiologic work involves keeping track of vast amounts of information. Besides age, sex, marital status and related information, epidemiologists collect information on health behaviors and environmental exposures.

To study the distribution and determinants of disease, RTI epidemiologists make use of the Institute's well-developed data-processing and statistical skills.

Left:
Medical researchers at RTI coordinate clinical trials of new treatments, devices and pharmaceutical entities.
Above:
Epidemiologic surveys are under way all over the world. In one study in Africa, information is being collected from food handlers in eateries along a major highway.

Minute Measurements for Big Problems

Asbestos. Benzene. Radon. These substances are making big news, but finding the pollutants in the air requires technology capable of minute measurements. Researchers at RTI use sophisticated equipment and techniques to track, measure and test other laboratories' ability to measure these pollutants.

Radon Detectors

RTI is coordinating a program for the Environmental Protection Agency to determine the effectiveness and accuracy of the plethora of radon detectors and laboratories now available to the public.

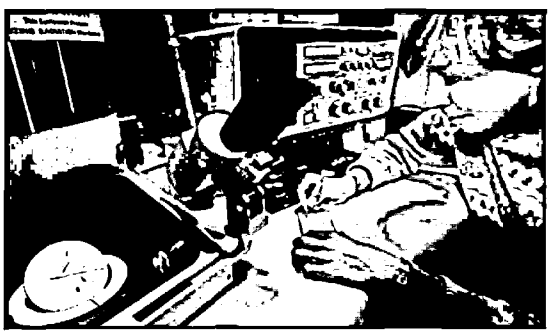
The researchers are evaluating companies' measurement capability through the National Radon Measurement Proficiency Program, a project designed to help the consuming public in its selection of companies and radon detectors. Devices ranging from $10 charcoal canisters to $15,000 pieces of equipment are being tested.

When the program began in 1986, 39 companies participated. In 1989, the program evaluated information on more than 8,000 companies that provide radon measurement services to the public.

Testing for Asbestos

Since the passage of legislation requiring the identification and control of asbestos-containing materials in schools, laboratories testing for this hazardous material have proliferated. RTI was selected by the National Institute of Standards and Technology (NIST) to conduct its National Voluntary Laboratory accreditation program for labs testing for bulk asbestos. This program currently involves about 700 laboratories.

RTI has also been contracted by NIST to work on the development and analysis of airborne asbestos materials to be used in the National Voluntary Laboratory Accreditation Program for transmission electron microscopy



and has been selected as the quality assurance laboratory for this program.

For these and similar programs, RTI prepares and distributes approximately 12,000 asbestos test samples per year.

Assuring Quality

Testing for environmental pollutants requires that precise measurements be maintained at all times. Quality assurance programs are a tool for maintaining those exacting standards.

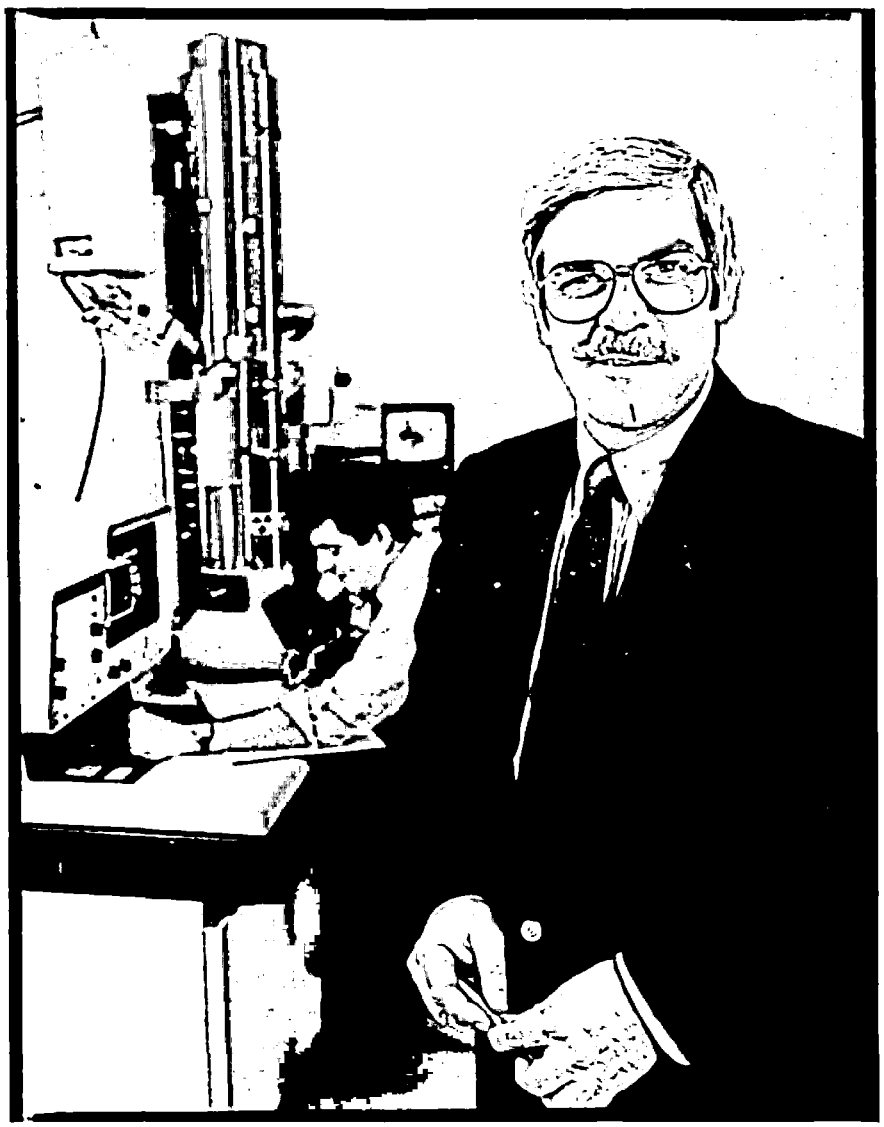
For the EPA, quality assurance staff here are assisting in planning referred to as the data quality objective process for environmental measurement projects. By planning on the front end, environmental scientists are able to ensure that complicated studies provide the data necessary for decision-making.

The researchers are also providing technical quality assurance support for projects ranging from studies of ambient air to solid waste.

For an industrial research association, RTI is developing and will implement a comprehensive quality assurance program.

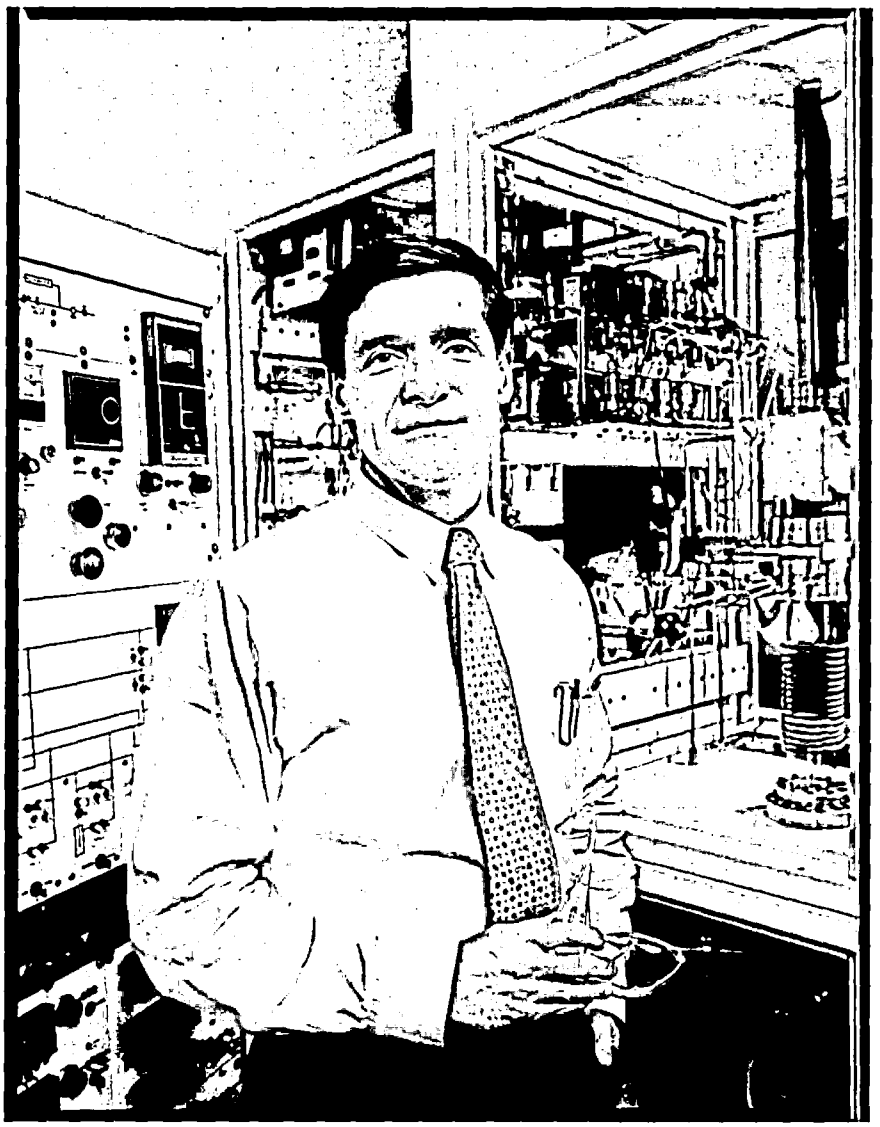
Above:
RTI conducts programs to assist environmental research and regulation development, including coordinating the EPA's radon detector effectiveness program.
Right:
With the transmission electron microscope, researchers are working on methods development for the airborne asbestos program.

DR. ROBERT PERKINS
RESEARCH GEOLOGIST



"More than 1,000 laboratories in the US perform asbestos analyses. We have been working with federal agencies to improve the analytical capabilities of these labs. By conducting proficiency testing and developing procedures, we are helping advance knowledge about this hazardous material."

DR. MICHAEL TIMMONS
SEMICONDUCTOR MATERIALS RESEARCH MANAGER



"With the problems nuclear and fossil fuels are presenting, waste storage and acid rain for instance, this is a critical time for solar cell technology. Solar energy is abundant and non-polluting, which makes this research both necessary and urgent."

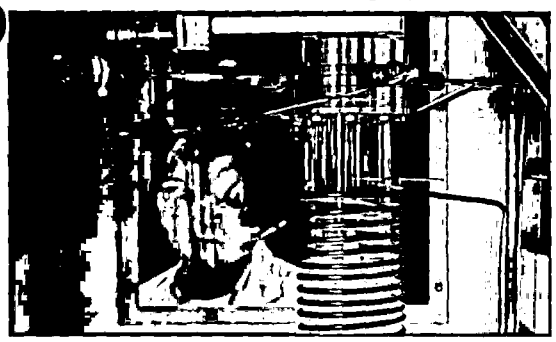
Solving Semiconductor Problems

Aluminum gallium arsenide. Crystalline silicon layers. Chlorofluorocarbons. Research at RTI is focusing on all these exotic sounding substances to yield scientific advances that will benefit everyday activities.

Cascade Solar Cells

Solar cells are an effective way of supplying power for a satellite's extended stay in space. The challenge is to make cells that are lightweight, highly efficient and radiation resistant.

Researchers are working on these challenges in Air Force-sponsored projects.



"We have been working on cells that will make better use of the entire solar spectrum," said Dr. Michael Timmons, semiconductor materials research manager. "We are working with a unique interconnect between cell sections and using lightweight aluminum gallium arsenide for the top cell and germanium for the bottom cell."

Using chemical vapor deposition, researchers at RTI grow the aluminum gallium arsenide and germanium needed for this work.

Replacing CFCs

A pressing problem in the surface cleaning industry is finding a replacement for the environmentally dangerous chlorofluorocarbons now used in many industrial cleaning processess. To help find a solution to this and other problems, semiconductor, aerospace and computer industry representatives are banding together in the Surface Cleaning Technology Consortium, formed by RTI.

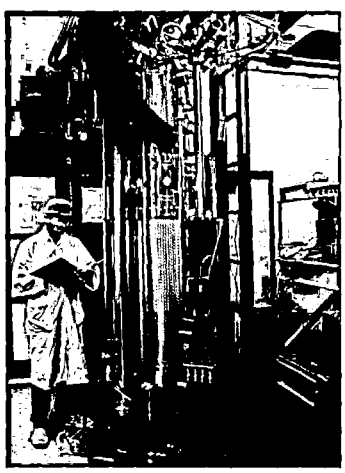
"By pooling their resources, each sponsor will receive the results of a research program much larger than could be supported by one company's investment," explained Robert Donovan, program manager for the consortium.

"Membership in the consortium is international, as are the problems to be solved," Mr. Donovan said.

Ultrathin Microchips

A technique for forming ultrathin components of microchips, pioneered by RTI and NC State University researchers, will allow significantly more information to be stored on the chips.

The process lowers by hundreds of degrees the temperature at which thin layers of crystalline silicon material can be grown. Researchers say that lower temperatures for crystalline silicon growth will allow much smaller transistors and many more transistors to be put on a single microchip. The result is a microchip that can hold substantially more data while remaining the same size.



Far left:
Researchers use vapor phase deposition to develop materials for cascade solar cell design.
Left:
Work in forming ultrathin components for microchips at significantly lower temperatures than previously used generated excitement in 1989.

Vital Information Gained in Complex Surveys

One of RTI's strengths is its ability to design, implement and conduct complex surveys. Such studies require collaborative teams of statisticians, computer specialists and scientists from fields such as economics, education, sociology, health and environmental protection.

Household Survey on Drug Abuse

In the ninth and largest National Household Survey on Drug Abuse, RTI interviewed 8,814 respondents. The survey covered the population age 12 and older living in households in the contiguous United States.

At the release of the findings in July

1989, William Bennett, director of the Office of National Drug Control Policy, noted the importance of the survey's results. He said, "Most use of most drugs by most Americans — overall drug use — is off sharply. But cocaine addiction has dramatically intensified."

In addition to information on drug use, the survey collected data on health consequences and measures of dependency.

Also in 1989, RTI began preparations for the next National Household Survey and another drug abuse survey focusing on Washington DC.

Transportation Survey

Can anyone possibly have a longer commute to work than you? That and many other questions will be answered by a study for the Federal Highway Administration, which RTI began this year.

For the survey, RTI staff and subcontractors will conduct telephone interviews of 20,000 households. The survey will collect information on number of cars owned, number of commuters sharing a car, number of miles traveled to work and other important statistics.

Results of the survey will help federal, state and local transportation agencies, and other concerned groups, better understand Americans' future transportation needs.

Questions about Radon

You can't see it or smell it or taste it. Is radon really a problem in households across the nation? RTI is conducting a large survey to find out.

The survey, for the Environmental Protection Agency, includes projects at both the state and national level. RTI has nearly a decade of experience with state surveys on radon, including the current project, for which 25 states and Indian reservations in three of the 10 EPA regions were surveyed.

The national survey uses alpha track radon detectors, which monitor a home for a year. Using personal interviews and the long-term alpha track monitors, researchers aim to collect information on 5,000 homes.

Right:
Computer-assisted telephone interviewing has long been a method RTI employs for national surveys.
Far right:
When survey designers determine that it is warranted, personal interviews are conducted to collect sensitive or other difficult to obtain data.

MARGO BRINKLEY
SURVEY COMPUTING DEPARTMENT MANAGER

"To get the proper information on important social issues such as drug use or education, we go through many tests to be virtually error-free in the final computer runs. RTI's survey projects are never simple, and we have to ensure that the computer gives as much help as possible to survey operations and statistical analysis."

JILL HALLENBECK
SENIOR RESEARCH ENGINEER

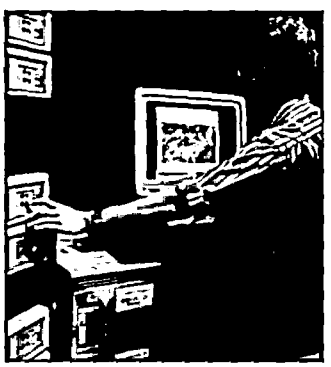
"By developing new computer tools, we help influence the way machines and equipment get from concept to reality. It is exciting when you can assist in advancing the state of the art, but it's most rewarding when your work pushes the state of the practice."

Software Engineers Design Solutions

Often a complicated job can be simplified with the right tool. Such is the case with a project to design graphic displays that will help reduce the number and variety of gauges and meters in airplane cockpits. It is one example of RTI's use of software engineering to solve problems for industry or government clients. Researchers are at work on several similar projects.

Analyzing Pollution Patterns

Cars, factories, weather and natural processes like photosynthesis all contribute to the complex and constantly changing atmosphere that forms a canopy over the US. If you were tracking a certain chemical entity, ozone for instance, how would you follow it as it drifts with air currents and mixes with other entities?



This mobile mix is the problem the EPA faces with its Regional Oxidant Model, a tool for analyzing large-scale pollution patterns and judging the effectiveness of particular emission control strategies. To solve the problem in a quick, cost-effective way, RTI researchers designed a prototype mutiprocessor, using a single host computer linked to 22 processing elements.

This system provided a peak speedup 11.2 times greater than uniprocessor performance, allowing the EPA to solve the model faster and get more research data out of it. Research continues to increase the speed of the model even more for possible use in the EPA's regulatory functions.

Designing Systems

Hardware and software design was a matter of sketches on the backs of envelopes at one time. Bottlenecks where the flow of information jammed were found when the system was up and running. An RTI-developed system that identifies problems in design at a much earlier stage was licensed this year to Cadre Technologies Inc., a research, development, marketing and sales company.

The Architecture Design and Assessment System (ADAS) was conceived as a tool for the Department of Defense to compare competing technical proposals. After modifications to the original ADAS, government, industry and defense researchers saw the many potential uses for the tool.

Computer Program for Indoor Air

Pollutants and environmental factors such as humidity can make air in homes and offices unpleasant and even dangerous. Physicists at RTI have developed a user-friendly computer program that can be run on many personal computers to plot airflow and evaluate filter and ventilation effectiveness.

The program allows architects to look at concepts that go into good building design to prevent poor air quality. The indoor air quality simulator takes into account the complex web of connections that influence air movements in buildings.

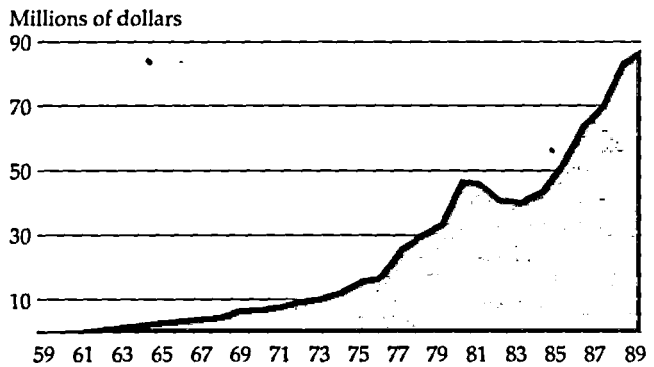
The software is able to hold information on up to 20 rooms all on one floor. The program grew out of work that researchers had done in particulate control on clean rooms.

Left:
Using RTI's system design capabilities, research engineers develop special purpose computer systems for many tasks.
Above:
RTI-developed Architecture Design and Assessment System (ADAS) identifies software system problems in design stages.

1989 Operating Highlights

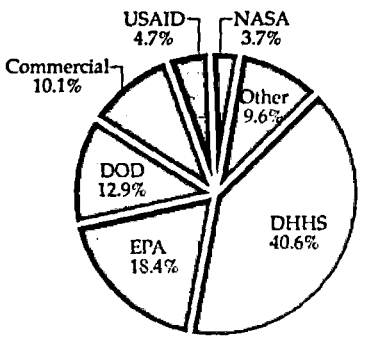
RTI's revenue rose in 1989 to a record $88.3 million, an increase of 4%. Project labor costs, a more direct measure of research activity, rose 9.7% for onsite operations and 22.9% for offsite.

Research Revenue

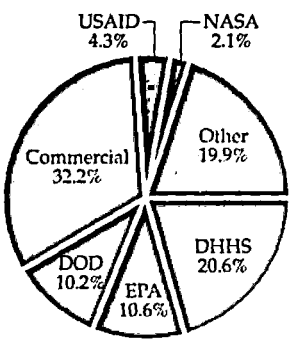


Sources of Revenue

by Contract Funds



by Number of Contracts



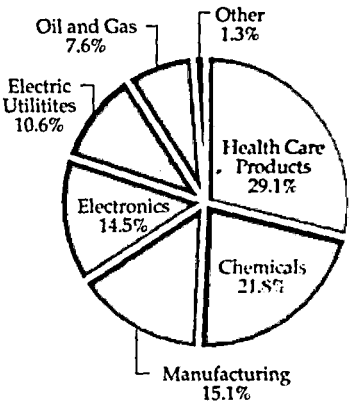
RTI's diversity of clients is indicated by the distribution of funds and by distribution of number of contracts (see charts).

The US Department of Health and Human Services accounted for 40.6% of revenue, an exceptional increase from 25.8% only two years ago. This is largely due to RTI's response to the AIDS epidemic, with clinical trials, epidemiology, and chemistry.

Support from the Department of Defense declined to 12.9% of revenue largely because of the completion of one large project. DOD remains an important client because many of its research interests match RTI's capabilities in electronics, environmental, and social science research.

The private sector accounted for 10.1% of revenue, up from 9% last year. The large number of contracts with the private sector illustrates the importance of such clients to RTI's business and scientific diversity.

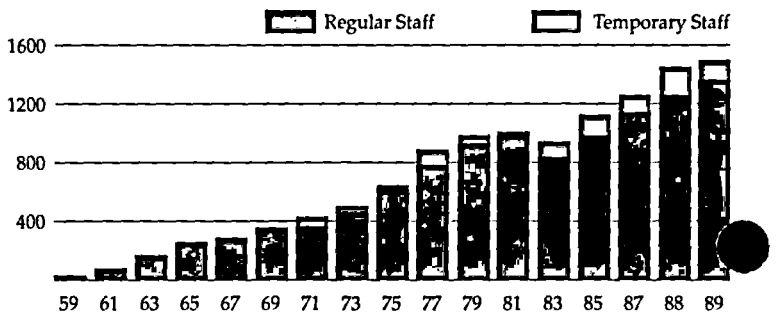
Private Sector Revenue



During 1989, the regular staff grew from 1,291 to 1,359. Offices in Washington DC, Virginia, and Florida continued to expand and now include more than 80 people.

New funding in 1989 reached $104 million, a substantial increase over the previous fiscal year.

Staff Growth



Governance and Corporate Officers

Board of Governors

Of the 31 Governors, five hold seats by virtue of their positions: the presidents of The University of North Carolina, Duke University, and the Research Triangle Institute, and the chancellors of NC State University and the University of North Carolina at Chapel Hill; three are specified in the By-Laws: George Watts Hill, William C. Friday, and George R. Herbert; nine are appointed annually to represent Duke University. The University of North Carolina general administration, NC State University, and UNC-Chapel Hill, up to 21 Governors are elected from the business and professional communities. A separate category of Lifetime Governor recognizes retired Board members who have made extraordinary contributions to the progress and welfare of RTI. Robert T. Armstrong is the current Lifetime Governor.

Chairman
George Watts Hill*, Chairman of the [illegible] and Central Carolina Bank and Trust Company, Durham

Vice Chairman
George R. Herbert, President Emeritus, Research Triangle Institute

Executive Committee Chairman
Marcus E. Hobbs*, University Distinguished Service Professor Emeritus of Chemistry, Duke University

John C. Bailar, III, Professor, Epidemiology & Biostatistics, McGill University

H. Keith H. Brodie, President, Duke University

Ivie L. Clayton, Business Consultant, Raleigh

Pedro Cuatrecasas, Vice President and President, Pharmaceutical Research Division, Warner-Lambert Co.

Raymond H. Dawson*, Senior Vice President and Vice President for Academic Affairs, The University of North Carolina

William C. Friday, President, William R. Kenan, Jr. Fund, Chapel Hill

Steve C. Griffith, Jr., Senior Vice President and General Counsel, Duke Power Company, Charlotte

Phillip A. Griffiths*, Provost, Duke University

Paul Hardin, III, Chancellor, University of North Carolina at Chapel Hill

Margaret T. Harper*, President, The Stevens Agency, Southport

Franklin D. Hart*, Vice Chancellor for Research, North Carolina State University

William G. Howard, Jr., Senior Fellow, National Academy of Engineering

Earl Johnson, Jr.*, President, Southern Industrial Constructors, Inc., Raleigh

Matthew Kuhn, President, Microelectronics Center of North Carolina, Research Triangle Park

William F. Little*, University Distinguished Professor of Chemistry, University of North Carolina at Chapel Hill

Larry K. Monteith, Interim Chancellor, North Carolina State University

George E. Norman, Jr.*, Greensboro

J. Dennis O'Connor*, Vice Chancellor for Academic Affairs and Provost, University of North Carolina at Chapel Hill

Charles E. Putman, Vice President for Research Administration and Policy, Duke University

Thomas A. Rose, President, Blue Cross and Blue Shield of North Carolina, Durham

Patricia C. Skarulis, Vice President for Information Systems, Duke University

C. D. Spangler, Jr., President, The University of North Carolina

Thomas J. Troup, Vice Chairman, Burr-Brown Corporation, Tucson, Arizona

Charles B. Wade, Jr., Winston-Salem

Nash N. Winstead*, Vice Chancellor and Provost, North Carolina State University

F. Thomas Wooten*, President, Research Triangle Institute

Phail Wynn, Jr., President, Durham Technical Community College

*Member, Executive Committee

Members of the Corporation

The Members are the equivalent of RTI shareholders. As such, they elect the Governors who represent the business and professional communities. Of the nine Members of the Corporation: four are the chairmen and presidents of The University of North Carolina and Duke University; one is George Watts Hill, a lifetime Member of the Corporation; four are elected annually, two from and by the Duke University Board of Trustees, and two from and by the Board of Governors of The University of North Carolina.

Members of the Corporation representing Duke University are: H. Keith H. Brodie, Durham; Nathan T. Garrett, Durham; Fitzgerald S. Hudson, Charlotte; Thad B. Wester, Raleigh

Members of the Corporation representing The University of North Carolina are: Robert L. Jones, Raleigh; T. Henry Redding, Asheboro; Hon. Robert W. Scott, Haw River; C.D. Spangler, Jr., Chapel Hill

Corporate Officers

RTI officers, including the research vice presidents listed on page 32, are elected by the Board of Governors.
F. Thomas Wooten, President
Alvin M. Cruze, Executive Vice President
William H. Perkins, Jr., Financial Vice President
Grace C. Boddie, Vice President - Senior Counsel
Suzanne P. Nash, Corporate Secretary
R.S. McLean, Treasurer
Carolyn J. Harris, Assistant Corporate Secretary

Research Organization

Board of Governors
Executive Committee

F. Thomas Wooten, President

Alvin M. Cruze, Executive Vice President
Distinguished Institute Scientist: Daniel G. Horvitz

Research Vice Presidents	Research Centers and Programs
James R. Chromy Statistical Sciences	Computer Science, Robert H. Thornton, director Ragland Computer Center, James C. Wright, director Research in Statistics, Robert E. Mason, director Survey Research, R. Paul Moore, director *Chief Scientist:* Ralph E. Folsom
James B. Clary Electronics and Systems	Digital Systems Research, Geoffrey A. Frank, acting director Systems Engineering, James G. Haidt, director Semiconductor Research, James A. Hutchby, director Technology Applications, Doris J. Rouse, director Biomedical Engineering, James N. Brown, Jr., acting director Neuroscience, Blake S. Wilson, senior program director *Chief Scientist:* James N. Brown, Jr.
C. Edgar Cook Chemistry and Life Sciences	Organic and Medicinal Chemistry, F. Ivy Carroll, director Life Sciences and Toxicology, Frederick J. de Serres, director Bioorganic Chemistry, A. Robert Jeffcoat, director Polymer Sciences, Vivian T. Stannett, Camille Dreyfus Scientist *Chief Scientist:* Monroe E. Wall
Ronald W. Johnson Social Sciences and International Development	International Programs, James S. McCullough, director Policy Studies, C. Lynn Usher, director Development Policy, James E. Kocher, director Social Research and Policy Analysis, J. Valley Rachal, director Economics Research, Allen K. Miedema, director Research in Education, John A. Riccobono, director *Chief Scientist:* George H. Dunteman
Edo D. Pellizzari Analytical and Chemical Sciences	Methods Development and Applications Mass Spectrometry Applied Analytical Systems, Charles M. Sparacino, director
W. Kenneth Poole Biometrics Research	Medical, Environmental and Energy Statistics, Tyler D. Hartwell, director Epidemiologic and Medical Studies, Fred A. Bryan, Jr., director *Chief Scientist:* B. V. Shah
James B. Tommerdahl Environmental Sciences and Engineering	Environmental Measurements, Clifford E. Decker, director Environmental Quality Assurance, Frank Smith, director Environmental Systems, Deane F. Tolman, director Environmental Risk and Geosciences, Dennis F. Naugle, director Aerosol Technology, David S. Ensor, director Process Research, James J. Spivey, director

An Overview of RTI

Research Triangle Institute (RTI) is a not-for-profit contract research organization located in the center of North Carolina's Research Triangle Park. RTI was established in 1958 by the University of North Carolina at Chapel Hill, Duke University, and NC State University.

RTI conducts applied and basic research in the United States and abroad for clients in government, industry, and public service.

Organization and Staff

RTI's organization supports the formation of multidisciplinary teams to address complex research issues.

The staff of more than 1,450 includes approximately 60 percent professionally trained research personnel. Of these, nearly two-thirds have advanced degrees. Their backgrounds include more than 115 degree fields.

Major areas of training and experience include:

Social Sciences: economics, econometrics, benefit-cost analysis, evaluation research, urban and regional planning, international development, health services and health policy research, agricultural development, sociology, psychology, social psychology, education, business administration, public administration, municipal financial management, criminology, law, political science, and the humanities.

Survey Research: sample design and selection, survey planning and execution, data collection and management, and research and development on survey methodology.

Mathematics, Statistics, and Computer Sciences: data management and analysis, statistical methods development, statistical analysis, biostatistics, clinical trials, epidemiology, computer-aided engineering, CAD/CAM, systems software, software verification, computer security and numerical modeling.

Environmental Sciences and Engineering: environmental controls and engineering, environmental chemistry, environmental health, industrial hygiene, hazardous materials management, hydrogeological and earth and mineral sciences, meteorology, and oceanography

Chemical and Biological Sciences: analytical, organic, inorganic, physical, polymer, and medicinal chemistry, toxicology, pharmacology, genetics, neuroscience, biology, biochemistry, and microbiology.

Engineering and Physics: electrical, electronics, systems, computer, semiconductors, chemical, biochemical, energy, industrial, mechanical, manufacturing, materials, biomedical, aerosol, civil, petroleum, nuclear, aeronautical, and transportation engineering.

University Affiliations

RTI was created as the focal point for growth in North Carolina's Research Triangle Park, an industrial and governmental scientific center built around the resources of the area's three major research universities.

RTI's capabilites are greatly expanded by frequent collaboration with university scientists. Additional relationships include joint staff appointments and cooperative research programs.

Laboratory and Office Facilities

RTI's 17 buildings contain more than 412,000 square feet of laboratory, computer, and related facilities for all RTI programs. RTI also maintains research offices in Washington DC, Newport News VA, Cocoa Beach FL, and at project locations in the US and abroad.

Computer Facilities

In-house facilities for data management, statistics, modeling, simulation, software R&D, computer-aided engineering, electronics, and laboratory management include microcomputers, two computer centers, and daily traffic with national and regional scientific networks.

Library Facilities

The RTI Technical Information Center provides on-line computerized literature searches via data bases relevant to RTI research programs. The Center maintains subscriptions to more than 1,035 professional periodicals. Specialized libraries are maintained in RTI research buildings.

RTI staff have full access to the combined libraries of the nearby universities, which have been cross-cataloged and shared since 1934.

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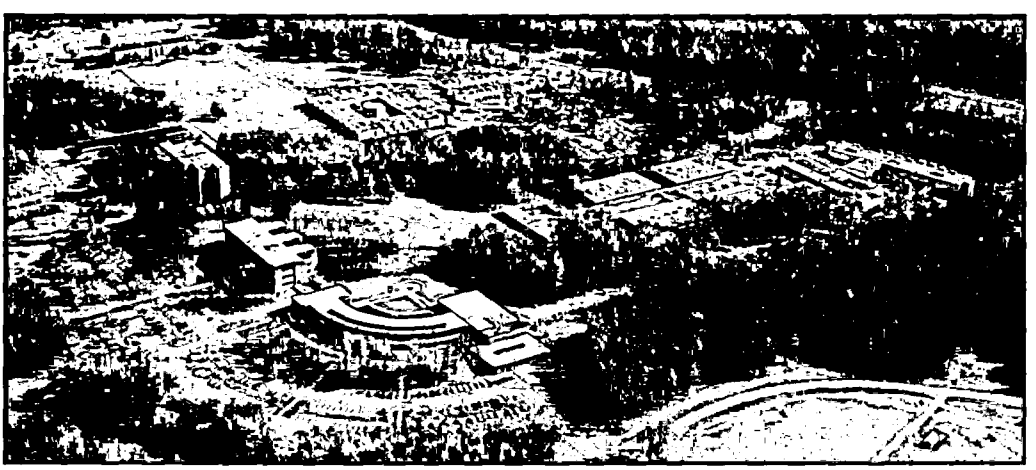

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RESEARCH TRIANGLE INSTITUTE
3040 Cornwallis Road PO Box 12194
Research Triangle Park NC 27709-2194
USA

Telephone: 919-541-6000
Cable RESTRINS, Raleigh NC
Telex 802509 (RTI RTPK)
Fax 919-541-5985