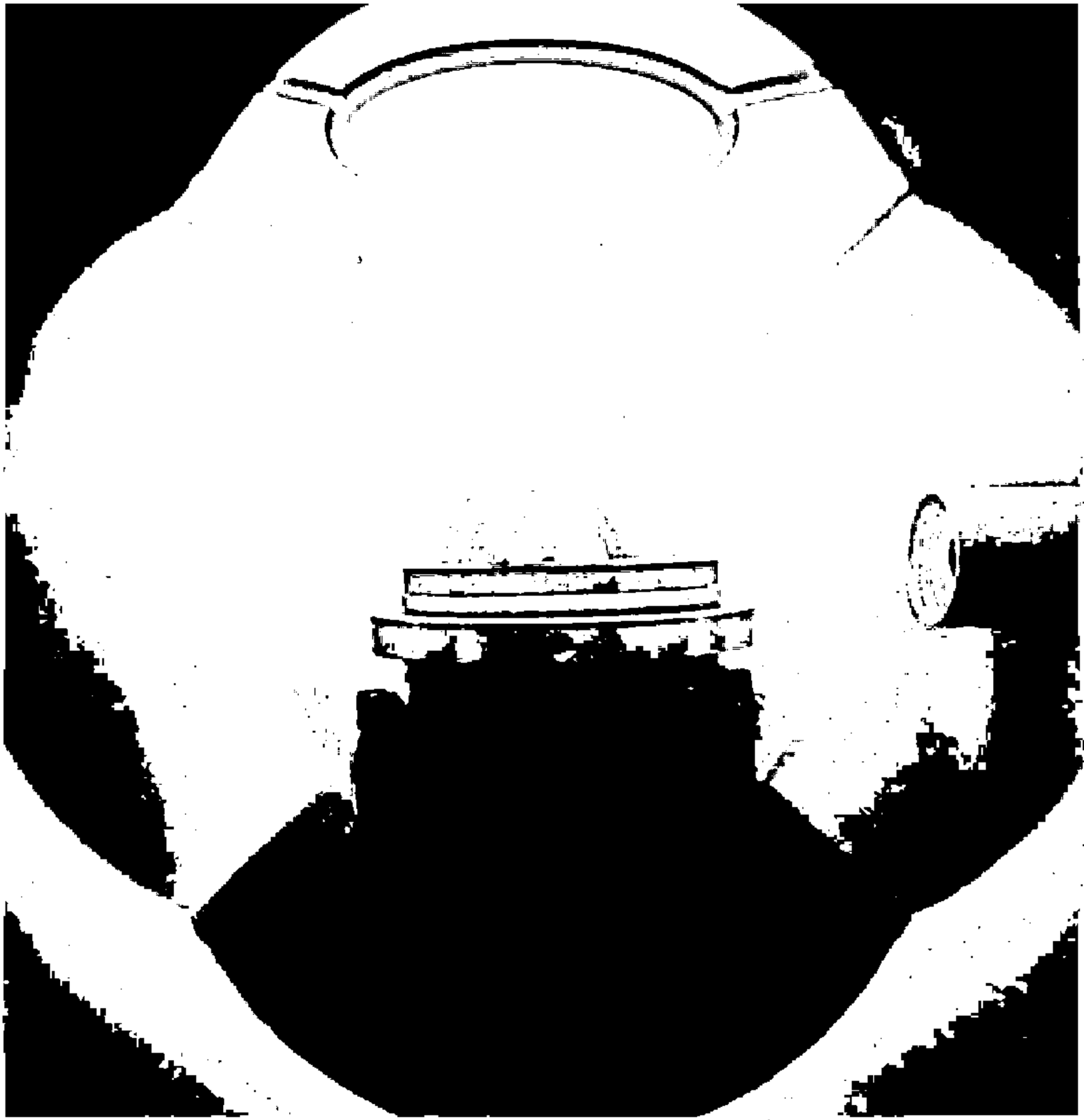


COVER:

RTI scientists, engineers, and technicians designed and built this remote plasma-enhanced chemical vapor deposition (RPECVD) reactor under a Department of Defense contract. In 1986 it enabled them to make the first demonstration of a new, low temperature (300° C) plasma process that prepares semiconductor surfaces and deposits amorphous dielectric and epitaxial semiconductor layers.

Completion of the RPECVD system promises even greater advances in semiconductor technology. It grows thin diamond epitaxial layers on a nickel substrate by a new process that yields dominant quantities of diamond material in the deposited layer, rather than the prodigious quantities of graphite that are present in layers deposited by other processes.

Research Triangle Institute's annual report for 1986 replaces the January/February 1987 issue of HYPOTENUSE. The magazine will resume regular publication with the March/April issue.

RTI in Brief:

Research Triangle Institute is a not-for-profit organization performing research in many disciplines for government, industry, and other clients throughout the United States and abroad.

RTI was incorporated at the end of 1958 by joint action of the University of North Carolina at Chapel Hill, Duke University in Durham, and North Carolina State University in Raleigh. RTI is a freestanding affiliate of the three schools with its own staff and facilities. Close working ties at many levels are maintained with the founding universities.

RTI's staff occupies 374,000 square feet in 16 laboratory and office buildings on a central campus of 180 acres in the 6,550-acre Research Triangle Park between Raleigh, Durham, and Chapel Hill. A separate organization, the Research Triangle Foundation, develops the resources of the park, which has grown around RTI to become the site for some 50 industrial, governmental, and university-related research installations.

RTI research operations are organized into units that conduct basic and applied research and provide technical services in the physical, chemical, life, engineering, environmental, statistical, social, and policy sciences.

GEORGE R. HERBERT
President

A year ago we reported new records in both Research Revenue ($52 million) and contract funding signed ($52.4 million), making 1985 a very tough act to follow.

The Institute staff rose to the challenge, however, and I am pleased that this year's report again highlights records in nearly all operating figures. In addition, during the year, we established, or strengthened, the Institute's position in several new research areas and made significant progress toward expansion of physical facilities. Some of these are discussed by Dr. Horvitz on page 6.

Pages 4 and 5 summarize the Institute's operating data for the 1986 fiscal year. Research revenue of $64 million was the highest in RTI's history and also exceeded last year's record by nearly 23 percent.

Net income from research operations rose to $2.2 million, an increase of 18 percent. Adding depreciation charges, "cash generation" rose 21 percent to $4,842,000. These, of course, are the only dollars we have to fund the annual capital equipment budgets, to repay building mortgages, to build a bit of a "kitty" toward future buildings, and to strengthen working capital.

During the year, new expenditures of $3.2 million for equipment and facilities brought our total investment in fixed assets, before depreciation, to more than $40 million. Corporate net worth rose to $21.8 million, from $19.5 million in 1985. Cumulative net income earned over 28 years reached approximately $17 million, and the Institute's total assets are now $41 million.

On September 30, the regular staff numbered 1,071. With 134 temporary, hourly employees, the total staff was 1,205, slightly higher than the peak employment reported in 1980.

Although most of the Institute's staff is located in the Research Triangle, we should not forget the important contributions of those who work at off-site locations. Their numbers have increased from 27 one year ago to 44 this year. These staff members work in permanent and semi-permanent project offices in Hampton, Virginia; Washington, D.C.; and Cocoa Beach, Florida. Others are survey district supervisors at locations across the United States, and a few are in residence in Morocco, Nepal, Mali, and the Ivory Coast for the duration of their projects.

By gender, the staff is close to evenly divided: 500 females and 571 males, with the women outnumbering the men in four of the ten research units. Over 400 of the staff have advanced degrees: 201 Ph.Ds and 216 Masters degrees.

In assessing our expectations, there will be continued revenue growth in 1987, although not at this year's 22-23 percent rate. Total funding officially signed and allocated to new or continuing contracts was a record $68.8 million, and the face value of new contracts and extensions signed would realize a total of $81.5 million if the expected future budget increments are funded. This, too, achieves a new record in contract values and provides a strong base for moving forward into 1987 and beyond.

Courtesy of Durham Sun

Near the middle of the column of white blocks stacked beside George Herbert is an almost invisible 3/16th-inch tile. It represents the $1.5 million "founding investment" in RTI. This consisted of a one-half million dollar start-up grant from contributions made in 1958 to the Research Triangle Foundation, and initial equipment grants of one million dollars appropriated by the State of North Carolina. In ascending order, the blocks show cumulative revenues for RTI's first eight years, and for each five-year increment thereafter. At the end of 1986, the 28-year return to North Carolina's economy on the $1.5 million founding investment totalled $541 million.

In 1986 (as shown on the overleaf) RTI's commercial clients accounted for 9.3 percent of research revenue (nearly $6 million) and 29.3 percent of active contracts.

Institute clients included 137 corporations funding 170 separate projects. Their geographic distribution demonstrates that RTI's reputation is not confined to North Carolina. They are located in 25 states and the District of Columbia, Europe, Canada, and Japan.

It is rewarding to know that the Institute's reputation is spreading, but there is a special satisfaction associated with working for companies in our home state. In North Carolina we had 44

corporate clients in 16 counties, including eleven of our Research Triangle Park neighbors.

It is natural to point, with pride, to projects conducted for large corporations that understand research and have their own research capabilities. And we can do so. Among those 137 clients are six of the ten largest industrials on the Fortune 500, and 50 of the 500; two large financial institutions; ten consortia; and eight of the 50 largest electric utilities.

It is at least as important that the talents and experience of RTI's staff also are available to small and growing companies. This, too, is true. Fifty-five of last year's clients had sales of less than $100 million, with most of them in the $2-$50 million range and fitting the small business definition. Three are start-up companies in pharmaceuticals and biotechnology, two are venture capital investors, and the smallest is a start-up with five employees and zero sales. Twenty-five of these small businesses are in North Carolina.

Over the years both visitors and local friends have probed to understand the contribution of RTI to the success of the total endeavor that has become known internationally as "North Carolina's Research Triangle." With slight variations, the basic question always is: "Was the Institute important to the development of the Research Triangle?" The simplest answer would be "Yes," but the question deserves more than that.

Answering in the context of early history, I always explain that the first decision of the business and academic leadership of North Carolina was to work in concert to create a major research center within the attractive environment surrounding the three graduate, research universities and their respective communities.

As the Research Triangle Foundation planned the development of its Research Triangle Park, knowledgeable university participants offered the concept of a university-oriented contract research institute to serve as the physical focal point for Park development, and to symbolize the effort to create a new center of scientific activity. The concept was warmly received, the planned institute's needs were incorporated in the Foundation's fund-raising goals, and RTI was born with three University parents.

By being just one element in a much larger Research Triangle endeavor, the new RTI assumed responsibilities that had not been faced by any other research institute in the United States. First, acceptance into the family of older, respected institutions carried with it the responsibility to build the new institution in a manner that not only benefited from the preexisting scientific strengths of the universities, but also in a way that contributed a net addition to the already distinguished reputation of those North Carolina institutions. Everyone who has worked to develop and guide RTI has, from the beginning, been constantly alert to that responsibility.

The second, unique responsibility was to the Research Triangle Foundation and to the success of its Park. Anyone who has known, or been associated with, RTI for only the last ten or fifteen years may not appreciate the importance, during the earlier years, of RTI's contribution to the ultimate success of the Foundation's Park. Decisions by IBM and the federal government in the mid-1960s brought the Park to "critical mass" and gave it a momentum that never has diminished. Until that time, however, life was hard and the road rough for the leaders of the Research Triangle Foundation as they worked toward the goals they had set in the late 1950s.

It was during those years that RTI's very existence and its successes responded uniquely to two critical needs: first, to sustain local and statewide confidence in the value of the Triangle concept until its success was assured and visible; and, second, to contribute to spreading the word that a thing called "the Research Triangle" was a "happening" in North Carolina.

By today's standards, the numbers demonstrating RTI's development in the early years of the Triangle would be considered "modest" at best. But the percentages and rates of growth were tremendous.

RTI proved that something was happening out here in the nearly empty woods and helped sustain the faith until larger neighbors appeared who would, from that time forward, dwarf our numbers, but not our reputation.

In those same years the activities of the Institute's growing staff probably contributed the most to increasing the awareness of a Research Triangle in North Carolina. Working for clients in Washington and elsewhere, giving papers at regional and national meetings of their technical and scientific societies, and constantly recruiting, the Institute staff carried the Research Triangle name to places where it had not been seen before.

I would expect a history of RTI's contributions to the ultimate success of the Park to focus on the people whose scientific reputations helped build RTI, or were established here; on the significance and contributions of their research; and on the unique university relationships.

While these contributions are difficult to quantify, there is another that can be weighed with reasonable accuracy. That is the local and regional impact of RTI's revenues, dollars brought into North Carolina and pumped into this state's economy through salaries, purchases of materials and services, construction, utility bills, bank interest, and other costs of building the Institute.

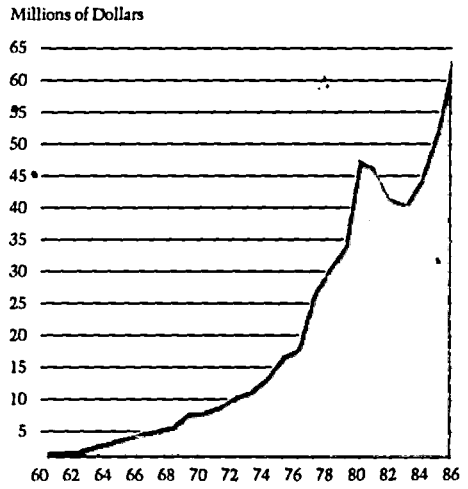
Because the leaders and planners of the 1950s appreciated the potential importance of the new institute to the total Research Triangle endeavor, an investment was made in RTI, and the return on that investment can be measured (see photo). Everyone associated with RTI can be proud of that contribution to North Carolina's economy, for, in general, these are dollars that never would have been seen in our state except for the existence of RTI and the work of its staff.

Having made that point, I will conclude by stating again an objective that I will never stop repeating as long as I share some responsibility for RTI: When all else has been said, and material contributions have been measured, we want Research Triangle Institute's reputation to be based on the quality of its research, the professionalism and integrity of its staff, and the high ethical standards we strive to maintain.

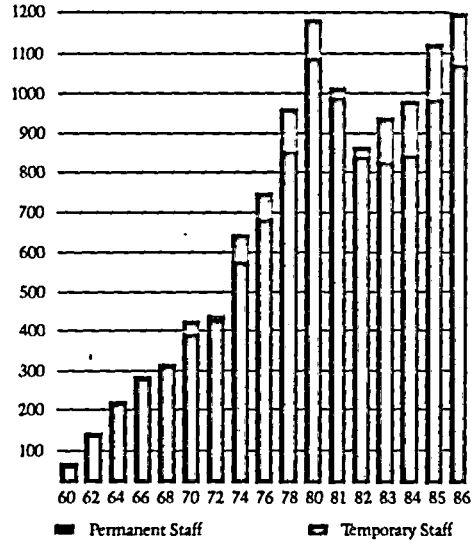
George L. Herbert

FINANCIAL HIGHLIGHTS

Research Revenue



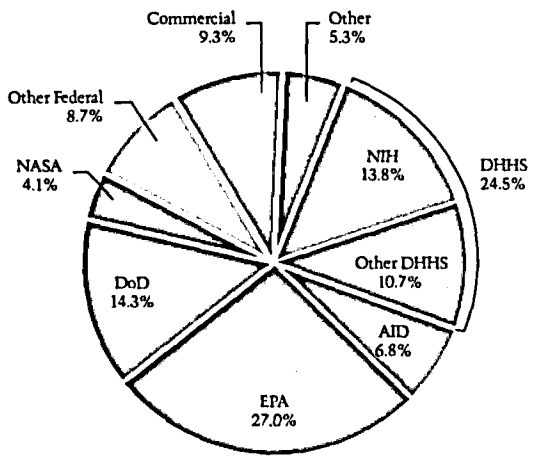
Staff



	Fiscal Year 1986
Revenue	$64,036,418
Direct Research Costs	$38,274,125
Operating Expense	$23,546,195
Net Revenue	**$2,216,098**
Facilities:	
Property and Equipment	41,346,864
Less Depreciation	(17,543,761)
Total Facilities	**$23,803,103**
Net Worth	**$21,804,749**
Total Staff at September 30	1,205

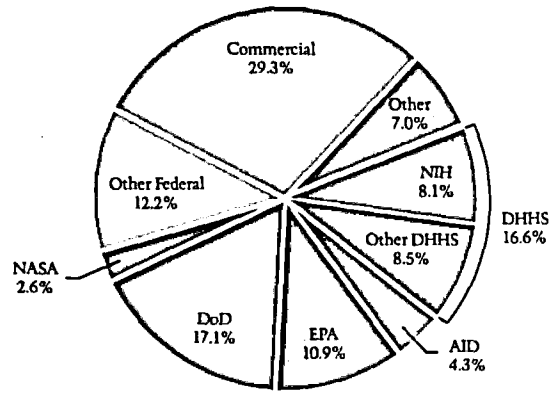
Fiscal Year 1985	Fiscal Year 1984
$52,186,067	$44,298,036
30,745,851	26,030,719
19,566,407	17,409,786
$1,873,809	**$857,531**
38,174,801	34,740,477
(16,222,003)	(14,140,918)
$21,952,798	**$20,599,559**
$19,581,889	**$17,655,844**
1,126	979

Distribution of Research by Contract Funds



Fiscal Year 1985

Distribution of Research by Number of Contracts



Fiscal Year 1985

DANIEL G. HORVITZ
Executive Vice-President

Meaningful scientific research hinges on two key factors. First and foremost, clearly, is the quality of the technical and support staff, the human resources available for research. Second is the availability of state-of-the-art equipment and facilities. The latter factor has grown in importance due to the continued advances in technical knowledge and the subsequent development of increasingly sophisticated research equipment.

Research Triangle Institute seeks to provide those physical resources essential to good science. RTI investment in capital equipment during the past two years has been at an all-time high. In 1985 nearly $2.5 million were allocated for new equipment. In 1986 the investment was nearly $2.9 million.

The major new resources have been closely tied to automation. Heading the list in computing is the addition of a VAX 8600 and establishment of a VAX computer cluster that consists of the 8600, a previously purchased VAX 785, and a VAX 780.

To support analytical and chemical sciences research, a high resolution high mass (HRMS) mass spectrometer was added to the six mass spectrometers already in operation. A cryolect gas chromotograph Fourier Transform infrared spectrophotometer was added to augment this molecular analysis capability. A Hewlett Packard data processor was installed to interface on-line with chromatographic systems also used in chemical analysis. A network of up to 14 different gas chromatographic and/or HPLC systems can interface simultaneously with the Hewlett Packard, and the data they generate are automatically monitored, processed, and stored.

Major equipment additions in 1986 also support research in semiconductors and in aerosol technology. An organometallic vapor phase epitaxy (OMVPE) reactor significantly expands our capability for developing more reliable and efficient semiconductor materials and devices. For research on chemical aerosols, RTI constructed a unique wind tunnel that simulates a wide range of environmental conditions.

Expansion of research facilities was also substantial in 1985 and 1986. An 8,000-square-foot structure for the safe handling of toxic chemicals was completed and, in the summer of 1986, we converted 8,000 square feet of warehouse space to accommodate the wind tunnel, laboratories, and offices of the aerosol research program. Plans for extensive additions and modifications to the RTI animal research facility were adopted. Finally, construction began on a 52,000-square-foot research office building designed to house 225 staff members. Many of them will move there in 1987 from leased quarters elsewhere in the Research Triangle Park.

Research capability and research opportunity abound at RTI. The two forces challenge each other, and combine to produce ever greater levels of achievement by the Institute's technical and support staff.

Most of RTI's research involves the close collaboration of scientists, engineers, and analysts from many disciplines, and nearly all of it addresses issues of specific national concern such as toxic wastes, radon, AIDS, and industrial technology.

The following pages report briefly on some of the health, environmental, defense, and industry research highlights of 1986.

GROUNDWATER

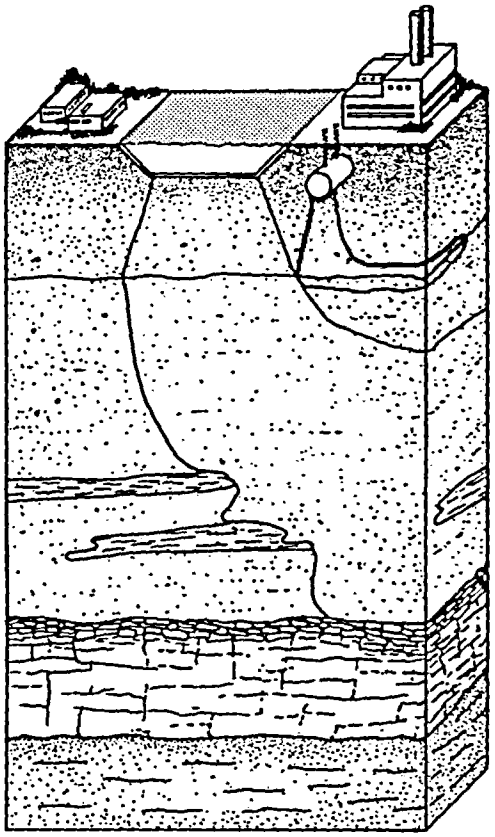
Toxic substances in water, soil, and air threaten Americans' health. RTI research deals with all three elements. Groundwater protection is an urgent matter, for nearly half the nation's drinking water comes from wells. RTI designed and is carrying out the National Pesticide Survey to assist the Environmental Protection Agency in tailoring suitable regulations to protect well water, and to assist farmers and chemical manufacturers. The survey covers 50 pesticides and all 3,144 counties in the United States. Teaming with survey statisticians, RTI hydrogeologists assessed the contamination vulnerability of community well water systems and rural domestic wells. They also conduct and monitor water and soils analyses for the EPA, for several military installations, and for industry.

RADON

Radon, like groundwater, has become one of the decade's most noticed health hazards. RTI research on its detection, measurement, and mitigation involves chemists, earth and mineral scientists, survey statisticians, economists, and chemical engineers.

RTI designed a national survey that will enable the EPA to describe radon concentrations in homes across the country, and is conducting a pilot study to test survey data-gathering methods and quality control procedures.

Sample survey households receive educational materials about radon exposure and mitigation.



A statewide random-digit-dialing survey of New York residential dwellings was part of a larger indoor air study for the state. Respondents have placed radon detectors in primary living areas and basements; their recordings will allow RTI to measure 2-month and 12-month exposure levels to the radioactive gas, and to examine relationships between basement and living area concentrations. The New York households are receiving educational materials about radon exposure risks and remedial measures. Focus group discussions in New York and the Reading Prong area of Pennsylvania yielded information from which the EPA can evaluate public perceptions about radon exposure health risks and the effectiveness of techniques for reducing them.

RTI radionuclide experts, geologists, and industrial hygienists operate an EPA technical information program to demonstrate the proficiency of commercial products for measuring indoor levels of radon and radon progeny. Directories are prepared listing laboratories and businesses whose detectors perform within a pre-established range of error. This program for the EPA also includes a national toll-free telephone service to meet the information needs of state agencies, homeowners, architects, builders, and firms that offer detection devices. A similar service of proficiency measurement and technical information for bulk asbestos began at RTI seven years ago, and has expanded to include asbestos air samples.

Thousands of lung cancer cases are attributed to long-term exposures to high radon concentrations indoors. An estimated two to five million homes may require some form of radon mitigation. Working with the EPA and the State of New Jersey at ten residences of varied design, RTI is developing and testing methods which either prevent radon infiltration into the home, or which dilute gas levels already contaminating it. Mitigation techniques include both altering the structure to reduce entry points, and installing ventilation systems to draw the soil gases away. Results from this research will demonstrate simple, effective, and low-cost mitigation measures for homeowners and home builders.

ACQUIRED IMMUNE DEFICIENCY SYNDROME

AIDS is an ominous health threat of worldwide proportions. As with radon, RTI confronts the deadly virus with research across a range of disciplines.

RTI is the data coordinating center for a five-year series of anti-AIDS clinical trials that will be made at 14 major medical research centers. As many as 1,000 patients per year may participate in this National Institutes of Health experimental therapy evaluation. RTI's role includes development of the study protocols, data management and processing, quality control procedures, and biostatistical analysis. A Duke University virologist is the study's physician monitor.

AIDS is caused by the Human Immunodeficiency Virus infection, which disables the body's immune response to pneumonia, cancer, and other illnesses. In a long-term National Cancer Institute project, RTI epidemiologists and survey specialists are using case-control studies and antibody screening surveys to examine the transmission of HIV and related retroviruses among certain high risk populations.

The drug dideoxyadenosine (ddA), originally developed for its

antitumor properties, has also exhibited antiviral activity against AIDS. Chemists at RTI are characterizing the compound and have tested several batches for solubility, purity, and stability. Although ddA's toxicity has yet to be determined, NIH gives it a high priority for further examination as a potential AIDS treatment.

Other AIDS-related research draws on RTI's 11-year study of drug abuse rehabilitation effectiveness and treatment outcomes. Institute social psychologists and health analysts are examining data for risk factors related to AIDS among 1,000 intravenous drug users who were participants in the treatment outcomes research.

HAZARDOUS WASTE

Environmental and health protection are the largest components of RTI effort (see chart on page 5). Hazardous waste is an environmental issue and a health issue, and RTI's approach to both sides of the problem is through chemistry, economics, and engineering.

The U.S. annually generates about 300 million metric tons of hazardous wastes that require handling at several thousand treatment, storage, and disposal facilities (TSDFs). In the second year of a five-year program, RTI is assisting the EPA to develop national standards for reducing air emissions from TSDF operations. One of RTI's significant contributions is SAM, a source assessment model that estimates controlled and uncontrolled emissions, abatement method costs, and health impacts from alternative control strategies.

5,600 hazardous waste management facilities were included in a census screening survey (with a 100 percent response rate) by RTI in the first year of a large-scale, four-year study of the industry. Phase one results are being used for congressional testimony and for revising EPA databases. Phase two in 1987 covers a sample of 1,500 sites, and will improve available data about industry technologies and capacity.

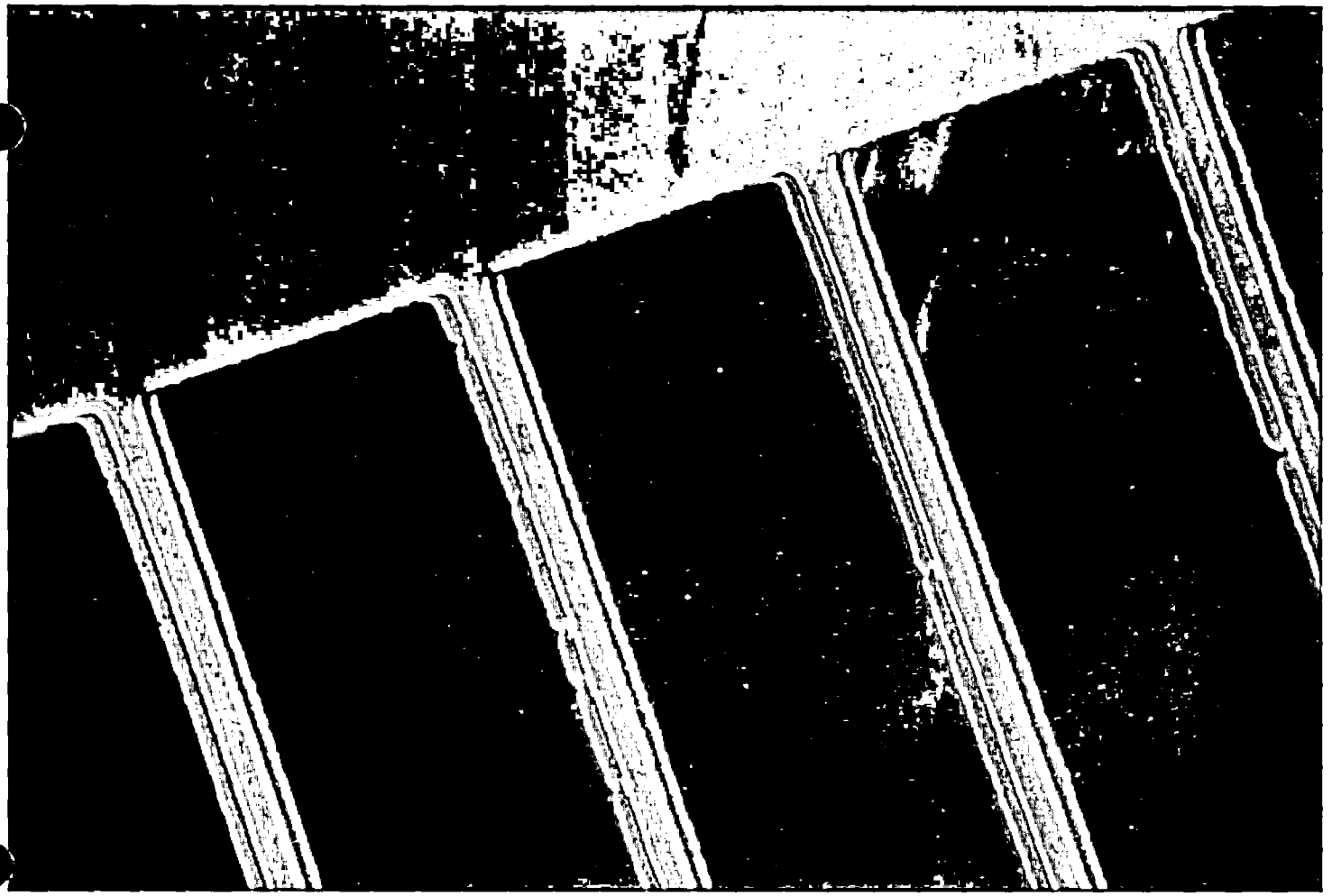
Volatile organic compounds are present in many wastes. As the wastes are processed, VOCs can enter the atmosphere, surface streams, and groundwater. RTI's hazardous materials research covers both removing VOCs before disposal and determining the residual volatiles after disposal. Waste treatment research at industrial sites determines not only the effectiveness of VOC removal techniques, but also the environmental effects of treatment plant operation. A cooperative investigation of treating petroleum sludges in a thin film evaporator involved RTI, the EPA, an equipment vendor, and a major oil company.

INDUSTRIAL TECHNOLOGY

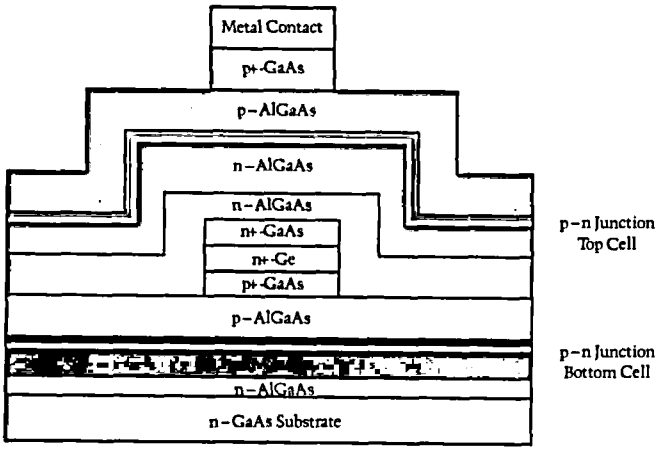
Industry clients and business firms in many categories benefit from research by RTI engineers, economists, and physical and life scientists. One important source is the technology applications program that RTI has carried out for more than 20 years to assist NASA in fulfilling its mission to transfer space exploration technologies for use in medicine, rehabilitation, materials, electronics, automation, and manufacturing.

Steel manufacturing provides a significant example of one of the many successful RTI/NASA technology transfers. Space vehicle

In research for the Department of Energy, RTI scientists made significant advances towards developing high-efficiency concentrator cascade solar cells by demonstrating new state-of-the-art tunnel junction interconnects that provide electrical conductivities 1,000 times greater than competing interconnect technology.

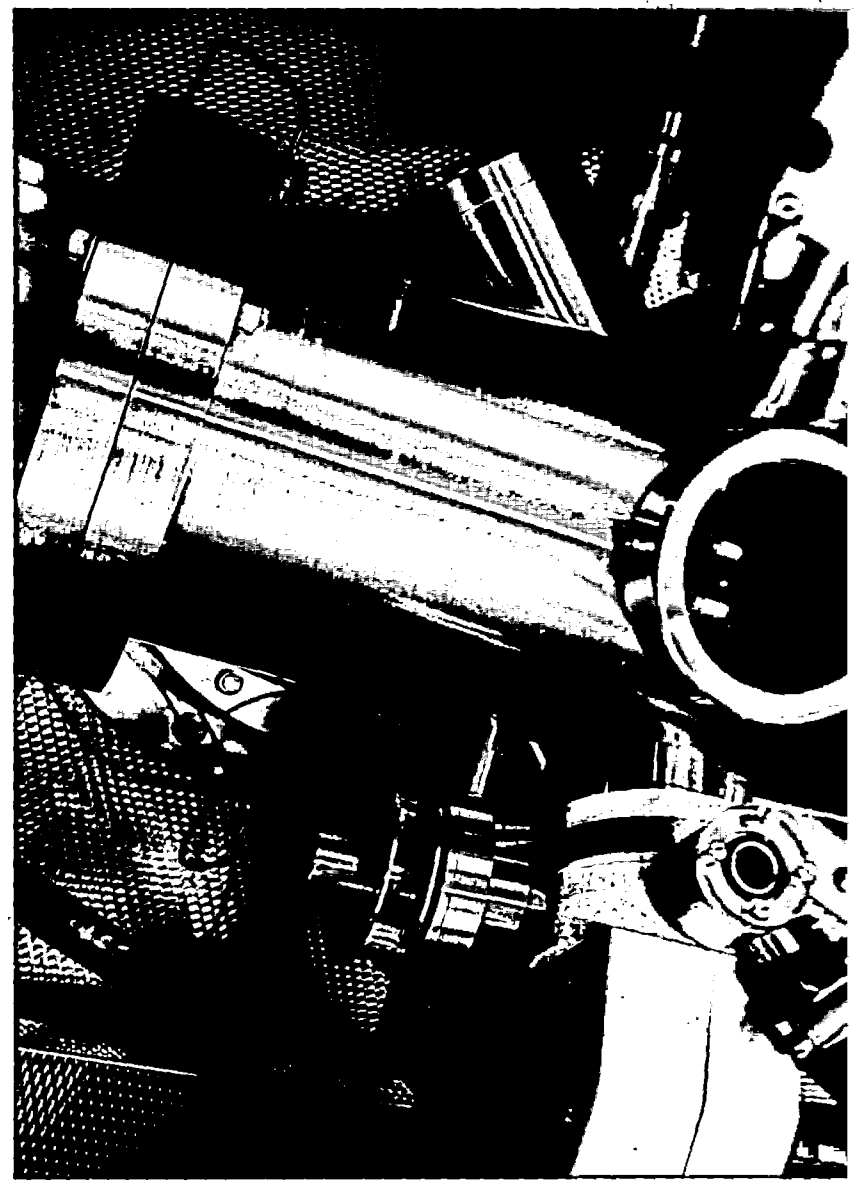


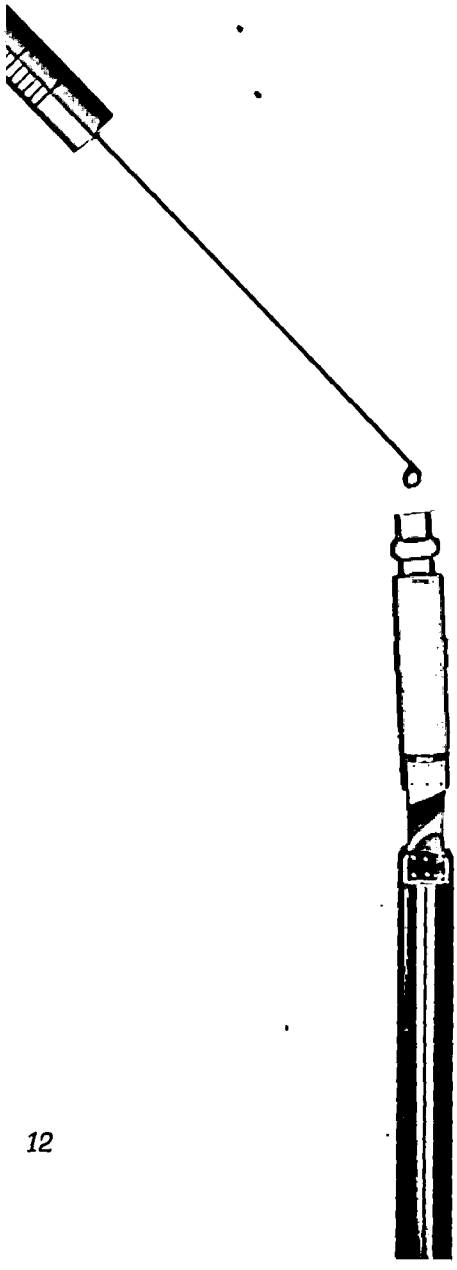
Structural Diagram of the Graded Bandgap AlGaAs-GaAs Patterned-Tunnel-Junction Cascade Solar Cell

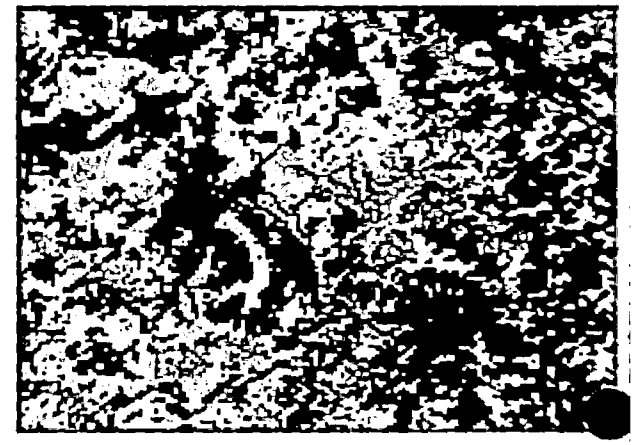


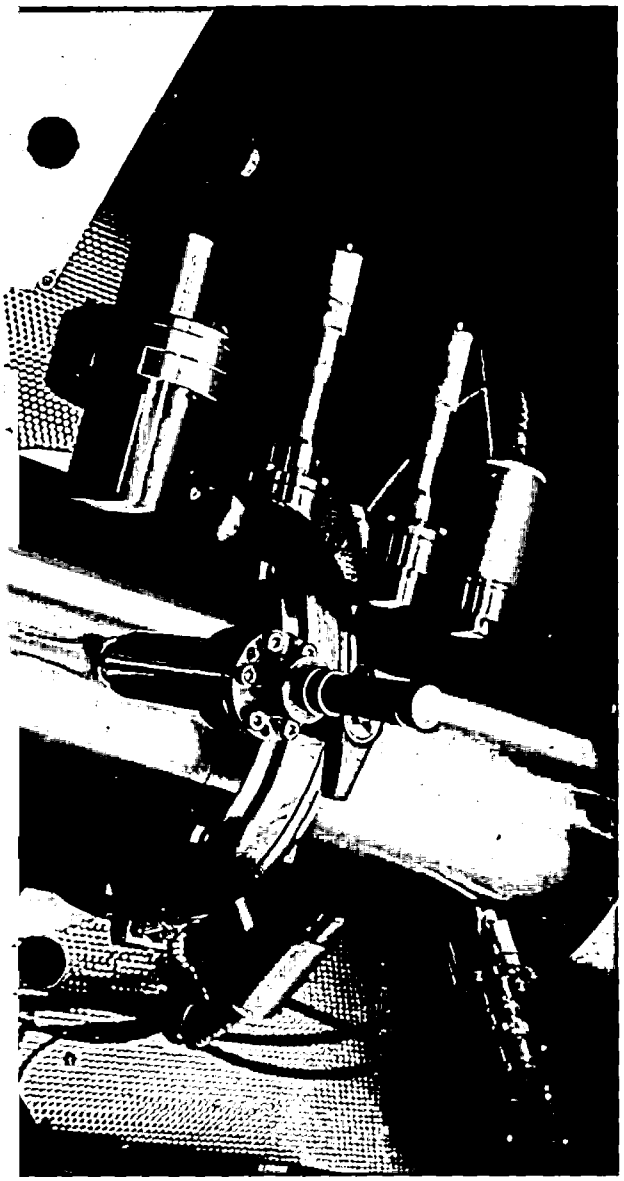
Low and high molecular weight compounds, such as those commonly found in biological systems, are analyzed in RTI's high resolution high mass (HRMS) mass spectrometry system.

Below, for example, a droplet of biological substance is applied to the tip of a fast atom bombardment probe.









A digital image processing display generated from satellite data uses color to distinguish surface features around the Raleigh-Durham Airport, center, near RTI.

nosecone alloys are extending the life of process surfaces in steel production by at least four times, with annual reductions predicted in the millions of dollars. Research also continued on methods for the computer-aided design and manufacturing of orthopedic shoes.

RTI technology transfer specialists were instrumental in identifying technology and funding sources for the first programmable implanted insulin pump to be tested in humans. Developed by industry and the Johns Hopkins Applied Physics Laboratory under NASA and National Institutes of Health sponsorship, the new pump benefits from NASA electronic and hydraulic technology.

Electric utility research since the 1960s has called on the talents of RTI economists, statisticians, and engineers. In 1986 Institute energy economists completed the first of a two-phase energy conservation and load management goals study for Southern California Edison. Results have been filed with the California Public Utilities Commission. The study's objectives were to evaluate the benefits and costs of conservation and load management options, and to construct a least-cost resource plan for the company. Options in residential, commercial, agricultural, and industrial sectors include energy-efficient technologies, electrical load control, and customer behavior.

For another major electrical utility, RTI engineers in 1986 completed a full year of operating a photovoltaic field in which a DC source interacts with the company's network, including the generation of high-frequency harmonics. Related work covered the analysis of manufacturing cost and required product pricing for photovoltaic modules, and forecasting performance and physical characteristics for thin film photovoltaic modules.

For a corporate client and the government, RTI semiconductor scientists deposited silicon oxide on silicon at low temperatures (300° C), achieving excellent gate-dielectric properties. This new result may make it possible, for the first time, to fabricate silicon chips using exclusively low-temperature processing technologies.

Research for the semiconductor industry also included the development and demonstration of a new aluminum gallium arsenide/gallium arsenide (AlGaAs/GaAs) bipolar transistor fabrication technology, and in-house work supported by RTI led to the design of a digital GaAs integrated circuit.

Other RTI research for industry involved computer-assisted automated machine design for improved manufacturing systems, materials, and products. Activities include development of special-purpose production equipment and components, manufacturing process cost analysis, and system integration.

STATISTICS AND SURVEY RESEARCH

Statistics and survey research were RTI's first areas of special skill and they continue as dominant activities, often in collaboration with scientists from other disciplines. During 1986 data collection from more than 26,000 survey respondents was conducted by computer-assisted telephone interviewing. CATI was used in:

- — the Centers for Disease Control's veterans health survey;
- — the National Center for Health Statistics' nursing home survey;

— the Department of Health and Human Services' national worksite health promotion study;
— the EPA's national survey of community water systems;
— the New York State Energy R&D Authority's survey of indoor air quality.

Also in 1986, statisticians and other scientists in seven of RTI's ten research units completed one three-year contract of technical support to the EPA's statistical policy staff, and began another. Topics assigned to RTI included sampling for hazardous waste sites, indoor air quality measurement, dietary exposure analysis, characterizing uncertainty in exposure assessment, carcinogenicity risks, sampling plans for the national pesticide study, radon measurement, water quality, and pattern recognition techniques applied to the reduction of mass spectrometry data.

EDUCATION

RTI conducted a nationwide, computer-assisted household telephone survey of nonschool learning among children, adolescents, and adults. The survey was sponsored by the Corporation for Public Broadcasting and the National Center for Educational Statistics. Findings provide valuable information to educational programmers and policymakers regarding the extent of informal learning that occurs among all ages and both sexes, what subjects different groups choose to learn about informally, and what resources, such as books, television, computers, and other persons, are useful.

Policy-relevant educational research at the state level focused on vocational education and community colleges, addressing appropriate agency responsibility, governance and administration, funding mechanisms, and staffing patterns. Local level studies considered such factors as school district structure, program service needs, and the organization of vocational training to meet specific educational and economic objectives.

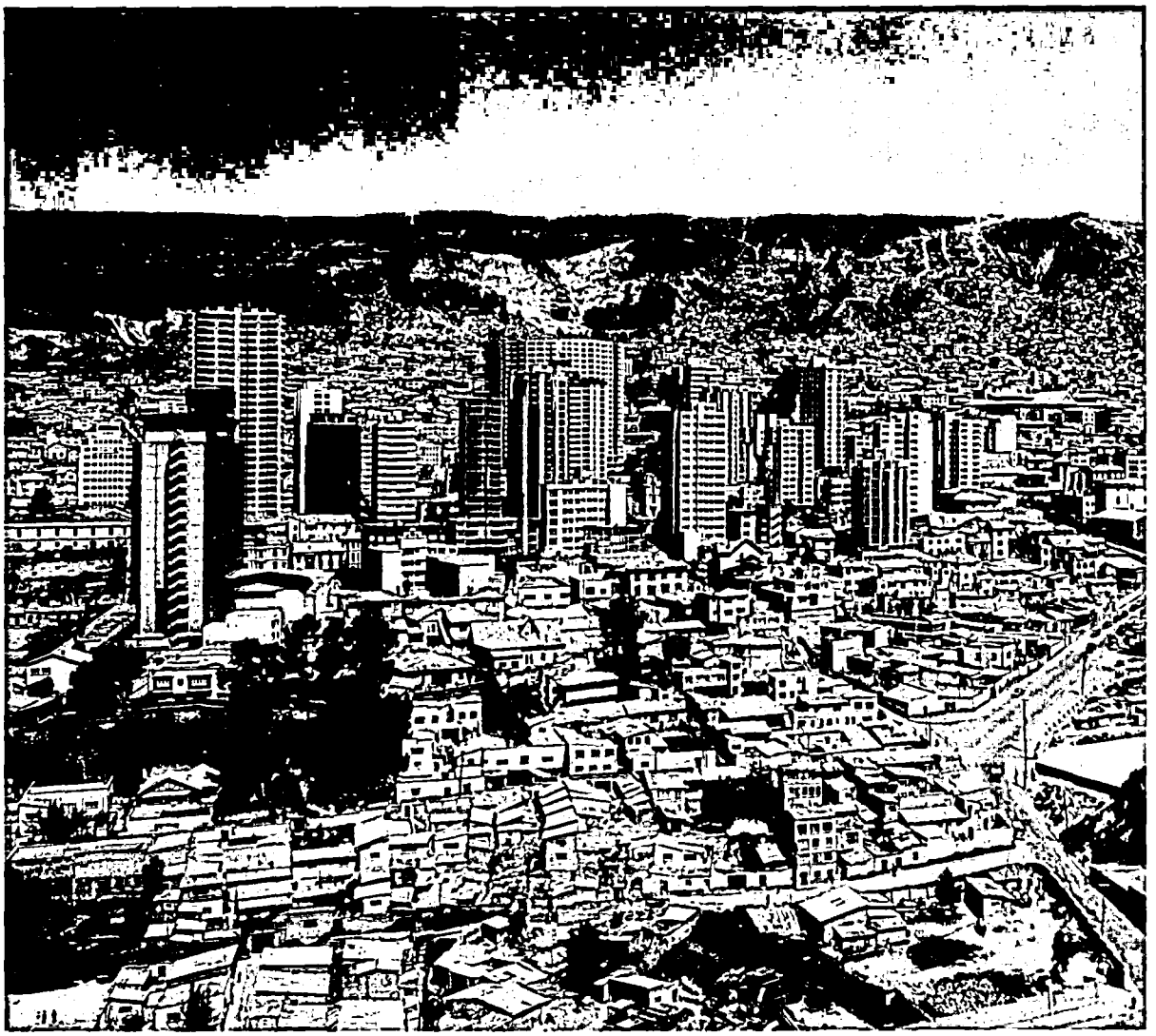
SOCIAL POLICY AND HEALTH

Problems affecting the young, the elderly, and the infirm were among RTI's priorities in 1986. In the crime and criminal justice research program, work began on a 2½-year examination of law enforcement practices and policies on missing children and homeless youth. RTI will develop a model program that agencies throughout the nation can use in responding to missing children cases. With recent arrestees at the jails of three large cities, Institute social scientists are using urinalysis and extensive interviews to replicate a landmark 1971 study that RTI made on the relationships between drug use and criminal activity.

Statistical analysis also went forward in the study of the relative efficacy of high frequency ventilation and conventional mechanical ventilation for treating babies who need assistance in breathing.

RTI response to the need for new research on current and future care of the elderly embraces several studies. They include analyses of the structure of the nursing home industry and its ability to recruit and retain registered nurses, a study of quality assurance in long-term care for victims of Alzheimer's disease, and a project for the American Association of Retired Persons to

RTI works in, for, and with many Third World countries under contract to the U.S. Agency for International Development, the World Bank, and the United Nations. Research topics include agricultural and urban development, municipal finance and taxation, family planning, water, sanitation, and renewable energy. At seminars here and abroad, RTI also provides microcomputer training and applications modeling for officials responsible for planning in key sectors such as education, employment, health, food supply, and housing.



Research psychologists, sociologists, and policy analysts at RTI are concerned with matters affecting family stability, the young, and the elderly.

More than 20 years ago, RTI scientists isolated and characterized a promising anticancer agent from a rare Chinese tree, the *Camptotheca acuminata.* Some new derivatives of the camptothecin compound have given cures in a number of experimental rodent leukemia and tumor test systems. These results have roused considerable interest in the potential for camptothecin analogs, which RTI is pursuing in studies for the National Cancer Institute.

Left. On more common ground, the humble collard has recently been shown to inhibit mutagenesis and the promotion of cancer. Intensive research is under way here to isolate and determine the chemical structure of the mutagenesis factor in this cabbage-like plant.

analyze and synthesize results of community-based, long-term care demonstration studies. Institute analysts also evaluated a national senior companion program, and completed the evaluation design and phase one data collection for testing the feasibility of using elderly volunteers to help delay the placement of frail older persons in nursing homes.

Public policy scientists contributed to Social Security Administration studies of the impact that new technology has on determining and classifying disability. Technology applications engineers continued work on the development of memory aids, and helped incorporate NASA composite materials and structural analysis technology into production of a commercially-available 25-pound wheelchair.

Deafness is a specific disability addressed by RTI research on sensory aids for persons with severe or total hearing loss. In 1986, effort was directed primarily to design and evaluation of speech processors for multichannel auditory prostheses, or cochlear implants. With coinvestigators at the University of California in San Francisco and at Duke University, extensive tests demonstrated that RTI's new speech processing strategies enable cochlear implants in the profoundly deaf to provide tremendously improved performance.

GENETICS AND BIOSENSORS

A new mouse model of a human genetic disorder has been detected and developed. In humans, a deficiency of the enzyme carbonic anhydrase-2 causes runting and disturbances of acid-base balance. A gene mutation which results in mice with defects similar to those in humans was induced by RTI scientists using the chemical mutagen ethylnitrosourea. Mice bearing this genetic defect will be used for experimental therapeutic studies, as well as in gene therapy experiments.

RTI chemists, immunologists and biomedical engineers participated in the unfolding field of biosensors. Sponsorship from the North Carolina Biotechnology Center and the Army Research Office supported investigations into a novel immobilization technique that couples biologically active proteins to an electrode for use as sensing devices in biotechnology and clinical settings.

THE FAMILY

Family matters are of importance to RTI researchers, whose efforts range over the social, policy, and physical sciences.

Arrangements were completed for Capronor, RTI's patented subdermal contraceptive drug delivery system, to undergo phase two clinical trials with some 200 subjects in the United States, Europe, Asia, and India. Phase one trials were conducted at Duke University in 1981. Two-year toxicology trials with monkeys and rats showed no adverse side effects, clearing the way for Food and Drug Administration approval of human trials. With funds from the World Health Organization, work has begun on an improved Capronor II system.

Demographers began an analysis of divorce and remarriage probability for use in Social Security Administration microsimulation programs, and other researchers examined longitudinal data from an income survey in an effort to better

understand the extent and nature of month-to-month changes in household and family composition. Computer models and graphic presentations are being designed to encourage developing countries to adopt policies that will increase women's participation in the workforce. A five-year study for the National Institute of Child Health and Human Development is examining the relationship between diet and children's growth.

DEFENSE MANPOWER AND TECHNOLOGY

Defense research also touches on family concerns. RTI analysts are studying survey data from enlisted and commissioned personnel, and their spouses, that describe their experiences with and their attitudes toward family life in the military services. Another round in the continuing youth attitude tracking study investigated young people's propensity for enlisting in the armed forces.

RTI's second worldwide survey of drug and alcohol use in the military found that drug use is declining, and that alcohol remains the most serious substance abuse problem. The analysis was based on information collected from 17,328 active duty personnel at 68 U.S. installations in Europe, the Pacific, and the Americas.

Defense agencies sponsored extensive research in semiconductors, digital systems, and engineering (see cover and illustrations on pages 19 and 20). As part of the Very High Speed Integrated Circuit program, work started for the Air Force on the VHSIC silicon compiler, and for the Navy on the VHSIC hardware description language.

Three advanced cockpit displays were developed for an Air Force laboratory that tests new avionics concepts, and a five-year program began for the Army on techniques for maintenance testing of electronic systems. Laser diode arrays are being grown and fabricated for the Air Force.

Air sampling data analysis continued for the occupational and environmental health laboratory at Brooks Air Force Base, new reactivator drugs are being synthesized for the Army, and labeled compounds of THC were prepared for the Navy and the Walter Reed Army Medical Center to aid in detecting and quantifying the presence of marijuana.

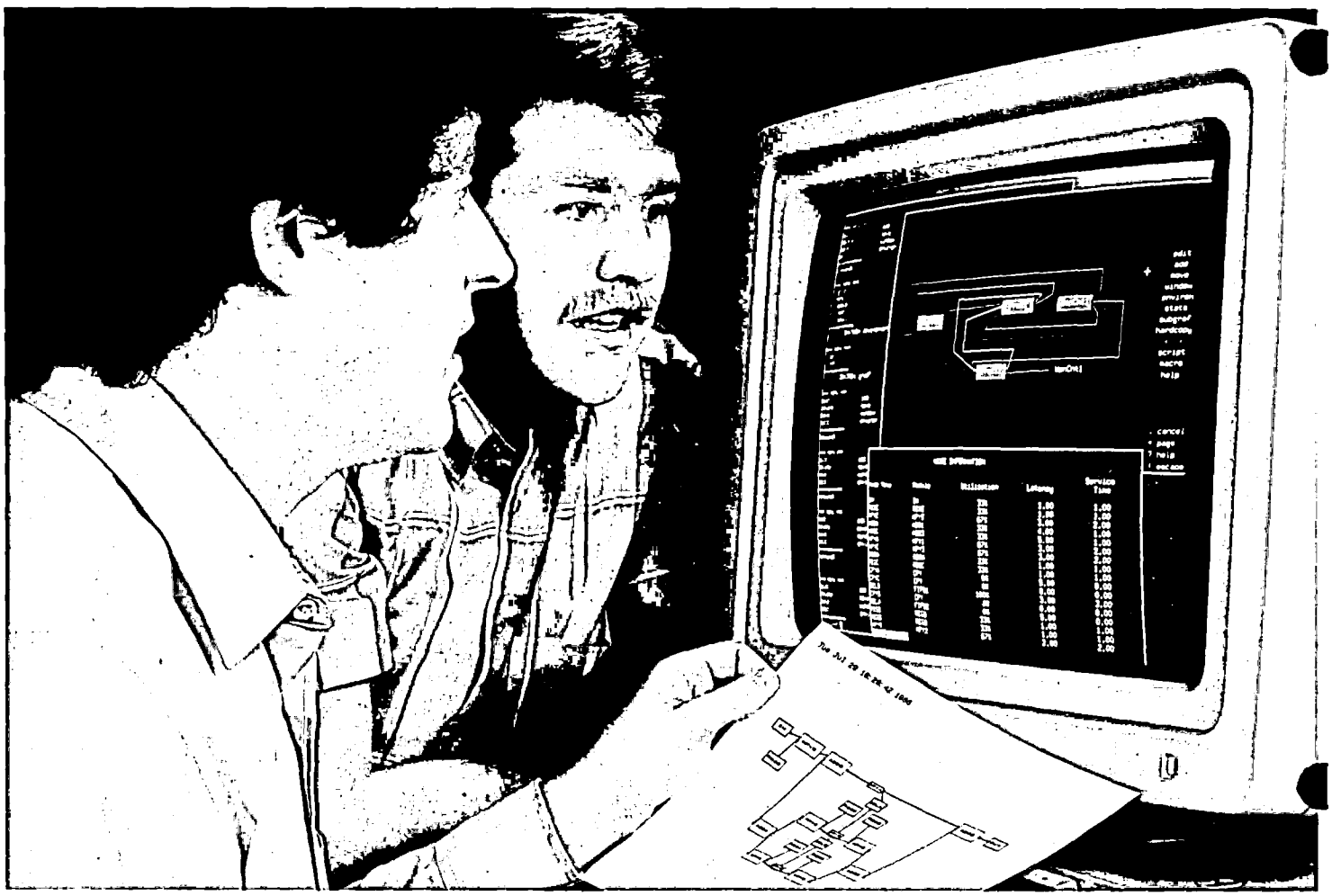
NASA TECHNOLOGY

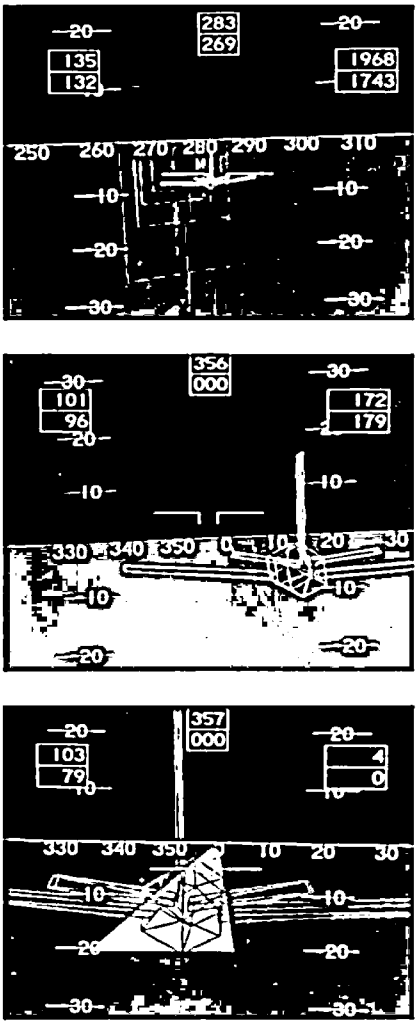
Research on fault-tolerant technologies to help assure the reliability of NASA's complex electronic systems has been under way at RTI since the early 1970s. In 1986, at the space agency's Langley Research Center AIRLAB facility, RTI completed a fault injection experiment, the first of its kind to be conducted there. Among the practical problems addressed were the design capture of large networks, simulation model validation, diagnostic tests for digital networks, applicability of various fault models, and the design of fault injection experiments.

For one of its annual technical highlights, NASA-Langley selected a new RTI technique to display characters with arbitrary orientation on raster displays. Institute scientists also completed a network simulation model for the Space Station data management system, and defined a series of Space Station technology demonstration experiments.

Wind-driven aerosols in liquid or solid phase can penetrate regular clothing, and the Army has developed a protective coverall for people who must operate in contaminated environments. RTI has constructed a unique, sealed wind tunnel and a life-sized manikin to evaluate the garment's ability to resist aerosol penetration. The wind tunnel, or wind room—it's 28 feet by 50 feet—is equipped with temperature, humidity, and wind speed controls to simulate a wide range of field conditions. The manikin can swing its arms, squat, and bend over, enabling researchers to assess the garment's performance under the stress of motion. Only safe aerosols are used. Three years of test results will be combined with theoretical principles to develop a model for predicting the level of aerosol penetration under any given set of environmental conditions.

RTI's Architecture Design and Assessment System is a set of computer-assisted engineering tools for the design and analysis of complex electronic systems. It may also be applied to manufacturing and other process systems. The ADAS software was initially developed for the Department of Defense's Very High Speed Integrated Circuit program. RTI computer scientists have completed ADAS installations for more than 40 defense agencies, electronics companies, and other users.





In cockpit research for NASA, RTI systems engineers developed a new technique for generating images on raster displays in clearly readable text. NASA's Langley Research Center selected this solution to a long-standing problem as one of its 1986 technology highlights.

ENVIRONMENTAL MODELING AND ANALYSIS

Computer modeling represents an important aspect of research for the EPA. Scientists in the RTI digital systems and geosciences centers produced two EPA research highlights in 1986. The former used the Architecture Design and Assessment Systems (ADAS) to design a multiprocessor system for the atmospheric modeling of pollution chemistry. Institute meteorologists developed another model that estimates the amounts of pollutants carried into the troposphere. Called CUVENT, this fair-weather cumulus cloud venting model, the first of its kind, will be used in the U.S. and Canada to study acid rain formation and control strategies.

Technical assistance by RTI continued to support the EPA's quality assurance program, whose objective is to ensure that all environmentally-related data produced by the agency, or under its sponsorship, are of known quality and are legally defensible. QA support included formulating an approach to the design of data collection methods based on Data Quality Objectives. The DQO process provides a logical, objective, and quantitative framework for establishing a balance between the resources required to collect data, and the quality of the data needed for decisionmaking.

Indoor air quality was the subject of other continuing research for the EPA. Topics covered were the chemical analysis of toxic organics, combustion sources, weatherization effectiveness, and measuring volatile organic emissions from building materials. RTI designed and implemented a follow-up to the Total Exposure Assessment Methodology study made for the EPA in 1984. TEAM took questionnaire data and air, breath, and water specimens at a sample of Southern California households. The new study, cosponsored by EPA and the California Air Resources Board, is determining the sources responsible for elevated indoor air levels of toxic organics.

For an expanding clientele of federal and state agencies and private sector firms, RTI analytical chemists engaged in research to develop and apply methods for measuring trace quantities of organic and inorganic chemicals in a variety of matrices. Examples include the specific determination of opioid peptides, improvement of methods for determining cyanide and total sulfide in waste materials, and determining azo dyes and related compounds in hazardous waste streams.

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