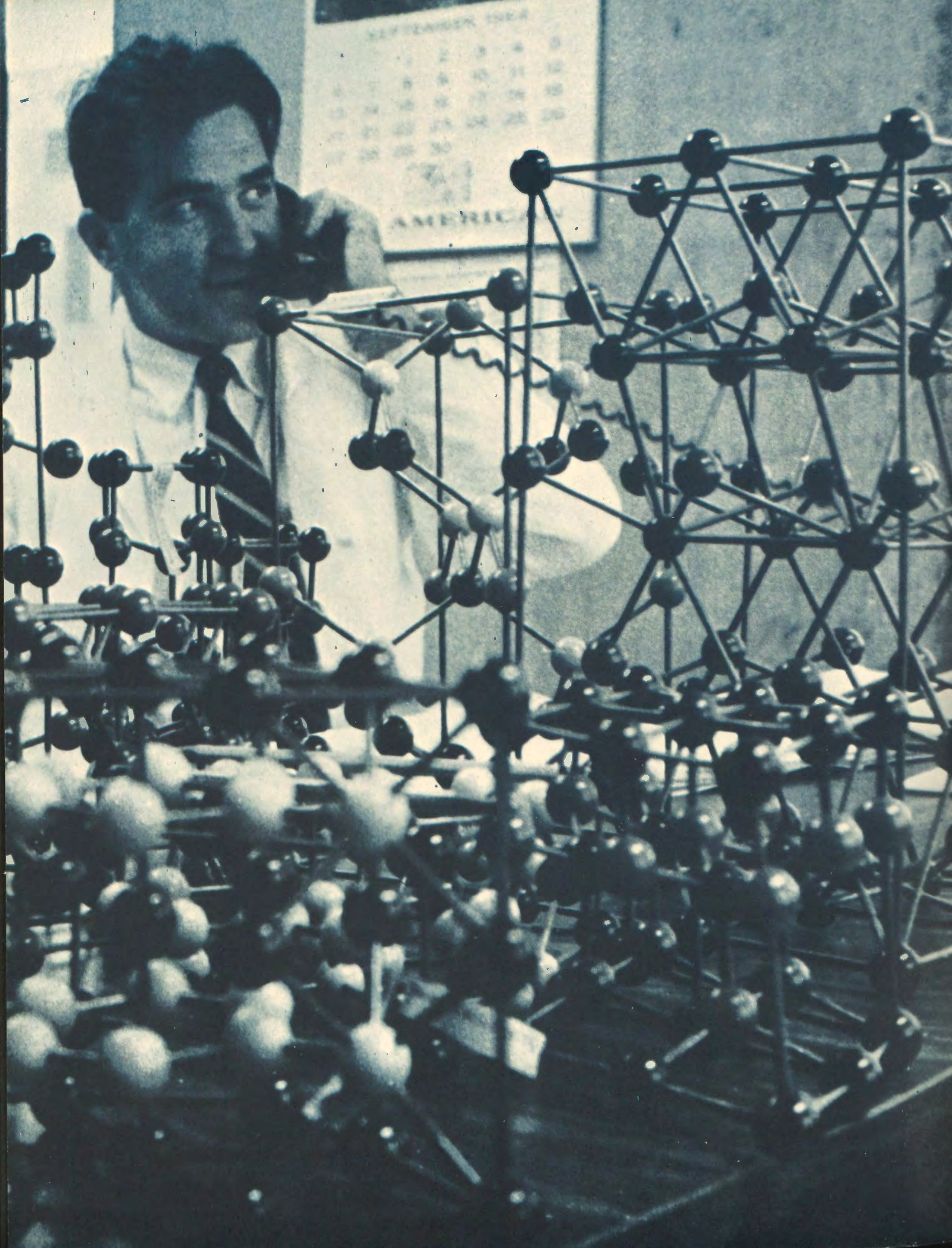
. . . to probe the structure of matter

The University of Pennsylvania's new Laboratory for Research on the Structure of Matter is unusual both in form and function, and offers hope for the creation of materials to match Space Age challenges.

Laboratory for Research on the Structure of Matter

OVER the past few years, Penn's campus has been the site of some of the most imaginative academic construction in this area. Newest and perhaps most unusual, both in form and function, is the Laboratory for Research on the Structure of Matter, a four-story, glass and concrete building housing the University's materials science center. The work to be carried on here, when the center is in full-scale operation, is interdisciplinary. It will bring together representatives of all sciences concerned with the structure and properties of matter. It also reflects the interested cooperation of a number of organizations. The Advanced Research Projects Agency of the U.S. Defense Department will underwrite about 40 percent of a projected annual budget of $6 million. The University itself will assume 30 percent, and the remaining 30 percent will come from public and private agencies.

DVA wishes to extend thanks to the University of Pennsylvania, to United Engineers & Constructors, and to Martin, Stewart, Noble and Class for their courtesy and cooperation in providing photographs and information.



Dr. John N. Hobstetter, professor of metallurgical engineering at Penn, is director of the new Laboratory for Research on the Structure of Matter.

Form and Function

Purely as a building, the Laboratory is an excellent example of architecture serving the highly specialized needs of a number of sciences. R. J. Reynolds, associate in the Philadelphia firm of Martin, Stewart, Noble and Class, architects of the building, gives some insights into how this came about.

"The initial relationship between clients and architect was a nearly ideal one," says Reynolds, project designer of the building. "The first contract involved the preparation of a detailed program. The science staff had already prepared a comprehensive statement of operational philosophy and projected equipment and personnel breakdown for the first five years of occupancy. When the staff and architect met for their first working session, it was obvious there were few restrictive, preconceived ideas present, and that a healthy search for facts could be achieved.

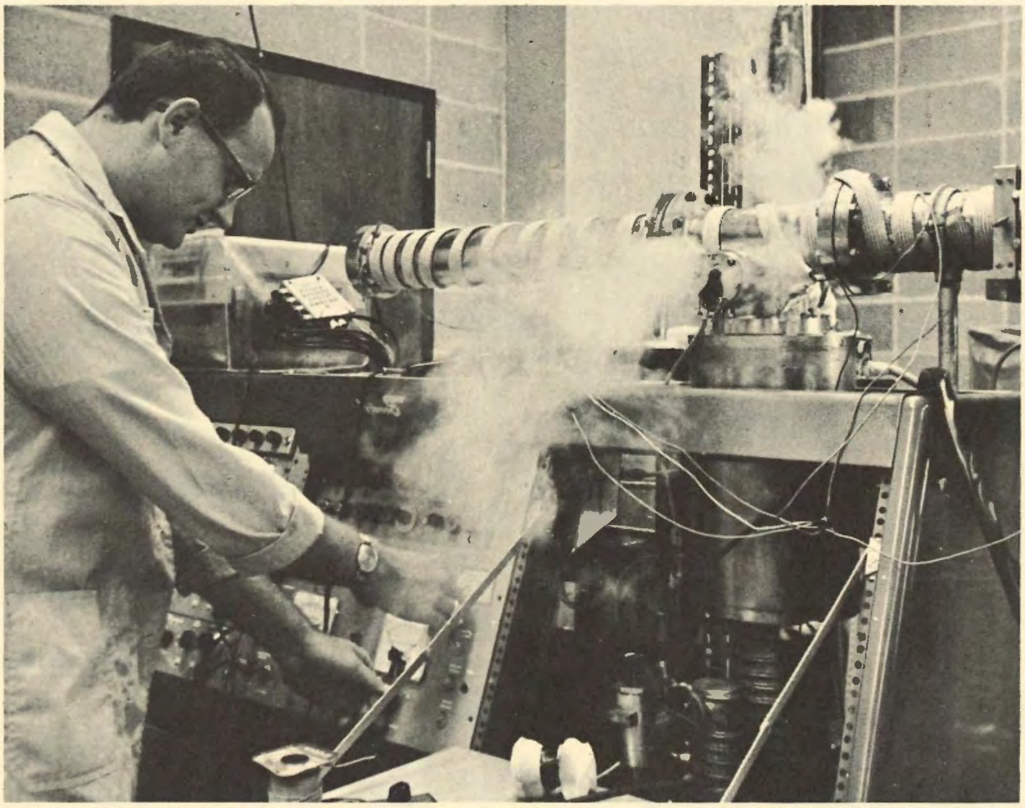
"One of the most difficult jobs for an architect," says Reynolds, "is getting to the roots of the real program." And he points out the vital role of Dr. John N. Hobstetter, director of the science center, who recognized the necessity for one man to sit as moderator and sometimes interpreter for his staff of scientists, and who assumed final responsibility for all functional decisions.

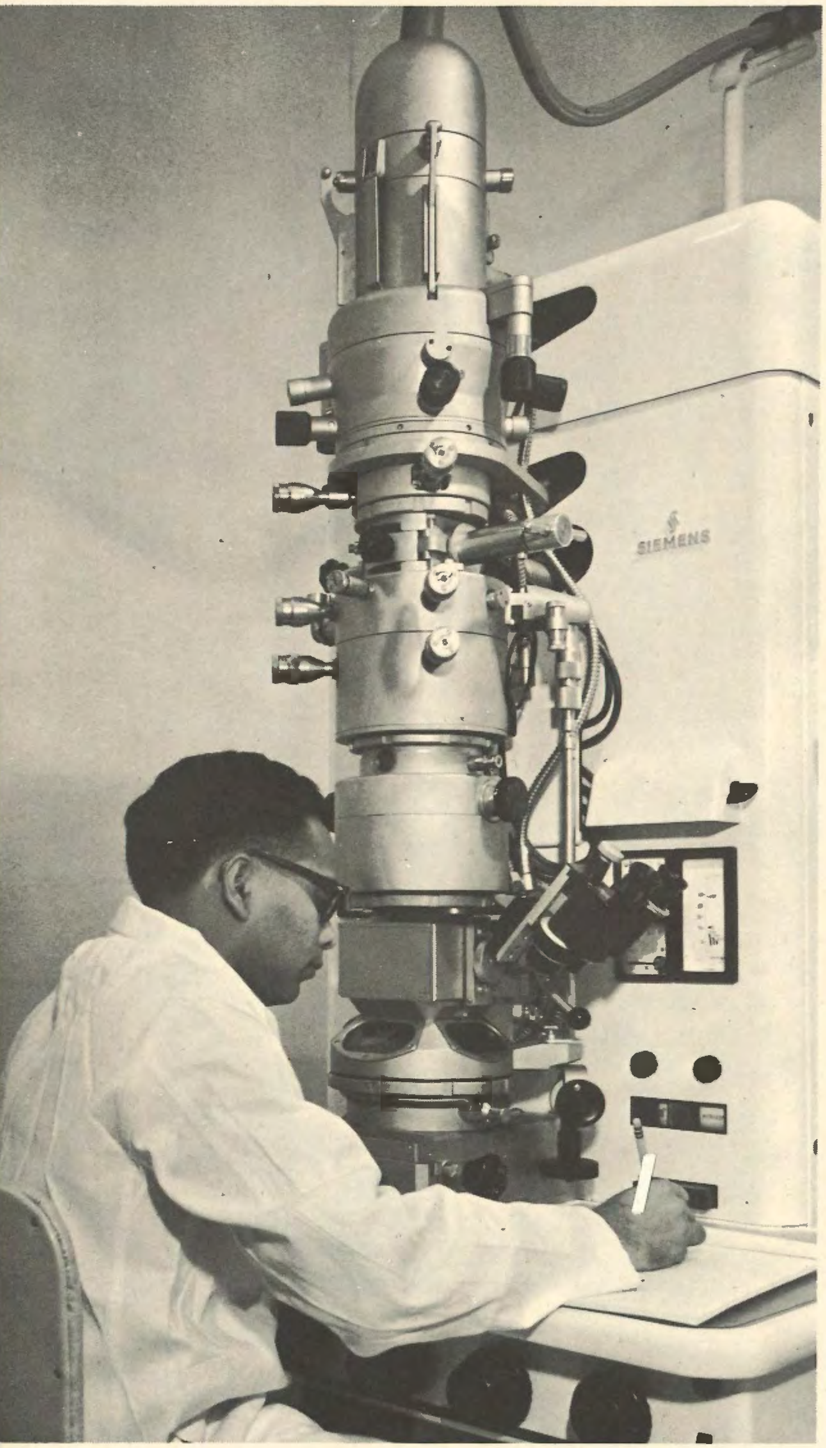
Molecular models aid in probing secrets of the structure of matter.

"Scientists working in the highly sophisticated areas of modern physics, chemistry, and metallurgy," says Reynolds, "frequently have difficulty in communication with a 'lay' architect. I attempted to relieve them of the need for explaining the nature of an electron microscope or mass spectrometer in favor of discussing the problems of installing, storing, and using these instruments, by learning as much as possible about their tools, laboratory practice, and the larger theoretical framework of each area of investigation."

In the case of the electron microscope, for example, it was determined that the moving mass of magnetic metal in the conventional elevator cab presented the greatest operational hazard. With the cooperation of the manufacturer, the architects programed and designed the first successful non-magnetic passenger elevator.

"The production of the final project program," says Reynolds, "included the better part of a year of conversation, snooping around laboratories, asking and answering a million questions, writing and rewriting. It provided a solid foundation for the next problem: the building design. Very few precedents for an interdisciplinary laboratory structure existed at that time, and this permitted great freedom for the designer's imagination."





A Productive Dialogue

The finished structure demonstrates not only the perception of Martin, Stewart, Noble and Class in understanding the demands of science, but also the value of productive dialogue between architect and client. The Laboratory features a combination of details both esthetic and functional.

Scientists, for example, can see through the "skin" of glare-reducing, heat-absorbing thermopane; but no one on the outside can see in. Solar load and glare are also reduced to such an extent that shades or blinds are seldom needed.

Windows in the Laboratory are not designed to open, but a balcony on the second floor offers room for strolling—and gardening, if the scientists are so inclined!

An air conditioning system renders the atmosphere practically dust-free. The passer-by might mistake the tall columns of aggregate-faced, pre-cast concrete for an esthetic adornment, for they are certainly the most striking feature in the building's physiognomy. Ornamentation is secondary. The columns are actually chimneys, each with its own axial-flow fan, which serve to discharge chemical fumes.

Facilities include a unique, high-intensity magnetic field laboratory which allows researchers to study detail of atomic and electronic behavior. In the materials processing center, high-temperature equipment can reach 5000C. At the other extreme of the thermometer, a cryogenics facility permits scientists to perform experiments at temperatures only a fraction of a degree above absolute zero.

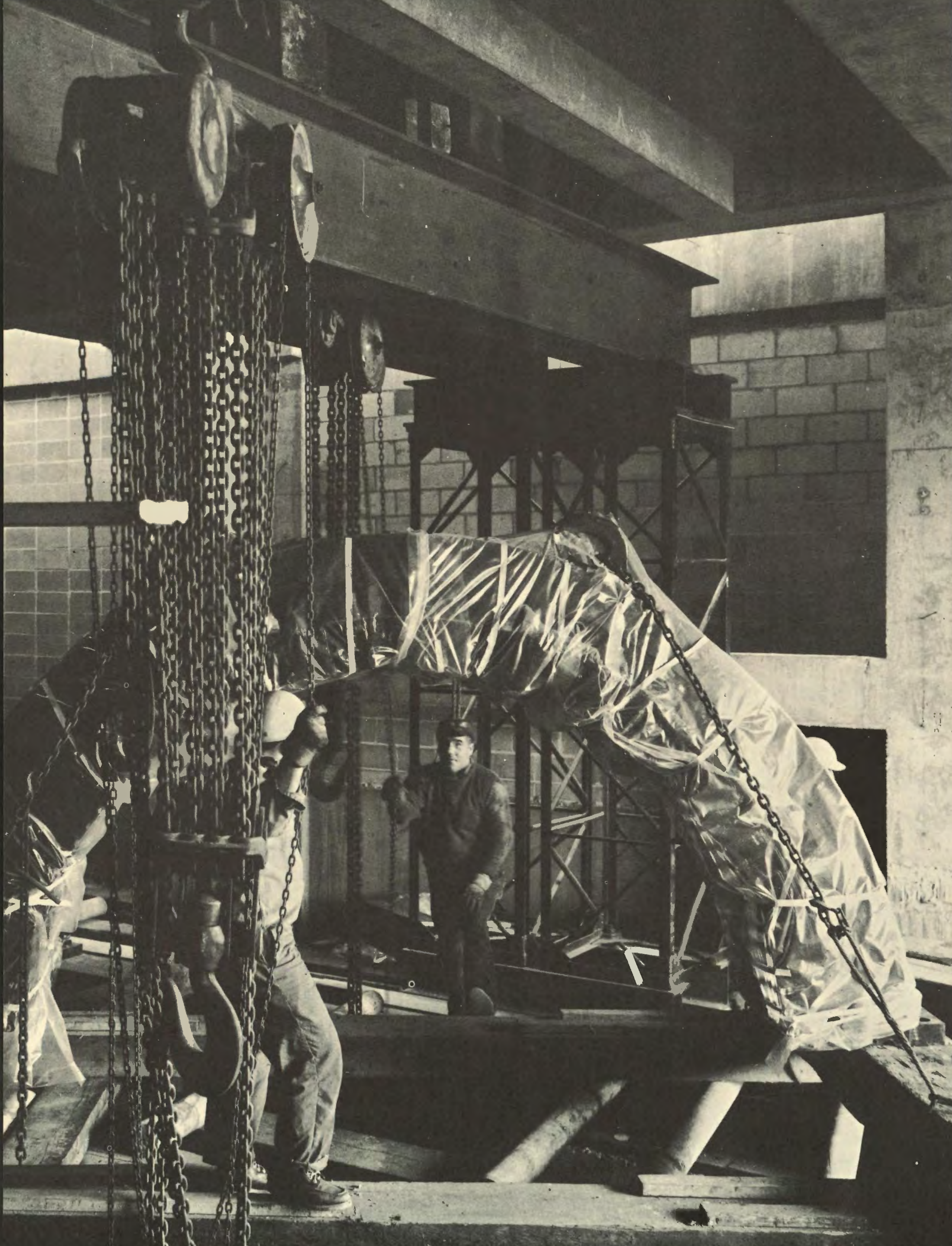
The Laboratory also offers an electron microscopy center, X-ray diffraction laboratories, an electrical standards laboratory, with other labs for spectroscopy, chemical analysis, magnetic resonance, and microwave spectroscopy.

These facilities are located on the second, third, and fourth floors. The first floor houses directors' offices, a seminar-library, seminar room, and machine, instrument and welding shops. Building service mechanical equipment is in a penthouse. A six-megawatt motor generator serving the high intensity magnet laboratory is housed in a two-story addition at the rear of the Laboratory.

STRUCTURAL
STEEL

FABRICATION
ERECTION

EDDYSTONE • ROYERSFORD

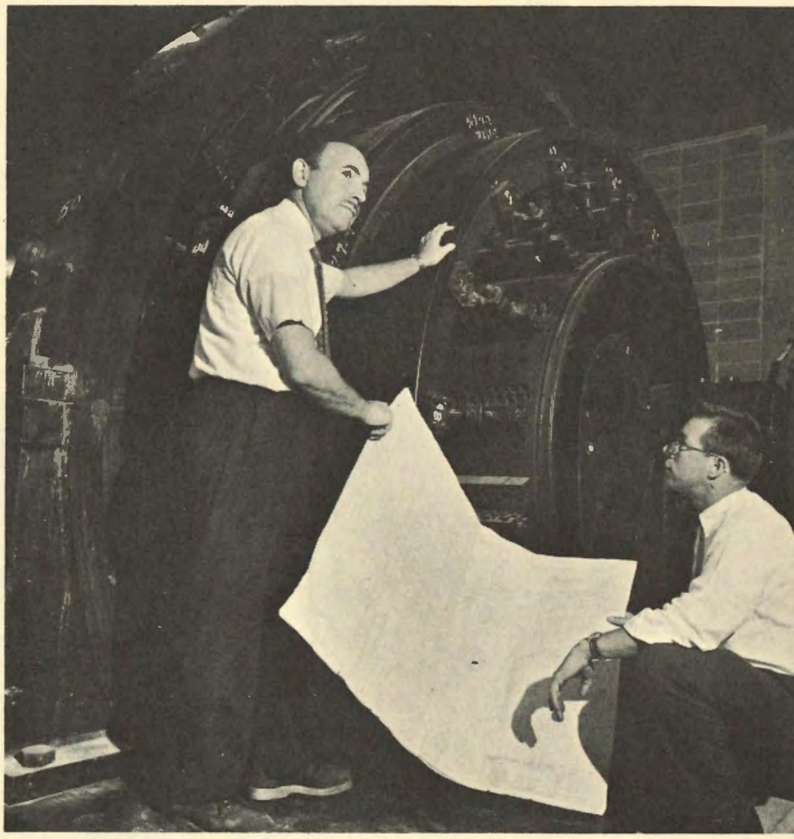


Construction Management

United Engineers & Constructors Inc. were the construction managers on the project. Their task was to take the basic plans and specifications prepared by the architect and transform them into the completed building with the surrounding land fully graded and landscaped, ready to be turned over to the University.

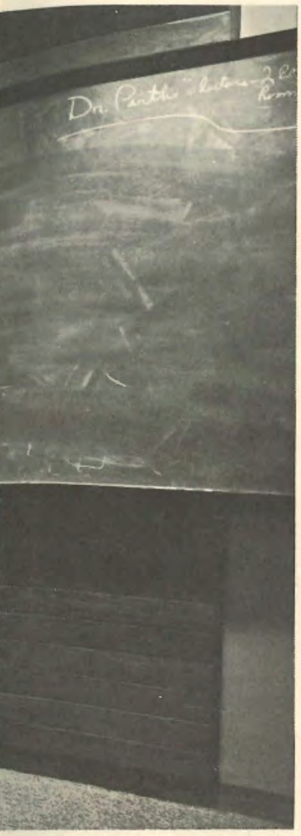
There were several major challenges. Materials had to be carefully selected to meet the specifications. Work had to be done to the highest standard of quality. The project had to be completed within the alloted time. And the costs had to be kept within the budget.

Initially United Engineers made a careful scrutiny of the plans and specifications and organized a team of engineers within its Building Department to follow the job through from start to finish. To make sure a complex construction project such as this is completed on schedule and with the most efficient use of manpower, the men of United Engineers look far ahead. Every step is anticipated and to the maximum possible extent, so is every conceivable problem—weather, materials, labor, etc. Then all details are co-ordinated into one project plan. This is called the Critical Path Method of scheduling. It was employed on this project and the rewards were many.



Facilities relating to high-intensity magnetic field laboratory. At right, the six-megawatt motor generator serving the high-intensity magnet lab.

Auditorium seats 145 persons in comfortable, modern chairs. Lighting is controlled by rheostats, and the room contains a built-in projection screen.



Seminar room on ground floor of the Laboratory. It adjoins library but can be separated from it by a movable partition.

To guard against the risk of settlement of the building with consequent later appearance of cracks in walls, the design called for caissons to be sunk to the underlying rock.

The work was started in the month of November—right at the beginning of winter. Hence it was anticipated that weather was going to interfere with the completion of the foundation. However, advantage was taken of the time to advance the other aspects of the planning of the building and make sure that all subcontractors were fully prepared to begin their part of the work on schedule and had approved materials on hand.

The project called for the co-ordination of the work of 44 separate vendors and subcontractors. First they had to be selected from a much larger number of separate bidders. Each had to be evaluated for his ability to meet the quality standards. The materials chosen had to be approved by United Engineers for compliance with the specifications and then also passed to the architect for his approval. All incoming materials had to be inspected and approved. Each subcontractor had to be ready to go to work on his share of the project precisely on schedule with both materials and manpower at his disposal. United Engineers took care to check on this.

In the process of supervising and inspecting the quality of all work during construction, there was one detail which was especially challenging: the vertical columns which rise so arrestingly on the outside of the building and serve as exhaust ducts for ventilation of fume hoods on the various floors. Each column above the 2nd floor balcony level is a single, pre-cast concrete section slightly over 49 feet long and weighing 16 tons. There are 30 of them on the building. Their length and weight made them cumbersome to maneuver and their relatively thin cross section made them fragile. The plan called for them to fit snugly against poured concrete columns rising flush with the perimeter of the floor areas. Therefore it was imperative that these poured columns be straight and truly vertical within relatively close tolerances in order to assure good, gap-free fit and a minimum risk of leaning of the concrete sections. This was achieved in every case. Furthermore in spite of their relative fragility, not a single cast concrete section was broken or significantly damaged.

The entire project was completed on schedule, within budget, and without incident.

New Materials for Tomorrow

The selection of Dr. John N. Hobstetter as director of the science center is a significant one, and reflects the Laboratory's basic concern with the materials of the future. A professor of metallurgical engineering, and a member of the Penn faculty since 1958, his special field of interest is semiconductors. Graduated from MIT in

1939, Dr. Hobstetter received his doctor of science degree from Harvard in 1946. He taught at Harvard until 1952, when he joined the technical staff of Bell Telephone.

Dr. Hobstetter points out that the chief purpose of the new center is the training of Ph.D's. At present, the University awards about 20 doctorates per year to students in materials science research and development, but expects this number will increase to 35—representing between five and ten percent of the national output in this field.

The Laboratory staff includes 33 professors and Dr. Hobstetter foresees an increase to 40 within the next two years. The graduate student body, which has risen from 78 to 118 since 1960, will eventually number 160.

Although faculty and students are drawn from different disciplines, they share a common interest in understanding the properties of materials—and how they can be controlled. With this knowledge, there is hope that science may eventually create new and undreamed of materials to meet demands which may not even exist today but which will become very real and pressing in tomorrow's world.

The main problem, the Penn report states, was to design a building flexible enough to house any research program that might be conceived today and for years to come. What has been created is a laboratory in which the complex tools of modern science can be put to optimum use, and a place, too, where men can dream.

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