Edited In Retrospect

About this issue

• *The Research Engineer's* October, 1957, issue on ceramics was prompted by the explosive growth of Georgia Tech's ceramics research group (the Ceramics Branch) during that year. We thought that this was a good story, one worthy of a special report. But even our prejudiced interest was caught short by the unprecedented demand for extra copies of that particular issue. We received as many as 100 requests for it in one week, and in a short time our entire supply was exhausted.

Because of the many requests for this issue that we have been unable to fill, and because of the increased importance of Tech's research work in this field, we feel that it is about time to devote another full issue to ceramics research at Georgia Tech. In fact, the activity of the Ceramics Branch has reached such a high level and is attracting such national attention that we are considering making this special issue an annual feature.

The Special issue

• This thought brings up one of those little problems that constantly plague editors but probably go unnoticed by the readership: Is it proper to have more "special" than "regular" issues of any magazine? With the annual research report, the annual nuclear science issue, a ceramics report, and an occasional special issue like the one in July on Textiles, *The Research Engineer* will soon have more "specials" than there are issues in a year. But then, this magazine is ideally suited to special issues on one subject. Probably the best solution is just to give them other labels, as we have done with this *Follow-up Report on Ceramics*.

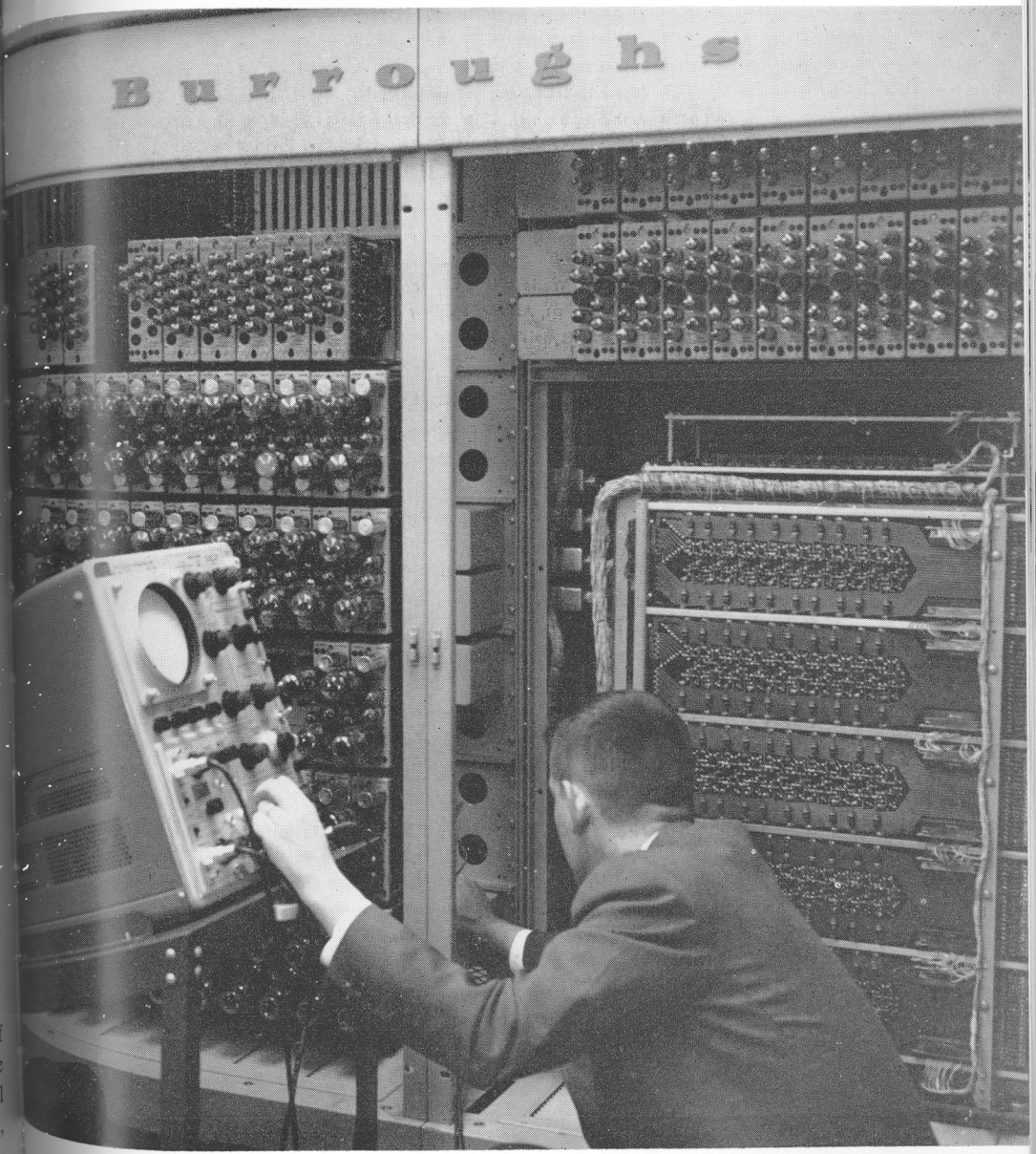
The new schedule

• As you have probably noticed this is the fifth issue of *The Research Engineer* for 1958, and the second one under our new publication schedule. The magazine will in the future reach you five times each year in February, April, June, October and December, a plan that supersedes the one announced in the past July issue.

FEBRUARY 1958

The Research Engineer

Published by the Georgia Tech Engineering Experiment Station



NEW COMPUTER

Minerals Development—Page 18

The Research Engineer

VOLUME 14, NO. 1 FEBRUARY, 195

Published five times a year by the Engineering Experiment Station
Georgia Institute of Technology, Atlanta, Georgia

contents

the cover

Technician Mickey Burns checks the driver circuitry to the magnetic core memory system of the Burroughs 220 computer, installed last month at the Rich Electronic Computer Center. This view shows part of the memory unit, which has a capacity of 5,000 words (44 bits per word) and is valued at approximately a quarter of a million dollars. The bits, or digits, are actually stored in the bank of memory cells just behind Mr. Burns' head. For more information on the Computer Center see the articles beginning on page 5 of this issue.

Cover and other photographs in this issue by Van Toole

THE RESEARCH ENGINEER is published five times a year in February, April, June, October and December by the Engineering Experiment Station, Georgia Institute of Technology. Entered as second-class matter September 1948 at the post office at Atlanta, Georgia under the act of August 24, 1912. Acceptance for mailing at the special rate of postage provided for in the act of February 28, 1952. Section 528, P.L.&R., authorized on October 18, 1948.

The President's Page

ONE TECHNIQUE used to combat the ever-increasing complexities of modern technology has been specialization. But the practical limits of this attack were reached years ago, when over-specialization became an obvious danger. Thus another approach, that of up-grading the subject matter at all levels of education, has become increasingly significant. This is no new process. But in the face of today's challenge in education, the speed and manner in which it is applied is of great importance.

Here at Georgia Tech, the acceleration of this up-grading process is felt perhaps most keenly by graduates of the past few years who, because of military service or other reasons, have just returned for graduate work. Many of them discover that some of the courses they had planned to take in graduate school are now required in the undergraduate curriculum.

But these changes concern not only the graduate school. They may be found at all levels and in all departments: Some topics formerly studied only in the junior and senior years are now encountered in the sophomore year; and even high school programs will be affected when some subjects now offered in the freshman year in college are required for admission.

The impetus for such advancement comes partly from the realities of modern science, which are felt directly through the research work done on the campus. Much of this research is done by graduate students and part-time faculty members, who greatly influence the undergraduates' appreciation for the "advanced" subjects.

But the impetus comes also from our departmental directors and their experienced staffs, who insist on preparing students for the technology of the future as well as for present-day science and engineering.

Perhaps there are practical limits to this method too, but they are not yet in sight. The process improves the capabilities of the student and tends to shift all technicians, engineers and scientists to higher, more valuable levels in their career activities. Rather than merely posing new difficulties, the growing complexities tend to expand the intellectual development of the individual.

E. D. Harrison
President

THE EXPANDING ROLE OF CAMPUS COMPUTERS

The first of three articles in this issue on Tech's Rich Electronic Computer Center, a young research and service facility of growing value

by William F. Atchison, Head
Rich Electronic Computer Center

IT WAS ESTIMATED by experts in early 1954 that perhaps 50 companies could eventually use the new electronic brains that were appearing on the horizon. Today there are close to 2,000 installed in our country. Even more surprising, in view of the cost of computers, is the fact that there are about 75 colleges and universities in the United States with at least one computer. And it would not be at all surprising to see both of these numbe doubled in another four years.

Several institutes of technology a currently considering initiating plans fo giving their entire student bodies actu computer experience before they gradu ate. There is, in fact, a great deal o discussion and some action directed to ward giving some high school student training on computers. This, of course

Dr. Atchison and the Computer Center's newest machine, the Burroughs 220. The Center's three digital computers provide a versatility equal to any other university

comes from geographical areas where the density of computers per square mile is particularly high. This scramble to train people on computers is easily understood when you consider that even the smallest of the 2,000 computers mentioned above takes at least four people to operate, maintain, and utilize.

Thanks to the foresight of leaders at Georgia Tech and in our State, and to the contributions of the Rich Foundation, Inc., the Georgia Tech Foundation, and the State of Georgia, the Rich Electronic Computer Center was able to begin operations in September, 1955. The first computer that went into operation was the UNIVAC SCIENTIFIC (ERA 1101) which was presented to Georgia Tech by Remington Rand, a division of Sperry Rand Corporation. At that time, very few people at Georgia Tech knew what to do with a computer, so there were only a very few projects that utilized it. There were three government-sponsored projects, one Ph.D. thesis problem, and one faculty research problem. Four months later, the Computer Center had accumulated only two more small government projects, one more thesis problem, and one research project for a faculty member from Vanderbilt University.

In June 1956 Georgia Tech obtained from the International Business Machines Corporation, on a special educational rental basis, their IBM 650. By September of that year—one year from the time the Computer Center had started operating—it had logged a total of 66 distinct problems. At tnis writing the Computer Center has logged a total of 490 distinct problems.

On January 8, 1959, Georgia Tech received a Burroughs 220, its third digital computer. This machine is being purchased from the ElectroData Division of Burroughs Corporation.

Prior to receiving the Burroughs 220, the Computer Center had come to the point where it was frequently using both of the computers on an overtime basis. The rate of expansion of the use of computers at Georgia Tech clearly indicated the need to enlarge the facilities. The new areas of application of computers that were opening up even further amplified this need. Now, with one computer from each of the major manufacturers, the Rich Electronic Computer Center offers a versatility of computers unsurpassed by any school in the nation.

The value of this facility can be measured in three major areas, (1) education, (2) research, and (3) service to industry and government.

Education

Georgia Tech's School of Applied Mathematics offered its first course on the use of digital computers back in 1954, even before Tech had a computer. Since then 17 such courses have been offered to a total of 517 students. This training has been supplemented by special non-credit seminars offered to the faculty and students by members of the Rich Electronic Computer Center staff almost every quarter since the fall quarter of 1955. These seminars have had as many as 60 people in them at one time.

Other schools are rapidly taking more and more advantage of the facilities by having their students use the computers to help solve problems that require many

Continued on page 6

tedious calculations. This quarter there are eight separate departmental courses using the computer for these purposes. Such courses so far have come from the following schools: Chemical Engineering, Civil Engineering, Industrial Engineering, Industrial Management, Mathematics, Mechanical Engineering and Physics. The training that these students receive will be of great value in their careers as engineers and scientists.

Research

Almost every department at Tech has now utilized the computer for at least one graduate thesis or faculty research problem. The greatest use so far in this area has been made by the Electrical Engineering, Chemical Engineering, Chemistry, Physics, Mechanical Engineering, Industrial Engineering, and Mathematics schools. The results of many of these studies have now appeared in the professional journals of the fields mentioned. From the point of view of the mathematics involved, most of these problems center around complex function of evaluation, integration, the solution of systems of differential equations, matrix algebra and statistical work. With a computer it becomes relatively easy to check values obtained in the laboratory against values computed from a mathematical model. It is also feasible to use a computer to collect empirical data from conceptual models; from such data the mathematical model may be improved, or one may be led to the deduction of applicable theorie. Thus, in a sense the computer becomes another powerful laboratory tool. It has been said that a computer in a university is about the equivalent of another professor in each engineering and scientific department.

Industry

Since its inception, the Rich Electronic Computer Center has made its facilities, both staff and computers, available to local industry for sponsored research, consultation and computation on problems which can advantageously utilize high-speed electronic digital computers. Examples of this type of service include the Georgia Power Company's use of Tech's facilities to develop and run programs to calculate turbine cycle heat rates for various steam generation stations; Rich's, Inc. use of the computers to develop and run their pay roll; and the use of the facilities by a number of consulting firms in the region such as Actuarial Computing Services, Patterson and Dewar, and Southern Engineering. The latter two firms are making calculations necessary for the design of electrical power distribution systems of Rural Electrification Administration (REA) Cooperatives (see below). Members of the Computer Center staff developed these programs in cooperation with members of the consulting firms. A limited amount of work of a statistical nature has been done for the Reynolds Metals Company concerning studies directed toward cutting down the electrical current consumption in the aluminum making process.

Government

The Rich Electronic Computer Center has served both the State and Federal governments in a variety of projects. The principal work with the State has been with the Highway Department. It has resulted in two major machine programs which are now being used by the bridge design group. The first one is entitled "The Design of Skewed Bridges on Horizontal Circular Curves" and the second one is "A Continuous Beam Bridge Design." Work with the Tennessee Valley Authority has been in the area of statistics, including studies of agricultural experiments, soil conservation, and stream pollution. A project has been carried out with the U. S. Geological Survey and one is underway with the Office of Civil and Defense Mobilization. Computational assistance has been rendered to a variety of government-sponsored projects at the Engineering Experiment Station, involving such areas as trajectory analysis, cosmic ray radiation studies, radio receiver sender studies, and meteor-trail communications.

Some of the current projects in these three catergories are described in the following article.

Programmers Jim Stein and Ray Austin detail machine instructions for a project.

CENTER LOGS VARIETY OF PROJECT EXPERIENCE

by Ed Manseau, Assistant Research Engineer

THE RICH ELECTRONIC COMPUTER Center is a good example of the advancing technology of our age. Combining the powerful techniques of mathematical logic and high-speed digital computation, it is one of the most effective tools in quickly providing the answers to the complicated problems of modern science and engineering. But to many people, the application and use of the electronic digital computer is still a mystery whose results are obtained in some magical way. One of the basic purposes of the Computer Center is to clarify the application and use of this tool through a continuing program of education.

Such a program has many interesting and diverse paths to follow. We can learn some things about the use of the digital computer through demonstrations, seminars, or classes and explanations of computer solutions to various kinds of problems, but this provides just a part of the real picture. It is rather like learning to drive a new "push-button" automobile; the function and operation of the many gadgets can be easily explained, but the full realization of their value comes only through actual performance—perhaps by many test drives. The Computer Center provides this "performance" training through its experienced staff and up-to-date computing equipment to all levels of business and industry, as well as to educational institutions engaged in research and training.

Many of these educational paths coincide with the solution of problems arising from investigative and applied research. Some examples of the investigations being performed at the Computer Center are:

Orbits of Earth Satellites

For the past six months several members of the staff have been making an extensive mathematical study of satellite orbital computational methods. This is being done for the Air Force and is di-

rected toward the development of faster and more accurate methods for determining the orbits of artificial satellites. Analytical as well as numerical methods are employed to obtain more refined techniques for digital computers. The problem has dealt with celestial mechanics, rapid solution of differential equations, high precision arithmetic operations, and orror analysis of current and proposed techniques. During the course of this study an orbital computation program has been developed, but it is being used only for mathematical studies rather than day-to-day tracking of the present earth satellites.

The Scheduling Problem

The scheduling of many interrelated activities occurring at the same time is a complicated problem. These activities may be physical processes such as a production line, or registration of classes at a school; or perhaps they are economic in nature, as in transportation problems or the allocation of limited resources. Scheduling problems generally require the solution of a "conflict table" of activities, and under certain conditions a specific technique such as the linear programming of these interdependent activities can be used. The investigation of the non-linear or general case is much more complex and requires the development of different methods of solution.

Language Translation

With the rapid growth of many technical fields the problem of communication has become acute. Development may be written in some language other than English, and there are not sufficient people with the technical as well as linguistic training to cope with evergrowing requirements for translation. It is natural to attempt to make a machine such as a digital computer do this kind of task. Some work has already been done with limited dictionaries or lexicons, but translation depends upon grammatical structure and use as well as words. At Georgia Tech an investigation of simple German sentences is being conducted with the help of a digital computer.

Common Computer Languages

The digital computer is instructed in the solution of problems by the use of numerical codes, which constitute a type of language or communication between the operator and the machine. These numerical instructions are very detailed and several hundred of them may be necessary to describe an involved problem. To minimize the effort and possibility of human error in describing a problem to a digital computer, condensed languages known as assemblers, compilers or interpretive routines have been developed, in which brief English or symbolic statements enable the machine to develop automatically its own numerically coded instructions. Since the form of these instructions differ among the various types of machines, the Computer Center has been working with one such language (known as FORTRAN) in the adaptation to the three different digital computers it has in its facility. With this adaptation, one can describe the problem in one common form and yet not be restricted to the use of a particular computer to obtain the solution.

Examples from the applied research problems at the Computer Center are:

Design of REA-type Electrical Distribution Systems

The digital computer is used to examine and project existing systems over periods of planned expansion. Factors such as load growth, regulation, and costs of various designs are considered. The computer handles vast quantities of detailed computations, enabling the engineers to study a large number of distribution systems in a relatively short time.

Structural Problems

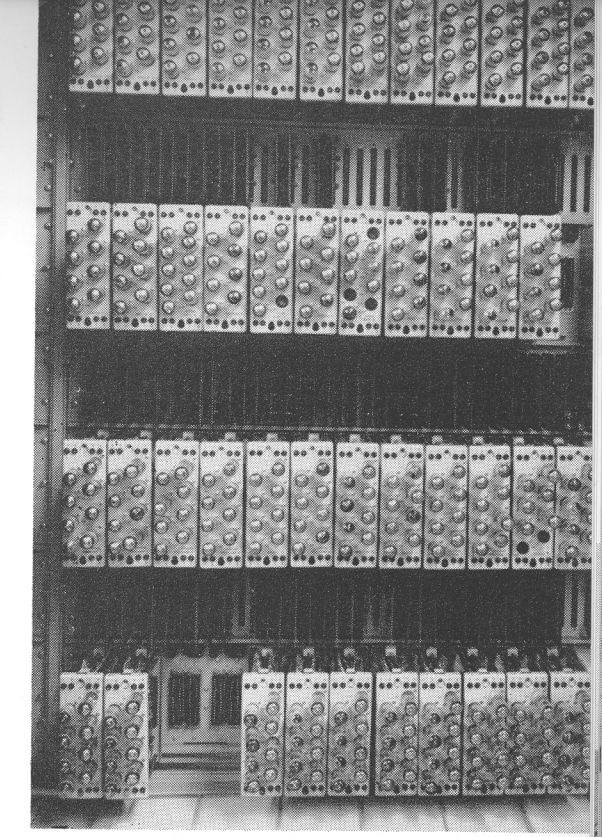
Many structural problems require long and tedious calculations in which accuracy is of importance. The digital computers at the Computer Center have been used to calculate and distribute moments in building frames, solve systems of equations arising from structures, design skewed bridges, analyze and compute pressure drops in a network of pipes, compute ultimate strength tables for reinforced concrete columns, and other similar problems.

Statistical Analysis

A statistical analysis also usually requires many lengthy and detailed calculations, a task effectively handled by the digital computer. Routines are available to provide the usual statistical measures of means, standard error of estimate, simple correlations of many variables, covariance analysis and a very complete multiple regression analysis. Statistical problems have encompassed areas of educational and testing techniques, surveys, agricultural experiments, and medical research in mental illness to cite a few.

Many of the projects in the foregoing categories are sponsored by commercial firms, since one of the basic purposes of the Computer Center is to provide service to industry in all areas of problem analysis and exploratory study of computer applications. With its broad base of experience and up-to-date computing equipment, the Rich Electronic Computer Center is an invaluable asset to companies of all sizes and represents a significant contribution in the industrial development of the Southeast.

UNIVAC'S OUTPUT MAY BE TYPEWRITTEN, OR CODED ON PAPER TAPE.
Bill Diehl, Jr.



One of the four sections of the data processing unit of the Burroughs 220 computer.

GROWTH CONTINUES

by W. J. McKune, Assoc. Prof. of Electrical Engineering

IN ORDER for a computational center to maintain its capabilities and services, a constant program of improvement of its facilities is necessary. Such improvement is necessary in two areas, that of acquiring new equipment for computation and data handling, and that of improving the equipment already in operation. In each of these areas the Rich Electronic Computer Center is quite active.

UNIVAC Modifications

A major undertaking of the engineering staff of the Computer Center is a program of modification of the UNIVAC SCIENTIFIC (ERA 1101) in order to incorporate recent advances of computer technology and to increase the input-output capabilities of the machine while retaining its extremely fast operation. The Univac Scientific is a large machine in terms of memory capacity, and it is extremely fast in arithmetic speed. The modification consists of the addition of a "random-access" memory to the present "rotating-drum" memory. The drum memory has the advantage of large storage capacity in a small volume, but the availability of the information at a given instant depends on the position of the information relative to the heads which receive and insert the information on the drum. The amount of time that can elapse before a word of information can be processed to and from the drum is not compatible with the inherent speed of the machine. The random-access magnetic core memory will eliminate this problem for the 4,096 words that can be stored there.

In addition to this modification, work is being carried out in the School of Electrical Engineering to add a punched-card input and output to the UNIVAC. At present the only input is punched-paper tape and output is punched-paper tape and typewriter. The ability to use information on punched cards will increase the capabilities of the machine to a great extent.

New Machine

The recent installation of the new Burroughs 220 computer is a major step in the acquisition of needed new equipment. The 220 is a large scale, general purpose digital computer. It has a storage capacity of five thousand ten-decimal-digit words and auxiliary magnetic tape storage with a capacity of five million words. The 220 is typical of the more modern

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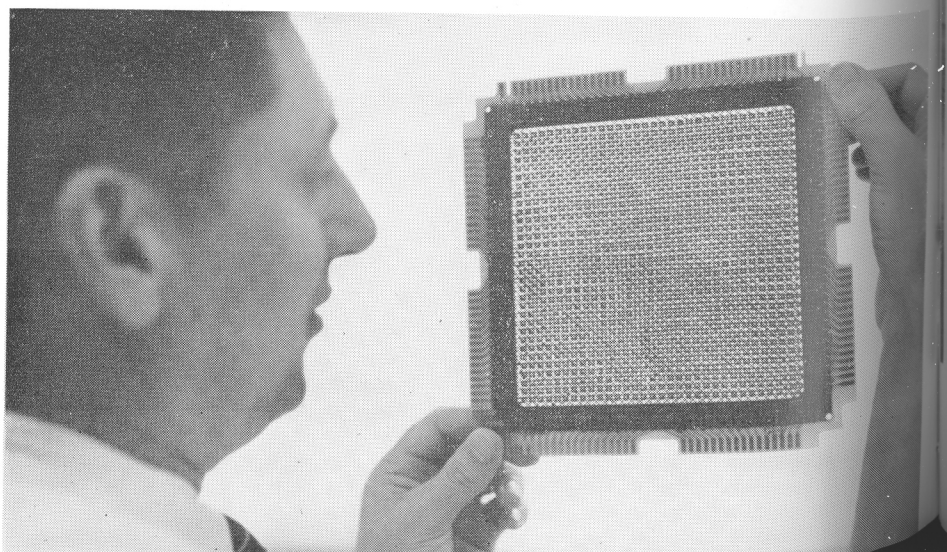

Engineer Jim Collins holds one of 24 planes of the magnetic core memory being installed in the UNIVAC. Each plane has 4,096 tiny cells; one cell stores one bit of information.

Special Design of New Laboratory

by Fred Sicilio, Head, Radioisotopes and Bioengineering Laboratory

THE NEW RADIOISOTOPES and Bioengineering Laboratory, which will be ready for occupancy in March, will provide space and facilities for both research and education in certain physical, chemical, biological and engineering phases of the nuclear sciences. The building of this laboratory has been accomplished through the wisdom and talents of individuals too numerous to enumerate; however, mention should be made of several men for their special contributions. Dr. D. C. Bardwell of Vanderbilt University and former Director of the Chemistry Division at the Oak Ridge National Laboratory worked closely with Dr. R. G. Wymer, former Georgia Tech Research Associate Professor, to formulate many of the basic design concepts. The new laboratory draws heavily on certain proven and time-tested features used by Dr. Bardwell in the design of the highly successful principal research building (the "4500" building) at the Oak Ridge National Laboratory. Messrs. John W. Cherry, architect, and Everett L. Roberts, associate architect, are to be commended for their planning and detailed design. Mr. John Butler, supervisor for Van Winkle Construction Company, and Mr. Joe D. Floyd, resident engineer inspector for the Board of Regents, have worked in close liaison with the architects and Georgia Tech personnel. The cooperative spirit displayed by all individuals involved in this project is already reflected in the excellent appearance of the building.

The laboratory building can easily be enlarged by the addition of 4,000 square feet to the existing 16,000 square feet of floor space (see floor plan on following pages), prior to addition of a second and eventually a third floor, without the need for structural modification of the existing facility. The second story floor is already in place underneath the top dressing of the roof, and two future elevator shafts are presently designated as storerooms. Office, service, and mechanical equipment rooms line the periphery of the laboratory area.

The use of radioisotopes as tracers will be restricted to low level or millicurie ranges. A vertical storage facility will be used to store up to 25 curies of beta- or low energy gamma-emitting isotopes, and will allow easy access to an isotope to the exclusion of the radiations emanating from other isotopes. In addition, underground storage wells can accommodate curie quantities of high energy gamma-emitting isotopes. One well of 12-foot depth may be used to accommodate up to 10 kilocuries of cobalt-60 or cesium-137 for radiation chemistry studies and research. In addition to the radioisotopes storage facilities, special design features of the laboratory include: a shielded hatch and port assembly for a one-Mev Van de Graaff positive particle accelerator; manually operated one-ton hoists in the neutron physics laboratory and radioisotopes storage area to facilitate handling of heavy shielding equipment; ceiling hatches to permit installation of continuous solvent extraction and continuous on exchange columns which require additional head room; a counting room furnished with regulated voltage; an aerobiology laboratory serviced with controlled temperature and humidity over wide ranges; an autoclave room; thirteen strategically-placed fume hoods containing high efficiency filters; five portable glove boxes, also containing high efficiency filters, for work with

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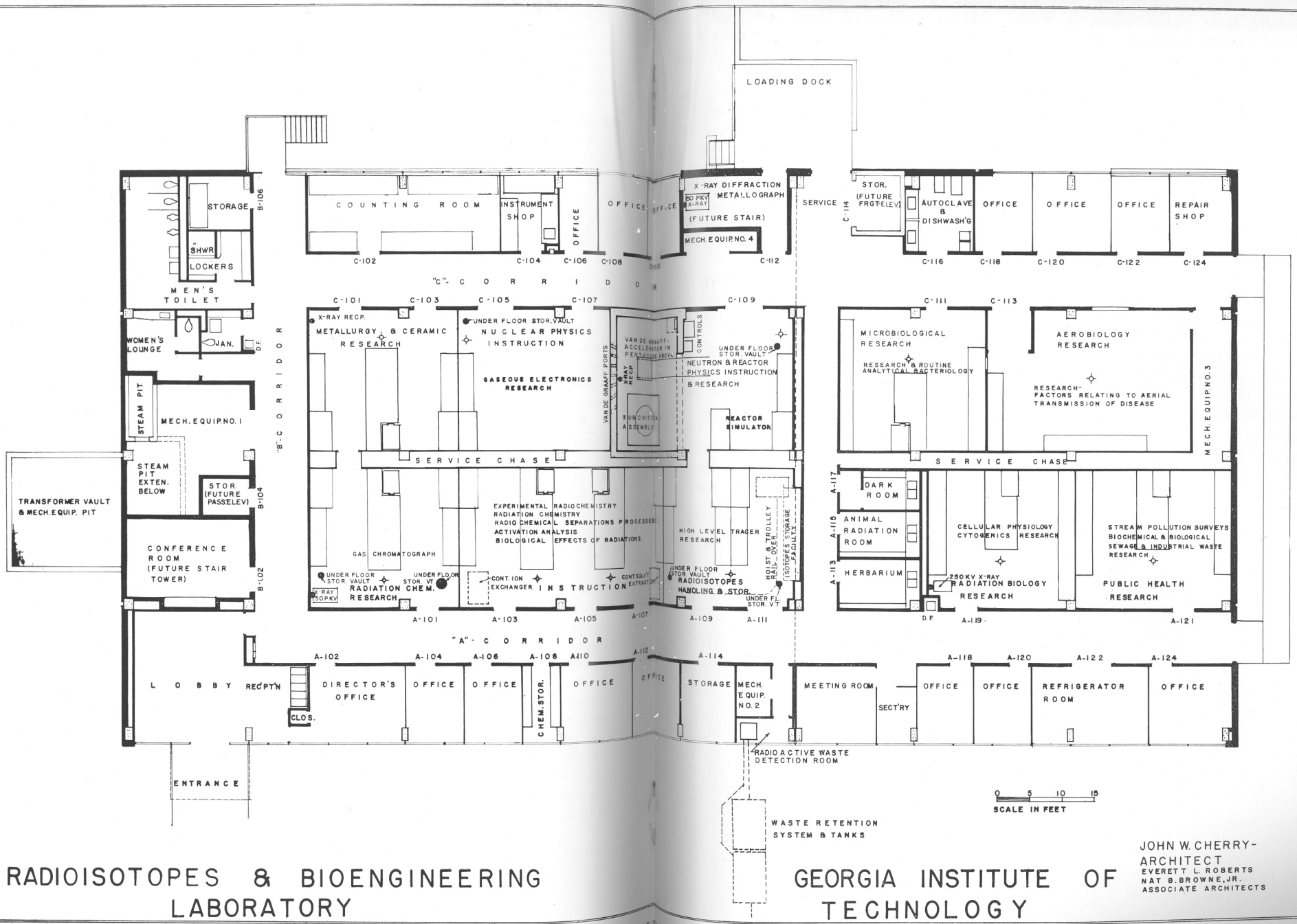

RADIOISOTOPES & BIOENGINEERING LABORATORY

GEORGIA INSTITUTE OF TECHNOLOGY

JOHN W. CHERRY-ARCHITECT
EVERETT L. ROBERTS
NAT B. BROWNE, JR.
ASSOCIATE ARCHITECTS

THE NEW LABORATORY IS ONE OF THE MOST MODERN FACILITIES IN THE WORLD FOR RESEARCH AND INSTRUCTION IN RADIOISOTOPES AND BIOENGINEERING.

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especially toxic radioisotopes; a waste disposal system, especially designed by Mr. James W. Austin, Jr., to preclude the posssibility of an accidental discharge into the Atlanta sewage system of levels of radioactivity higher than those prescribed by the Atomic Energy Commission; a service chase allowing for easy maintenance of utilities; and an electronics shop for the repair of electronic equipment.

In addition to normal laboratory equipment and those items already mentioned, the new laboratory will contain specialized types of radiation detection, counting, survey and monitoring instruments. X-ray machines will include one 50-KVP unit and one 250-KV unit as radiation sources, and one diffraction unit. A subcritical assembly will allow the study of neutron diffusion, and a reactor simulator will permit the safe instruction of reactor control procedures. Gas chromotographic units will allow the determination of trace quantities of radiation-induced products. A locally designed and fabricated gaseous electronic device will allow the study of the behavior of ions at low energies.

The value of the new laboratory has already been manifested in the interest it has helped to generate. The U. S. AEC Office of Isotopes Development, Lockheed Aircraft Corporation, and Georgia Tech, on a co-sponsorship basis, are planning a symposium on the industrial uses of radioisotopes, to be held on the campus on May 11 and 12 of this year. Tech is negotiating with the same AEC agency for a project of considerable magnitude concerning research on the development of new uses of radioisotopes for industry.

Contract work totaling over $200,000 is already scheduled to be performed at the new facility. This laboratory is paying dividends before it is completed.

Governor Marvin Griffin speaks at the dedication ceremonies on January 7. The laboratory is expected to be of great value to education and industry in the Southeast.

Bill Diehl, Jr.

BUILDING PROGRAM IN HIGH GEAR

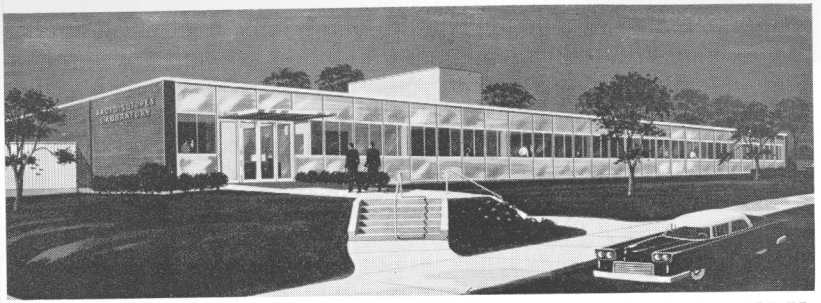
IT IS OUR PLEASURE to report that presently Georgia Tech is in the midst of the biggest building program in its history . . . This new construction, now amounting to over $17,000,000, was made possible mainly through the foresight of the Governor, the Legislature, and the Board of Regents; and the hard work of the late president, Dr. Blake R. Van Leer, former Acting President Paul Weber, and the Georgia Tech Advanced Planning Committee.

E. D. Harrison, *Technological Education and the Future; The President's Report, 1958*

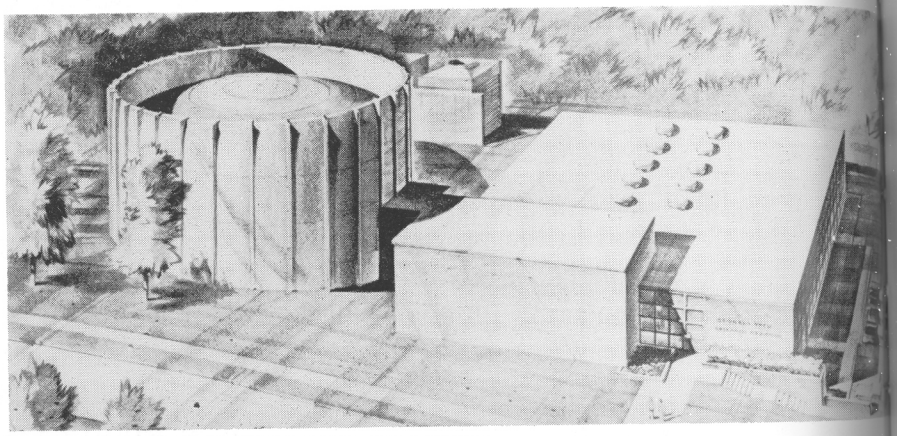
THE Radioisotopes and Bioengineering Laboratory, described in the previous article, is the first building to be completed in this program. The $3.7 million Electrical Engineering Building will be started this spring, and the nuclear research reactor and its associated construction, valued at $4.5 million (THE RESEARCH ENGINEER, January issues, 1956, '57, '58), is expected to be completed in late 1960.

These three buildings are of direct and vital importance to the growing research activities at Georgia Tech. But since education, research and service are almost indistinguishable activities at Tech, often employing the same personnel and laboratories, all of these programs will benefit greatly by the new facilities. The other buildings, such as the long-needed Classroom Building now under construction, will likewise improve research capabilities by relieving some of the crowded conditions in other buildings on the campus; and the entire building program will aid significantly in retaining and attracting the best students, teachers and research personnel.

On the following pages are artists' renderings of six of the new buildings.

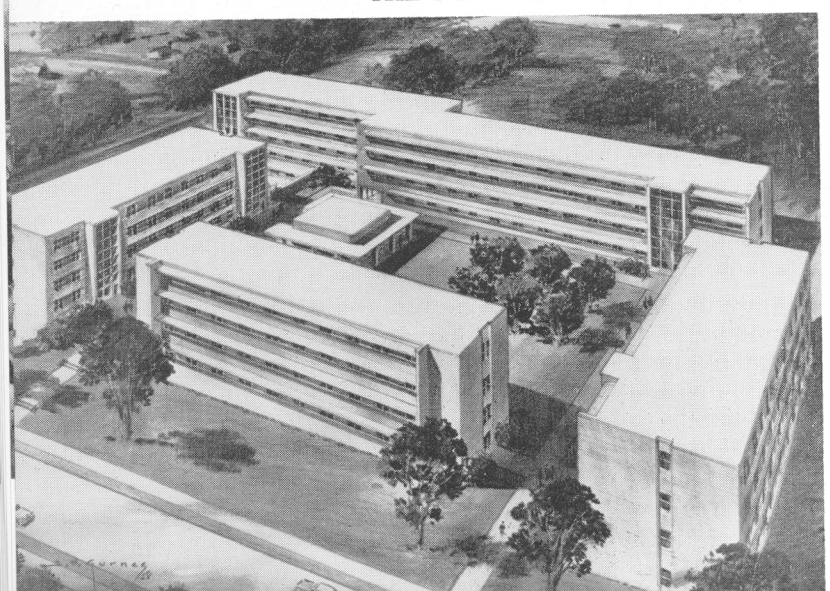


THE RADIOISOTOPES AND BIOENGINEERING LABORATORY



THE NUCLEAR RESEARCH REACTOR

THE NEW DOMITORY BUILDINGS

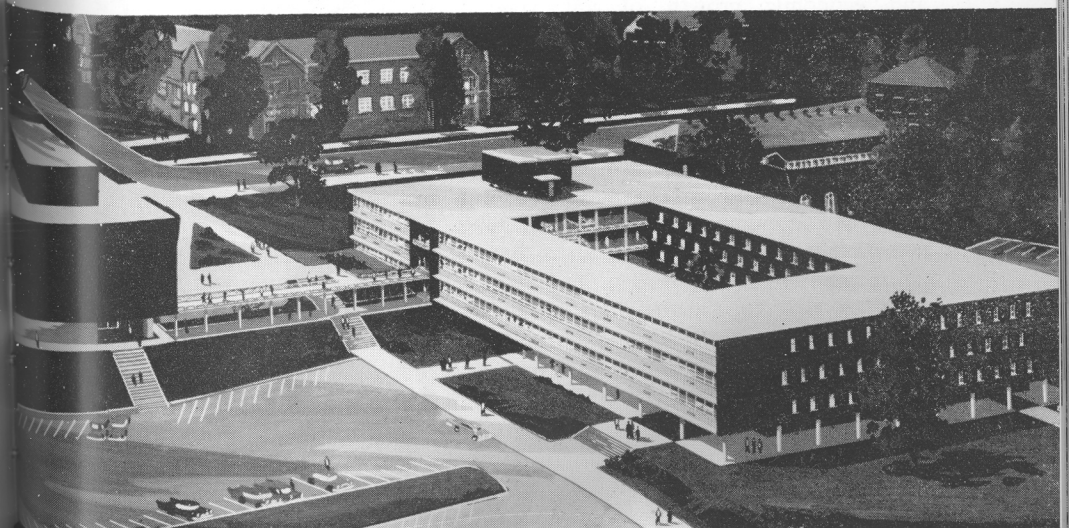


THE NEW INFIRMARY

Six of the new campus buildings

THE NEW ELECTRICAL ENGINEERING BUILDING

THE NEW CLASSROOM BUILDING



CLAY ISN'T ALL

by Frederick Bellinger, Chief, Materials Sciences Divisio

To meet pressing needs for more natural resources in the State, Georgia Tech is prepared to launch a complete minerals development program, from the initial economic research to pilot-plant investigations

THE RAPIDLY CHANGING technologies, so much in the news these days, are affecting not only the traffic in space and the budgets in the Pentagon, but the very dirt under our feet as well. The new metals, alloys, and chemicals that continue to spring from nuclear and missile research and development are actually increasing the value of our nation's soil.

Many mineral deposits considered worthless just a few years ago have become valuable sources of supply for the newest military and commercial products. Some of them are low-grade ores that have gained in value simply through the depletion of the more concentrated deposits. Others are minerals that have never before been in demand in quantity.

But what of Georgia? What is the quality of its mineral deposits? The quantity? How is its soil being affected? Is the mineral wealth of the State increasing at a rate comparable to other states with similar resources? Unfortunately, the answers to these and many other related questions are not available at this time. Yet, such information is vital to plans for industrial expansion and economic growth of any state. Hence, one of Georgia's greatest economic needs is a continuing program aimed at the evaluation and development of the State's mineral resources.

Many people are interested in Georgia's mineral resources. Those already in the industry, of course, are especially concerned. A number of individual prospectors are always searching for a "pot of gold." Others interested include Stat and Federal officials who need data o potential resource producers and manu facturers; the transportation industry banks; market development agencies labor; and Georgia Tech, with its respon sibility for the training of engineers and scientists and developing the resources of the State. All of these interests are becoming more and more active in gath ering the needed information.

As a result of this activity, the exist ing mineral industries in Georgia have been growing at a fairly steady rate and have reached a volume of more than $97 million a year. This effort is largely

Basic research on materials is a complementary activity in minerals development. Here single crystals of UO_2 and ThO_2 are prepared for studies of cleavage structure.

concentrated in a few areas, notably in the kaolin- and clay-producing region of Middle Georgia. Yet the development of Georgia's minerals has barely scratched the surface of the State's potential.

In the publicized stories of Georgia's industrial and economic growth, it is easy to overlook the fact that many counties are lagging, others are missing out entirely. Some areas are becoming poorer and losing in population each year. Their best hope for reversing the trend is in the development of their natural resources. And here minerals may play a dominant role. The addition of even a few major mineral-producing and mineral-using plants could have a far-reaching beneficial effect on the economic structure both of the immediate community and of the State as a whole. Basic industries like minerals have a "breeding" effect, bringing in other new industries, increasing the service, trade, household industries, and generally increasing the industrial and agricultural activities in support of the basic plant.

Not every county can expect to have valuable minerals in its soil. *Valuable* minerals by definition are scarce, and some counties may have to develop other sources of income from agriculture and its products, from forest products, manufacturing or service industries. Even if a minerals study gives negative results, an area can proceed in other directions without the chance of building a factory or developing housing on top of a potential marble quarry or magnesium mine. Yet new technical processes have been and are being used by which ores previously thought uneconomical are now large income producers.

Until a thorough geologic-mineral engineering study is made, we can only speculate about Georgia's future in mineral industries. Some of the most promising metals known to exist in Georgia are titanium, manganese, magnesium and iron. Of the non-metals, there are prospects for graphite, fullers-earth, special types of granite, light-weight aggregate, as well as kaolin and always possibly oil. Many others undoubtedly would be uncovered by a thorough survey. Such surveys are admittedly costly and time consuming, yet the probable benefits are so tremendous as to stagger the imagination even in this space age.

Witness the case of titanium. Until about 20 years ago, titanium had few uses and remained as one of the most abundant but valueless elements of the earth's crust. Then the paint and enameling industry found titania to have advantages over white lead and tin oxide. The aircraft industry demanded increasing quantities of this light and high-heat-resistant metal until now the use of metallic titanium is about 14,000 tons per year, at a price for the metal sponge close to $4,000 a ton. There are titanium ore mines on the Atlantic Coast near and on both sides of Georgia. Dr. H. W. Straley, geologist at Georgia Tech, and others have found plenty of titania "color" in the sands of Georgia's Coastal Plain. Beneath the sands may be even richer deposits but we just don't *know*. Dr. Straley has said that "we have every reason to suspect that the deposits on both ends of Georgia's coastline continue through Camden, Glynn, McIntosh, Liberty, Bryan, and Chatham counties."

Modern technology with new meth-

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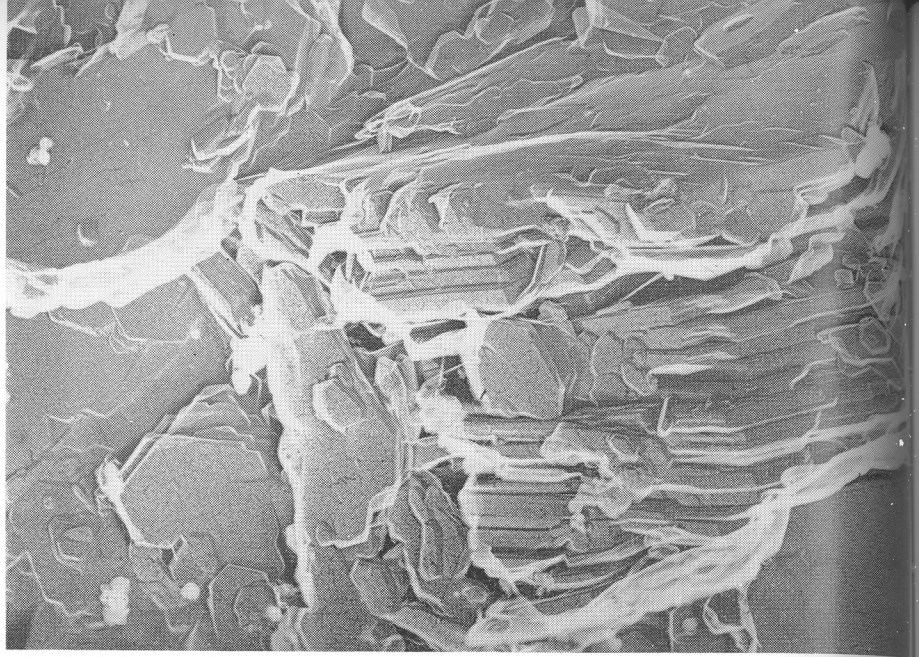

Enlarged 36,000 times by Tech's electron microscope, a specimen of a Georgia kaolin reveals a "stack" of crystals. Tech is also

ods of minerals preparation, more commonly referred to in the past as ore dressing, permits the economical use of many deposits heretofore considered to be so low in quality that they could not be mined profitably. For example, after years of mining ore of high quality (50% iron) in the Lake Superior region at the rate of over 100 million tons per year, the visible end of these deposits became disturbingly evident. After extensive minerals preparations research, it is now possible economically to use the taconite deposits — ores containing only about 27% iron. Even more recently a process has been developed to reduce low grade iron ores to iron by a hydrogen reduction process in which the usual blast furnace step is eliminated.

What about Georgia's "low-grade" iron ores? Can our known deposits of low-grade graphite be processed economically? Can we extract minerals from sea water? How about copper, gold, vanadium, zirconium, manganese? Can we not

equipped for and experienced in the study of optical properties of minerals by chemical microscopy, and analysis by spectroscopy

up-grade low-quality deposits of clay, cement, mica, glass-sand, and flourspar. These questions cannot be answered until research is carried out. Often the solution will entail a redical departure from old methods, involving the latest discoveries in chemistry and physics, and the resources peculiar to the locality—such as availability of natural gas or chemicals needed in the process. Tech's mineral engineers are ready to tackle such research.

Finding deposits and the development of processes is not the whole story. Capital investment in the land, equipment, buildings, roads, houses and so on is required. Potential investors need to know about existing and potential markets, local highways and rail service, availability of skilled and unskilled labor, water supply, local costs of power and fuel, political stability of the State and community, the attitude of the community towards the new industry and many other related economic and social details. The staff of Tech's Industrial Development Branch is prepared to dig out, analyze and report on these factors.

What Is Georgia Tech Doing?

Tech's Engineering Experiment Station last January established a Material Sciences Division with assigned responsibilities including a concentrated and coordinated effort in the fields of ceramic and mineral engineering. Simultaneously, the Station's Industrial Development Branch added to its staff two mineral economists, each having a broad background in the minerals industries. The Station now has a staff capability to conduct economic studies, field exploration, and experimental identification and analysis of the extent and quality of mineral deposits. Soon, space and equipment will be available for bench-scale and pilot-plant investigations to determine the practicality of washing and other ore-dressing processes.

Through the Georgia Tech Research Institute, Tech is capable of doing minerals development work under contract with the State, the Federal Government, chambers of commerce, commercial firms, or private individuals, from exploration to (and soon through) pilot-plant investigations. This set-up is unique in the Southeast and in fact is matched perhaps by only a few organizations in the nation.

Tech's staff at the Experiment Station works cooperatively with the State Department of Mines, Mining, and Geology, headed by Captain Garland Peyton. Under its charter of responsibilities and its policies, this Department conducts field explorations leading to the basic knowledge of the geological history and mineral resources, collects and coordinates data from all available published material, and reports its findings. The "Georgia Mineral Newsletter" is published quarterly by the Georgia Geological Survey of the Department for the benefit of those interested in the minerals and geology of the State. The staff of the Department is generous with their time and willingness to advise people regarding mineral and geological problems. Department policies do not permit work for the benefit of a single firm or individual unless the information gained may be released immediately for the benefit of all.

It is easy to see that the two organizations complement one another and their work overlaps only in the interest of

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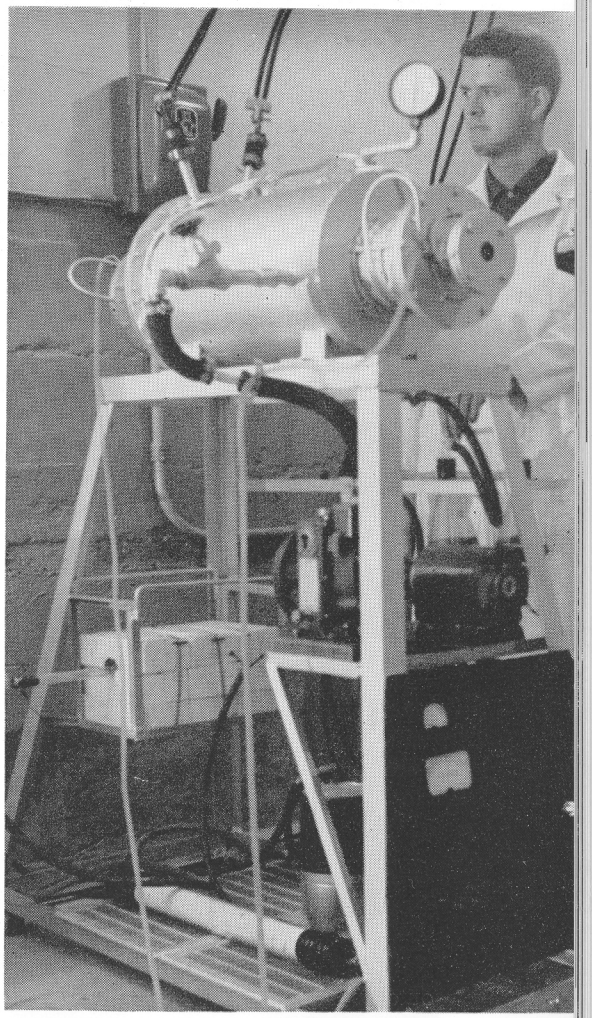

To study the properties of certain minerals in special applications, Tech ceramic engineers built this hydrogen-atmosphere furnace to fabricate the long tubular shapes needed.

CLAY ISN'T ALL

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both in obtaining and disseminating knowledge of Georgia's mineral resources and in the proper conservation (which means the economic utilization) of our resources. As scientific knowledge is almost always the foundation for technical development, the basic work of the Department of Mines, Mining, and Geology is of vital interest to Tech's scientists and engineers. Conversely, the development of mineral industries in Georgia is of vital interest to the Department in view of the basic information obtained and its charge of responsibility for conservation of the State's resources.

Typical Program

Let's see how a complete program of a specific mineral's development might be carried out from scratch.

Step 1. A need for a study arises. This may stem from a planned economic study by a group such as Tech's Industrial Development Branch; from a desire to obtain basic information; from a group needing the information to plan a program of development, or from an individual who wants to know what his land contains and for one reason or another is interested mainly in one specific mineral, or one specific deposit.

Step 2. A preliminary economic study by industrial economists, such as Tech's, correlates information on suitable quality of an ore, markets, utilities, labor, transportation and competition; all needed to determine if it is worthwhile spending money at this time on an experimental program. Included in the study is a review of basic data available, "probabilities" of deposits of economic size, and discussions between Tech's economists, scientists and engineers.

Step 3. Field exploration may then be carried out by Tech's Mineral Engineering group. "Rights of entry" for the field party are obtained by the sponsor in advance. The field party examines the potential area and collects samples from outcropping, road and railway cuts, stream beds, and in most cases probably obtains a number of core samples by drilling, which will reveal mineral "layers" from which the extent of deposit may be estimated. Preliminary laboratory examinations are then made by Tech's scientists to determine the mineral values—what they are—in what form, in what "quality," etc. In this step, commercial drilling outfits and analytical chemical firms may be employed. Simple bench-scale tests may be tried to see if a washing, screening or centrifugal separation will be easy and give a high quality product.

Step 4. A review of the data by the scientists, engineers, and economists is then made. Estimates of plant size consistent with the extent of the deposit and market, plant costs, operating costs and returns can then be estimated roughly as a basis for recommending further action.

Step 5. Bench-scale and pilot-plant studies as necessary would be carried out by the Mineral Engineering group with full use made of services of equipment manufacturers and their laboratories. The results provide the data for production plant design, cost estimates, probable markets, personnel requirements, and so on. Usually Tech's work is then completed; except, if desired, in an advisory capacity, during preparation of construction drawings and procurement of equipment.

Step 6. The plant, if any, is constructed and the mine and plant operated. Georgia Tech can still render engineering and development service in process, equipment, and organizational development.

It is emphasized that Tech cooperates with and is not in competition with private concerns dealing with services; such as architects, building contractors, equipment manufacturers, and testing laboratories. Tech maintains its role strictly in areas of research and development, providing service type tests only where highly specialized equipment is needed and not normally available by concerns in Georgia.

COMPUTER CENTER

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machines having an elaborate list of instructions which the machine can recognize and execute, together with input-output facilities for punched cards, paper tape, magnetic tape or typewriter. The full memory capacity of the machine can be used for storage of alphabetic and special characters (commas, etc) or for storage of numbers.

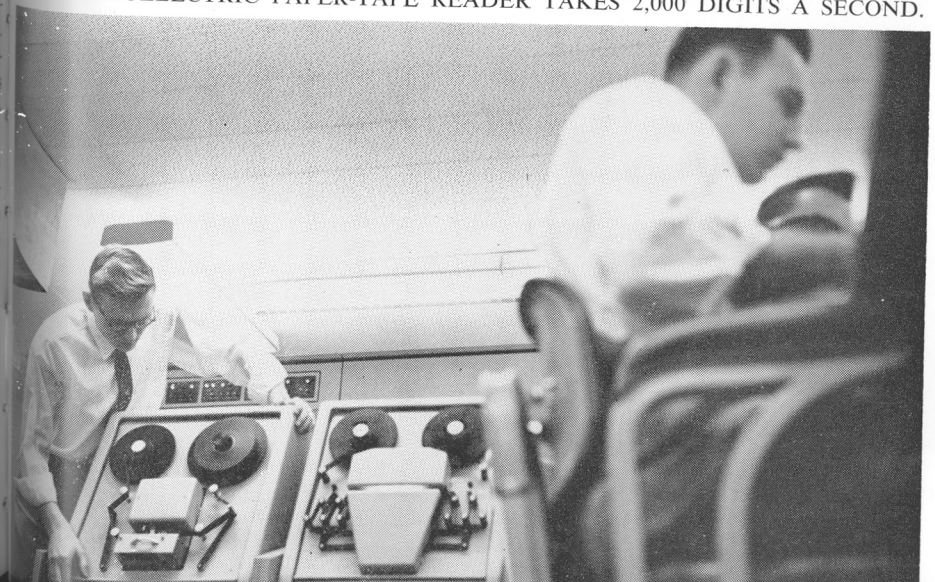
The speed, flexibility and storage capabilities of the 220 will increase the number and types of problems that can be handled at the Computer Center. Some problems, such as many types of engineering analysis, require a great number of arithmetical operations with a limited amount of input and output data. For such a problem the speed of the machine will be important. Other types of problems, such as forecasting, statistical analysis and trend analysis, require large amounts of storage as well as flexible and fast input and output. The flexibility and speed of the input will also be of advantage for those problems in which the input data is already available on either punched cards, paper tape or magnetic tape. The recent increase in the number of commercially available devices which record data in some card or tape form will make this feature of the machine quite useful. The alphabetic capabilities will make it applicable to many types of data processing problems and problems requiring an output in the form of a report. And, the decimal representation of numbers inside the machine will make its operation easier for those who only occasionally utilize computers.

Plans for Future Growth

The growth of Georgia Tech as an educational and research center and the growth of industry in the southeastern area will require a continued improvement in computational facilities. The advent of the nuclear reactor at Tech and the resulting atomic research alone will necessitate facilities of the highest caliber.

In anticipation of these future requirements, plans are under way to construct a machine similar to the one now being built at the University of Illinois. This machine will be larger and faster than any commercially available general purpose machine that has thus far been announced for the future. Toward this end one member of the engineering staff of the Computer Center is spending the present academic year at the University of Illinois working on their machine. His experience and the results of the present expansion and modifications will insure that the necessary improvements of the facilities can be carried out, and that the Rich Electronic Computer Center will continue to serve the computational needs of the institution and indusrty.

220'S PHOTOELECTRIC PAPER-TAPE READER TAKES 2,000 DIGITS A SECOND.



Edited In Retrospect

service by association

• In the middle of January Georgia Tech was host for the first time at a meeting of the Inter-Service Committee on Technical Facilities, Southeastern, USA. This is a cooperative association, primarily of military research organizations, intended to avoid costly duplication of research facilities, such as electronic computers, hydraulics and electronics laboratories, etc. The committee encourages the sharing of such facilities and the exchange of technical information of mutual interest.

The January conference was devoted to developments in the applications of computers, including an accounting of the various computers available in the committee membership. The visitors were given tours of the Rich Electronic Computer Center, the Analog Computer Laboratory and other research laboratories at Georgia Tech. The Engineering Experiment Station is honored to serve as the only non-federal member of the eight-member committee, which includes agencies of the Army, Navy, Air Force and the Tennessee Valley Authority.

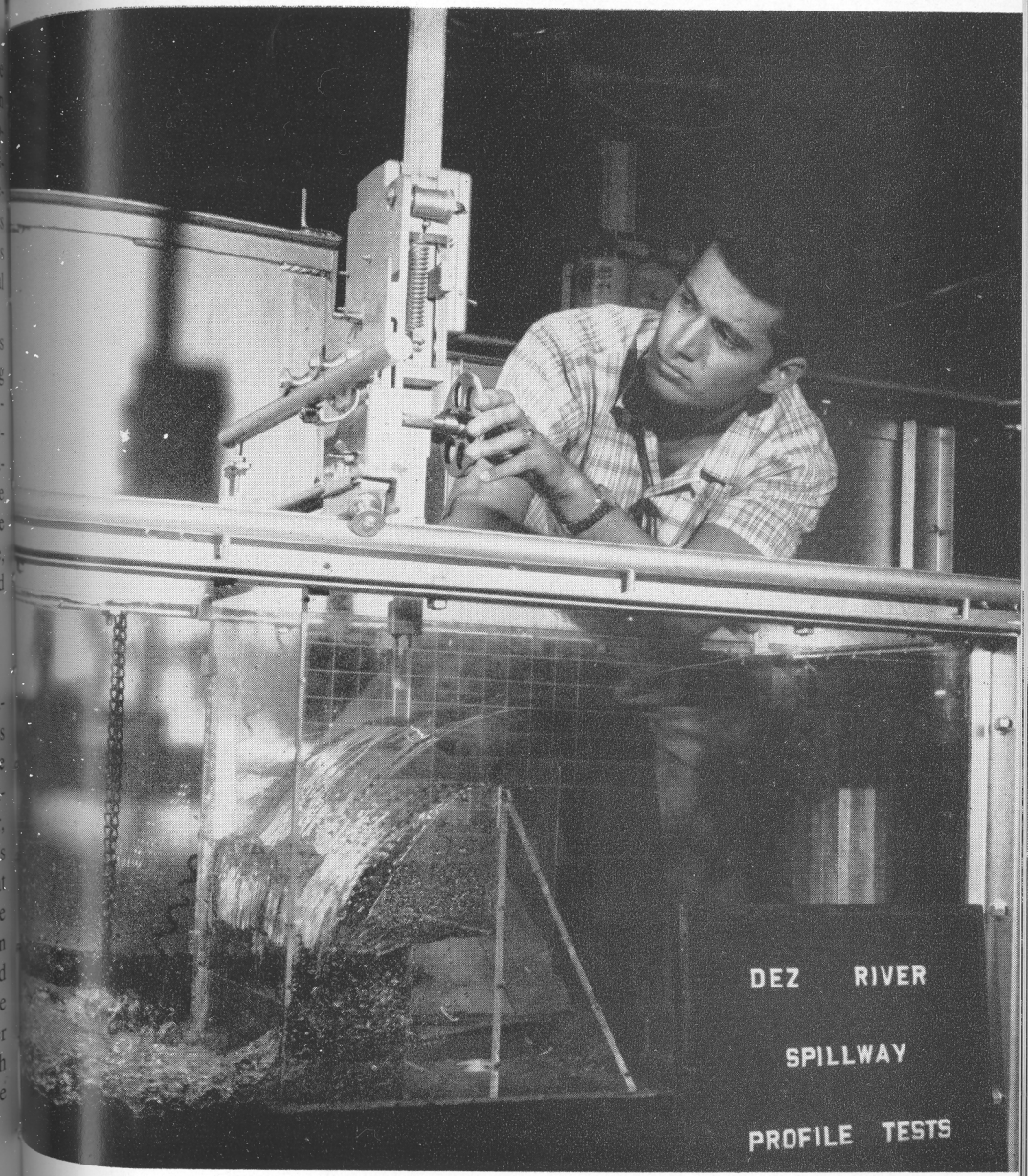
think or swim

• It isn't often that we hear of someone spending his vacation playing games with electronic computers, much less carrying on such an engagement by proxy. But it has come to our attention that one of Georgia Tech's resident experts on games of chance and strategy, Dean Ralph Hefner, not only played tic-tac-toe with Tech's IBM 650 from his mountain hideaway, but he won. It seems that someone at the University of Florida wrote a 650 program for the game and challenged anyone to beat it. Last summer Dean Hefner accepted the challenge, made one move, noted the machine's rapid return move, then retired to the shade of his cabin porch at Lake Rlue Ridge, Georgia, to ponder his strategy. After a few exchanges of post cards with Computer Center operators who refereed the contest, the dean was pronounced winner and still champion.

APRIL, 1959

The Research Engineer

Published by the Georgia Tech Engineering Experiment Station



HYDRAULICS RESEARCH FOR IRAN

Psychology Program - page 12