commented, "and wonder whether accidents are accidental or whether they mean you've been doing something wrong." "It isn't that we didn't worry about safety," one of the CEA scientist-administrators explained. "We were extraordinarily conscious of radiation hazards, and we thought hard about other things too. But some things just never entered our minds—who would have thought that coaxial cables, for instance, would burn the way they did?"

Whether or not anyone would have thought about it before, it is plain they will begin thinking about it now. Accelerator safety is a joint responsibility of the AEC and the research laboratories which look to it for support. So far, the AEC has said little publicly, but there is speculation on the part of some scientists that, if its findings warrant, the commission may issue new safety regulations. Meanwhile, scientists at other laboratories are said to have reacted to the Cambridge incident by checking and reviewing their own procedures and policies.

In Cambridge, the emphasis seems to have shifted from taking things apart to putting them back together again. The question of safety appears to have been one factor leading the CEA to abandon its $1-million bubble chamber. A post-accident survey of the facility led to the conclusion that an instrument the size of the M.I.T.-designed chamber, which, when full, would have contained about 500 liters of liquid hydrogen, could not be safely operated under the crowded conditions existing in the CEA's relatively modest experimental space (about 100 feet wide by 300 feet long). To house the bubble chamber in a separate building adjacent to the present site on the Harvard campus would have cost several hundred thousand dollars and have caused a delay of at least 2 years while funding was obtained and construction undertaken. By that time, it appears, the completion of other research facilities in this country and abroad would have made the CEA bubble chamber less useful for the experimental program it was designed to carry out. As a result, it was decided that the rebuilt chamber will be offered to either Brookhaven National Laboratory, the Argonne National Laboratory, or the Stanford Linear Accelerator; all these facilities have larger experimental areas than the CEA, and their accelerators will be operating at energies higher than those available on the 6-Bev machine in Cambridge.

The Cambridge bubble chamber group, at present made up of scientists from Harvard, M.I.T., and Brown, will meanwhile proceed with another phase of its experimental program, utilizing a 12-inch bubble chamber which was used in an earlier phase of the program and which will now be reactivated. The scientists plan to take the later phases of their experiment elsewhere. "Of course it is always easier to do the work in your own back-yard," one M.I.T. physicist commented, "and no one believes the accident contained any hidden benefits, but we do feel its bad effects can be minimized." For the dozen or so graduate students working with the bubble chamber, the disruption may be more serious, but Livingston and other scientists feel the students can be accommodated either through modifications of their own plans or through the hospitality of other laboratories. As for other experiments in the CEA, they await the rebuilding of the roof and restoration of heating and electricity; all this work, having missed a November target date, is now expected to be finished by January. The AEC's final report, which has also missed a few target dates, is expected to be out about the same time.—ELINOR LANGER

Research Triangle Seeks High-Technology Industry

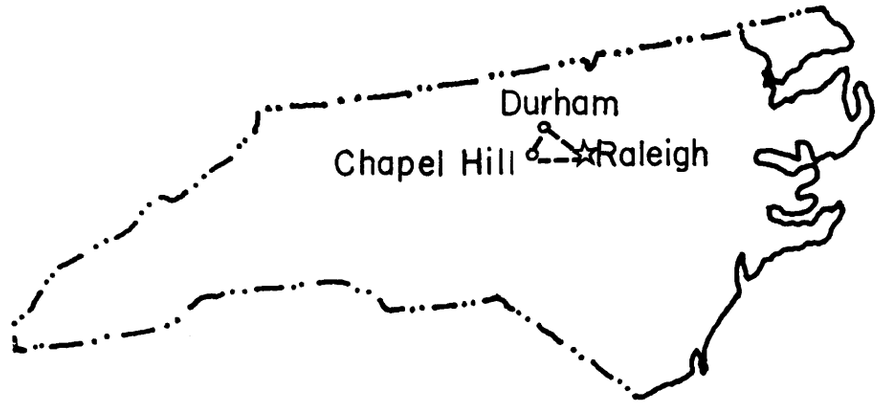
Durham, N.C. After a modest beginning and a few quiet years that some well-wishers found discouraging, North Carolina's "Research Triangle" is entering a phase of rapid growth that has produced a mood of unlimited optimism. The Triangle is bounded by the Chapel Hill and Raleigh campuses of the University of North Carolina and by Duke University at Durham. Near the center of the 5000-acre research park within the Triangle is the Research Triangle Institute (RTI), a not-for-profit, multidisciplinary institution which, since its founding in 1959, has gradually built up its capabilities until now it has eight laboratories and divisions that earned about $3½ million on contracts in fiscal 1965. As a symbol, the Triangle represents the idea that industrial advance and innovation are closely linked to centers of learning.

Until this year, the Triangle's hopes have ridden well ahead of its success. But now it has captured two major enterprises that would make any economic development specialist ecstatic. In January the Triangle was chosen as the site for the $25-million Environmental Health Center to be built by the U.S. Public Health Service; then in April it was selected as the location for a $15-million International Business Machines plant. It is beginning to live up to its billing as a promising venture for encouraging the growth of technologically advanced industry in a state long dependent on farming and such traditional low-wage industries as textiles and tobacco.

As one looks back, the Triangle has about it an aspect of historical inevitability. In the years since World War II such a multitude of industrial parks have sprung up across the United States that the smallest towns often advertise one, even if sometimes it is hardly more than a weedy pasture. More recently, "research parks," a refinement encouraged by the rapid growth of research activities, have multiplied until now they number at least 80.

A further refinement has been the research park created and nurtured by a university. These parks reflect the theory that the natural habitat of industries based on a high technology is a region, such as the Boston and San Francisco Bay areas, where strong educational institutions exist. The first park of this kind was created in the early 1950's by Stanford University. Its success in attracting firms such as General Electric, Control Data Corporation, and Beckman Instruments, Inc., has encouraged the establishment of similar parks, and today about one-fourth of all research parks are associated with a university or technical college.

The possibility of developing high-skill, high-wage industry is attractive to the people of North Carolina, which, despite substantial industrial growth during the postwar years, still had a median family income of less than $4000 as late as 1960. It was scarcely surprising that in the mid-1950's a group of the state's business, educational, and political leaders should have sought to make use of the proximity of the three campuses in an effort to make high-technology industry the dominant force in the state's economy.



Authorship of the triangle concept seems uncertain, but the first person to make use of it was a Greensboro building contractor. He prepared a brochure picturing the triangle and suggesting the advantages to industry of the combined research resources of the three campuses. In 1955, the idea came to the attention of Governor Luther H. Hodges (later to become U.S. Secretary of Commerce), who immediately saw its potential and appointed a Research Triangle Committee. The members included several industrialists and the presidents of Duke and the University of North Carolina. A "working committee" of senior faculty people was named to bring some scientists and engineers into the project.

The working group, in a statement giving sharper definition to the Research Triangle idea, said: "It is not anticipated that the three universities in the Triangle shall engage directly in the conduct of industrial research, except under carefully designed and administered policies. Rather, the principal functions of the Triangle are to stimulate industrial research by the research atmosphere their very existence creates and to supplement industrial research talents and facilities by providing a wellspring of knowledge and talents for the stimulation and guidance of research by industrial firms."

Plans envisaging a research park in the center of the Triangle, together with an institute to do contract work for government and industry, were adopted by Hodges' Committee in early 1957. Hodges invited to the governor's mansion a wealthy friend from New York, who had owned textile mills in North Carolina, and persuaded him to invest in the Triangle project. As a result, most of the land for the research park was quickly acquired.

A real estate company to manage the park was formed and opened to any investors who wanted to participate. In 1958, however, it was decided to make the Triangle a nonprofit endeavor and to ask business and industry in North Carolina for the $1.5 million needed to get under way. The park investors, few in number and all friends of Hodges, readily agreed to accept notes for their stock at its original price. The fund campaign met its goal within a few months, and the Triangle project gained new momentum.

The Research Triangle Institute was incorporated by Duke and the University of North Carolina. It was placed under a governing board, half of whose members are academic officers of the two universities. The Triangle Park was created as a separate entity owned by and directly responsible to the Research Triangle Foundation, which has been headed by Hodges since his retirement from public life.

George R. Herbert, president of RTI, says that although research parks and institutes were common, the Research Triangle was exceptional. "The important thing about the Triangle is that, to my knowledge, it is the first research complex to be developed in the United States with a university-oriented research institute as its focal point," Herbert told *Science* last month. "The participation of leaders of business, higher education, and state government in the planning and execution of the project also made it unique."

The tract of scrub pineland in the center of the Triangle was no more than 15 miles from the most distant of the three university campuses. It was easy for the Triangle's founders to

Research Triangle Institute headquarters and foundation and industrial park offices are housed in building named for the late Robert M. Hanes, the first chairman of the original Governor's Research Triangle Committee.

visualize the pines giving way to a colony of industrial research laboratories growing up in a quiet, campus-like setting. Research scientists and engineers could breathe the country air and pursue their thoughts. They and their families would profit from the associations and cultural opportunities afforded by the university communities. Life in the Triangle would be found congenial.

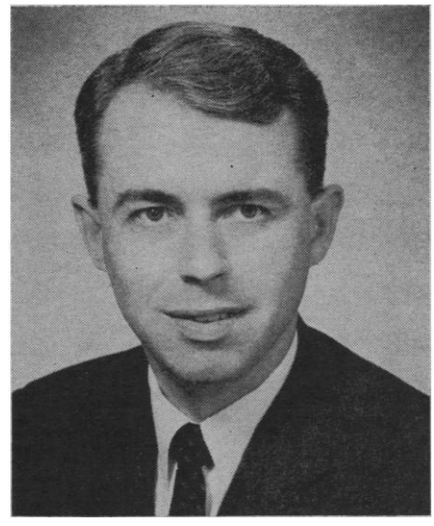
Moreover, the universities would provide consultants and services useful to the new industrial laboratories. RTI could serve the laboratories, too, while pursuing its primary objective of becoming a major research institution in its own right. This was the vision of those, who, in early 1959, converted the Triangle idea into a going enterprise.

Almost 7 years have passed since the Triangle began to take concrete form. It is the business of promoters to promote, and to show enthusiasm under the worst as well as the best circumstances, but the spokesmen for the project appear to be genuinely convinced that it has reached the takeoff point. It is freely predicted that the coming of the Environmental Health Center and the IBM plant will generate enough interest to assure the Triangle's continued development.

The Triangle leaders indicated that if their early vision was not altogether prophetic, it erred only by being too narrow. In the beginning, the Triangle Park was to be reserved exclusively for research. Under the original rules, the new IBM plant could not have qualified for a site in the park.

The rules also restricted construction to 5 percent of a site. A few quite desirable companies that were interested in the Triangle were disqualified by these restrictions, which eventually were relaxed to permit building on as much as 15 percent of a site and to allow manufacturing of the high-technology variety in most of the park.

The heavy direct impact of the IBM and the Environmental Health Center decisions on the Triangle is easily measured. Within the Triangle Park there are now some 1000 employees, including 265 at RTI they use facilities representing an investment of about $8½ million. Exclusive of other new facilities that will come to the Triangle over the next several years, the health center and the IBM installation alone will increase the number of jobs by at lease 5200 and raise total investment in the park by $40 million.



George R. Herbert

The only major commercial facility now in the Triangle is Chemstrand Research Center, Inc., which conducts fundamental and applied research in polymers and fibers for a division of Monsanto Chemical Company. It was built at a cost of several million dollars and has a staff of 500, one-fourth of whom are Ph.D.'s. The American Association of Textile Chemists and Colorists has a small headquarters and laboratory in the park, and Technitrol, Inc., a Philadelphia-based manufacturer of electronic pulse transformers and specialized computers, has a plant employing about 105 people. In addition, there is a small laboratory operated by the U.S. Forestry Service. That completes the Triangle's current inventory, but the North Carolina Board of Science and Technology soon will open a small research center and the Beaunit Corporation of New York has announced plans to build a $5-million laboratory which will employ 400 people.

The opening of the Chemstrand laboratory in 1960 produced a euphoria in some quarters which subsided into doubt and disappointment when several years went by without any other large commercial laboratory coming to the Triangle. Chemstrand's reasons for choosing the Triangle could have been taken as encouragement, however. "We felt a need for continuing contact with universities," Kenneth Johnson, Chemstrand's director of research administration, said recently. "Outside of the Boston area, it was difficult to find a location as near three institutions of the stature of the University of North Carolina, Duke, and North Carolina State," he added. Other reasons, such as convenient access to the company's customers in the Carolinas, entered into the decision, but the proximity of the universities was of prime importance. Johnson indicated that the association with these institutions has been no less rewarding than had been expected. Each year about 35 Chemstrand employees have studied at the institutions. Many of them are technicians who earned their bachelor's degrees from small North Carolina colleges not accredited by the American Chemical Society; by attending one of the Triangle institutions they upgrade their professional qualifications. A Chemstrand staff member has taught a course in polymer chemistry at U.N.C.; a North Carolina State professor has done consultant work for Chemstrand, and RTI's statistics division has been helpful to the laboratory. Chemstrand people take part frequently in seminars or other educational and cultural activities at the universities.

The Triangle universities appear to have weighed heavily in the IBM and Environmental Health Center decisions, too. Luther L. Terry, Surgeon General of the Public Health Service when plans for the health center were announced, commented: "Its location in the Research Triangle will provide . . . ample and diverse opportunities for the exchange of ideas and research findings among people engaged in similar professional interests. The broad reservoir of experienced consultants in these distinguished academic institutions will be of great help in supplementing the work of our own people in the center as needs, now unforeseen, may arise." The Johnson administration owed a political debt to Terry Sanford, who was still Governor of North Carolina when the health-center decision was announced; while this, too, undoubtedly was a factor, such decisions are rarely altogether free of political influences.

IBM's decision was based on a number of considerations, which included such matters as the availability of trainable labor, taxes, and land costs as well as the proximity of the universities. The latter appears to have been important, however. Besides producing data communications products and systems, IBM's Triangle facility will carry on product development in a laboratory employing scientists, engineers, technicians, and marketing specialists. IBM will expect many of its promising young professionals to take advantage of the company's work-study program and earn a master's degree or Ph.D. at one

of the Triangle universities. Moreover, IBM believes joint research endeavors with the universities or RTI are likely.

Continued growth of the Triangle's research and industrial activities will have greater effect upon North Carolina's economy than it would have on the economy of a state where sophisticated, high-technology industry has been common. Some industry of this type has existed in North Carolina for a number of years. But Celanese Corporation and Douglas Aircraft Company at Charlotte, Western Electric Company across the Piedmont, and a few others make up the list. Much of the investment in North Carolina's industrial expansion, which has exceeded $2½ billion over the last 10 years and which increased by almost $400 million in 1964, has been in textiles and other traditional industries, although investment in chemicals, metal-working, and mining (especially phosphate) has become of growing importance.

A strong center of research and high-technology industry in the Triangle should benefit North Carolina as a whole. The state's relatively unskilled labor force would be improved. Science and engineering graduates of the Triangle universities and other North Carolina institutions would be less likely to leave and give other states the benefit of the training they received at home. In this regard, it is significant that, as of last May, 61 of RTI's 165 professional staff members held degrees from the Triangle universities; many had given up jobs out of state to return to North Carolina and join RTI.

Significant intangible benefits to the state are expected from the Triangle's growth, too. The ties between North Carolina and the industrial and financial centers of the North are increased every time a large company such as Monsanto or IBM establishes a facility in the Triangle. The Triangle aids the entire state by imparting sharper focus to industrial promotion efforts and presenting a new picture of North Carolina to companies looking for sites.

RTI has been assigned a significant role in this image-building. Its president, George Herbert, who was executive associate director of Stanford Research Institute in the mid-1950's, was a consultant to the Research Triangle Committee during the days when the Triangle project was being defined. His influence quite clearly was on the side of giving RTI a national orientation. Herbert recalls that, at RTI's inception, Governor Hodges was asked what the institute should become. Should RTI confine itself to regional development projects? Or should it become part of the total national research resource? Hodges replied: "The Institute should go as far afield as it chooses so long as it brings credit to the state."

Hodges' answer may have been the only realistic response possible. As Herbert has observed, before a new research institute can achieve anything at all, it must recruit a staff of able scientists and find the revenues to support their research. Large contracts are most readily obtained from large national corporations and the federal government. It is to them, and especially to the government, that one looks. Some three-fourths of RTI's $3½ million in revenue last year was derived from federal contracts. RTI has been awarded more than a score of contracts priced at $100,000 or more; however, all but five have been federal contracts.

The government and the big corporations not only have more money to spend on research, they are more conscious of its value. "You build on the identified sources of support that understand research and have a history of using it," Herbert said. "Then, having established a research capability, you begin to put time and effort into the missionary process of showing local industry how it can use research."

RTI believes that it has established an extensive research capability and has earned a good reputation by its work and publications. RTI has a statistics research division, an operations research and economics division, and six laboratories devoted to the study of geophysics, radiation systems, natural products, solid state phenomena, measurement and controls problems, and polymers (the polymers laboratory was created with a $2½-million grant from the Camille and Henry Dreyfus Foundation). Ph.D.'s make up more than half of the professional staff and 21 RTI staff members received faculty appointments last year from the Triangle universities.

A modest start has been made in missionary work. For example, an operations research symposium for textile firms was held, and, from subsequent contacts with the textilists, three small contracts were undertaken. An Office of Industry Services has been established to identify ways for RTI to help regional industry through its own facilities or by referrals to other competent sources. An office is just now being established as RTI's focal point for regional economic development studies. Before the year is out Herbert hopes to get the North Carolina textile and furniture manufacturers associations, together with the state Board of Science and Technology, to sponsor programs to aid their industries.

RTI and the Triangle project as a whole have increased the points of contact between Duke, U.N.C., and N.C. State, encouraging them to undertake new cooperative endeavors. The Triangle Universities Computer Center, which they hope to establish in the park with the help of a National Science Foundation grant, is a current example of such cooperation.

RTI, with its emphasis on a multidisciplinary approach to research, is encouraging university faculty people to look beyond their own departmental walls. A Duke professor of electrical engineering recalls how once during the Institute's first years, professors of physics, electrical engineering, and psychology met with RTI staff people to discuss an RTI contract proposal for a defense project that would draw on all of their disciplines. This conference of faculty people from the Triangle universities is said to be typical of a number of multidisciplinary meetings which RTI has initiated. In working somewhat more on problems of applied research than their counterparts at the universities, the RTI staff often must consult faculty people whose specialties are so different that ordinarily they would never come into contact.

The fact that RTI is owned by the Triangle universities and draws half of its board from their academic officers is considered an assurance that fruitful cooperation between RTI and its parent institutions will be maintained and unhealthy rivalries avoided. Douglas Knight, president of Duke, believes problems in this relationship can be avoided so long as RTI does not grow too large. It should not, he suggested, ever approach the size of an organization such as the Massachusetts Institute of Technology's Lincoln Laboratory. "It would be like keeping a walrus in the bathtub," he said. The growth of RTI is no more to be discouraged than the growth of the universities, he indicated, however. "I don't see any major pitfalls as long as we keep the present relative scale," he said.

Delegations of out-of-state visitors arrive at the Triangle frequently and in strength, according to Herbert. Although nothing quite like it has devel-

oped elsewhere in the United States, Herbert believes the Triangle will exercise a growing influence as new research parks and institutes come into being. Altogether, the Triangle seems to be remarkably free of critics and doubters, and, after an unspectacular start, to be crossing the threshold into a period of sustained growth.

—LUTHER J. CARTER

Announcements

The **AAAS Committee on Council Affairs** will hold open hearings in Berkeley 27 December to review resolutions that members of Council or other members of the Association wish to submit for Council consideration. To facilitate orderly planning for these hearings, the Committee on Council Affairs requests that copies of resolutions be sent to the Executive Officer of the Association, 1515 Massachusetts Avenue, NW, Washington, D.C. 20005, by 1 December.

The Oak Ridge Institute of Nuclear Studies will change its corporate name to "**Oak Ridge Associated Universities,**" effective 1 January. According to Paul M. Gross, president of the corporation, the change is designed to increase opportunities for the 40 member-institutions to participate collectively in fields of education and research besides those related to nuclear energy. The association's structure will be similar to that of ORINS. It will include a council consisting of one representative of each sponsoring school, and it will be managed by a board of directors elected by the council. ORINS will remain an operating unit of the corporation, continuing to function as a means for the members to participate in and support the nation's nuclear energy program.

Meeting Notes

A seminar on **psychology** and its relationship to natural sciences, to have been held at Gujarat University, Ahmedabad, India, last month, has been rescheduled for next March, because of the "present emergency situation in the country." The meeting will be sponsored by the Indian government's University Grants Commission. Topics to be discussed during the seminar include psycholinguistics, cybernetics, chemistry of thought processes, and creativity. (P. H. Prabhu, School of Psychology, Education, and Philosophy, Gujarat University, Ahmedabad 9, India)

The 7th annual joint **automatic control** conference will be held 17–19 August 1966 at the University of Washington. The sponsors are the American Institute of Aeronautics and the Astronautics, Institute of Electrical and Electronics Engineers, the Instrument Society of America, and the American Institute of Chemical Engineers. Unclassified papers are invited on automatic control system theory, design, applications, and components. Four copies of the completed papers are required; deadline: *3 January*. (A. E. Bryson, Harvard University, Cambridge, Massachusetts)

Courses

Northeastern University will sponsor a workshop in **electron microscopy** for the biological sciences, 17–28 January, in Weston, Massachusetts. The course will emphasize laboratory and specimen preparation techniques. Supervised instruction will be from 9 a.m. to 10 p.m. Monday through Friday, and the laboratories will be open for the participants' use 24 hours a day, including weekends. Participation will be limited to 12 students; tuition is $600. Deadline for submission of applications: *15 December*. (C. Youse, Northeastern University Center for Continuing Education, 360 Huntington Avenue, Boston, Massachusetts)

Scientists in the News

Harold L. James is the new chief geologist of the U.S. Geological Survey, succeeding **William T. Pecora**, who recently became director of the Survey. James, associated with USGS since 1938, had been a research geologist in the Survey's Pacific Region Field Center, Menlo Park, California, since last year. Previously, he was a geology professor at the University of Minnesota.

The American Public Health Association has awarded three physicians the 1965 Bronfman prizes for public health achievement. Recipients of the $5000 prizes are:

Guillermo Arbona, director of the Puerto Rico Department of Health, for guiding the development of Puerto Rico from "an impoverished, disease-ridden island into a healthy, vigorous community" during a 30-year career.

George James, New York City health commissioner, for mobilizing government, private, and voluntary agencies in new programs of preventive medicine to treat chronic illnesses, poverty, and narcotics addiction on a community level.

Alexander D. Langmuir, chief of the epidemiology branch, PHS Communicable Disease Center in Atlanta, for his work as founder of the Epidemic Intelligence Service.

Thomas L. Saaty, mathematician with the Arms Control and Disarmament Agency, has become executive director of the Conference Board of the Mathematical Sciences (CBMS), succeeding Leon Cohen, whose term expired in July.

Robert Zeppa, formerly associate professor of surgery at the University of North Carolina, has become professor of surgery at the University of Miami medical school and chief of surgical service at the VA Hospital, Miami.

The new director of Harvard's Center for the Behavioral Sciences is **Edward L. Pattullo**, formerly vice president of York University, Toronto.

Joseph B. Boatman, formerly director of research at Midwest Medical Research Foundation, has become chief of physiology and biophysics research at the Columbus Laboratories, Battelle Memorial Institute.

Stephen F. Jacobs, formerly with T.R.G., Inc., has become research professor in the optical sciences group at the University of Arizona's Steward Observatory.

Barry Commoner, professor of plant physiology at Washington University, has been named chairman of the botany department at the school.

Erratum: The announcement of a summer institute in mathematics for life scientists, scheduled 1 June to 23 August at the University of Michigan (*Science* **149**, 1360, 1965) failed to mention explicitly that participation is limited to 10 established life scientists "who have demonstrated substantial research accomplishments." Applications must be received by 30 November, by R. M. Thrall, Department of Mathematics, University of Michigan, Ann Arbor 48104.

Erratum: In a caption accompanying an article on strip mining (8 Oct., p. 197), the electric-powered shovel pictured was described as "capable of moving 115 cubic feet of earth." The quantity should have been given as 115 cubic yards.