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THE COLLEGE AND UNIVERSITY SCIENCE CENTER, REPORT FROM A WORKSHOP SPONSORED BY EDUCATIONAL EXECUTIVE'S OVERVIEW MAGAZINE AND PERKINS AND WILL, ARCHITECTS, NEW YORK CITY, OCTOBER 26, 1961.

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PERKINS AND WILL, ARCHITECTS, CHICAGO, ILL.

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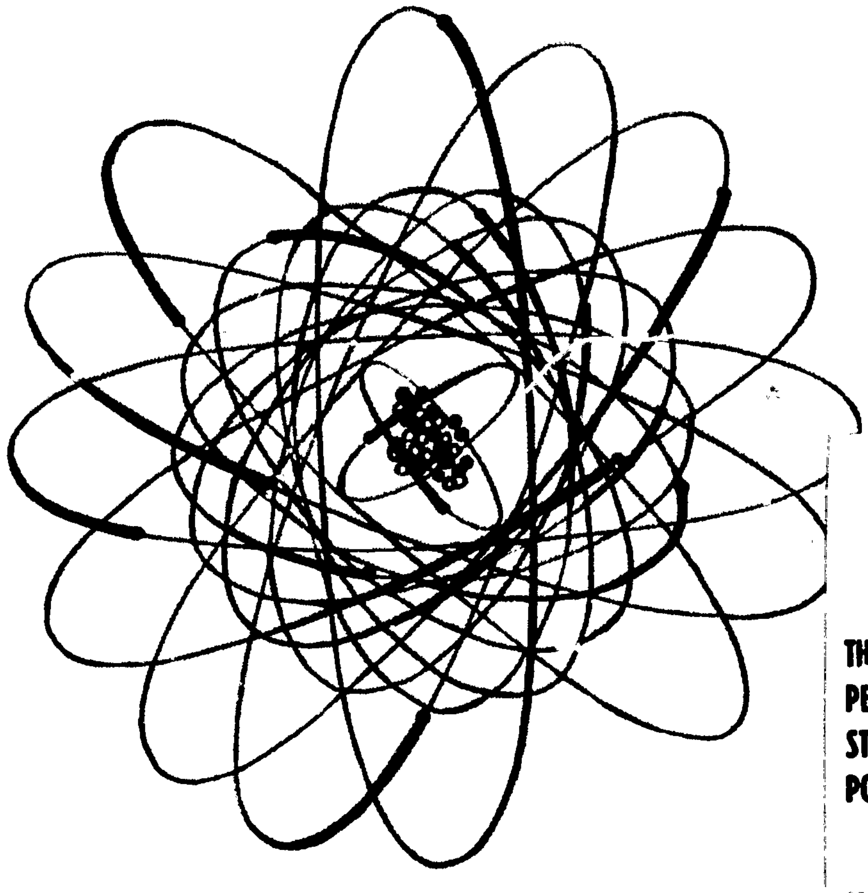
THIS IS A REPORT OF A DAY'S WORKSHOP ON THE COLLEGE SCIENCE CENTER, WITH A GROUP OF ARCHITECTS, COLLEGE ADMINISTRATORS, AND FACULTY. THE EMPHASIS WAS ON A DISCUSSION OF THE CONSOLIDATION OR CENTRALIZATION OF SCIENCE FACILITIES ON THE LIBERAL ARTS CAMPUS. SPECIFIC TOPICS INCLUDED--(1) WHY BUILD A SCIENCE CENTER, (2) BRIDGING OVER SUBJECT BOUNDARIES, (3) LABORATORIES AND THE STUDENT, AND (4) RESEARCH AND THE PROFESSOR. ILLUSTRATIONS WERE GIVEN OF ACTUAL AND THEORETICAL SCIENCE CENTER LAYOUTS, SUCH AS--(1) HALLS OF SCIENCE, (2) EXPANSION OF EXISTING SCIENCE BUILDING, (3) EARTH SCIENCES BUILDING, (4) SCIENCE-ENGINEERING-RESEARCH CENTER, (5) MEDICAL RESEARCH BUILDING, (6) IBM LABORATORY, (7) CHEMISTRY BUILDING, (8) BIOLOGY AND GEOLOGY LABORATORY, AND (9) SCIENCE AND PHARMACY BUILDINGS. A DETAILED CASE STUDY WAS GIVEN FOR SWARTHMORE'S SCIENCE CENTER. A FINAL STATEMENT WAS MADE ON FLEXIBILITY. (MM)



The College and University

SCIENCE CENTER

Report from a Workshop

sponsored by

Educational Executives' OVERVIEW Magazine

and

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New York City

October 26, 1961

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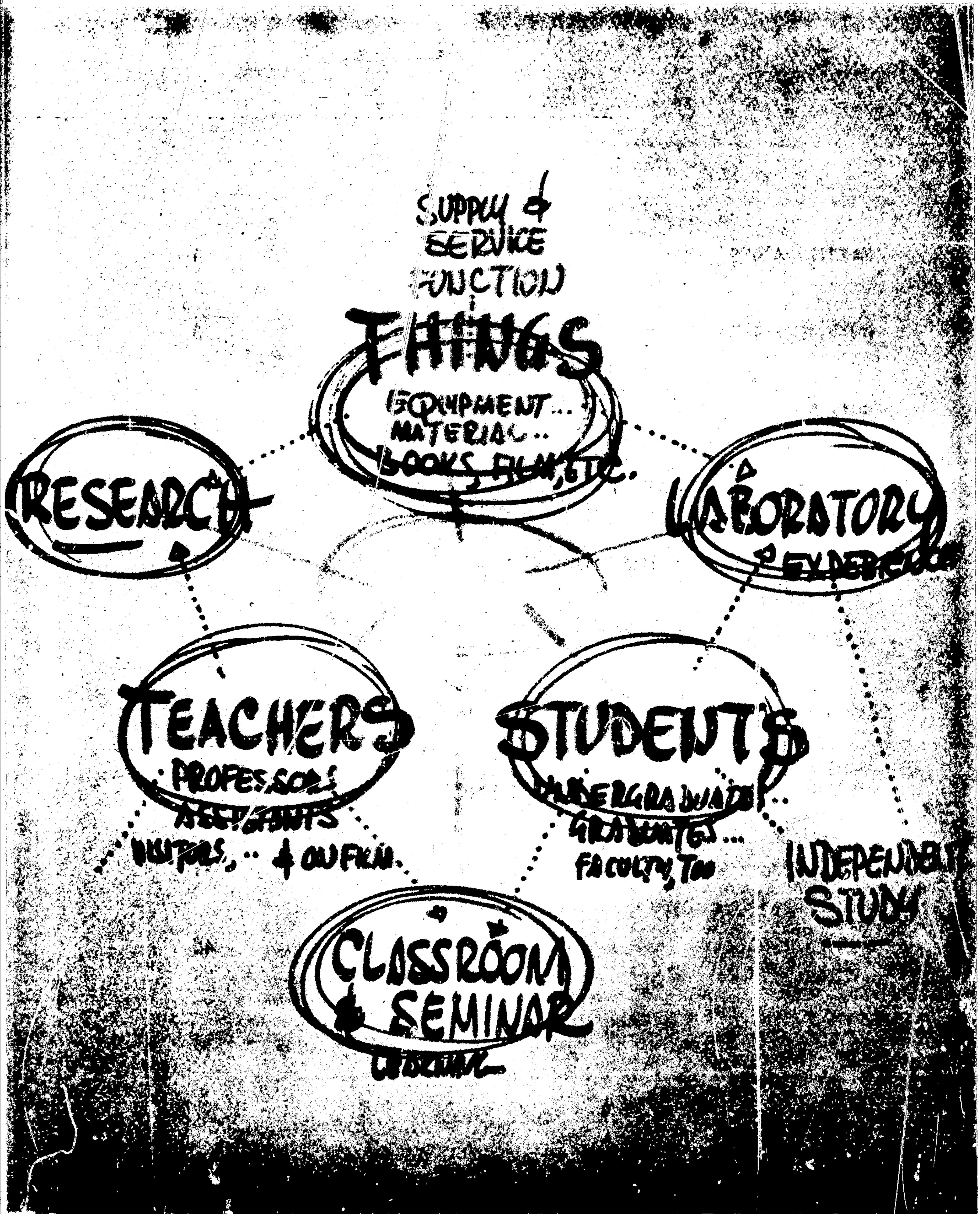
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CLASSROOM & SEMINAR

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INTRODUCTION

After the dust of World War II settled to reveal a world divided into two polar camps, the United States government began appropriating a record peacetime share of the national budget to scientific research and development to bolster the nation's defenses. But it took a small spherical object, put into orbit by the Soviet camp in 1957, to shock the American public into an awareness of the danger of scientific lag.

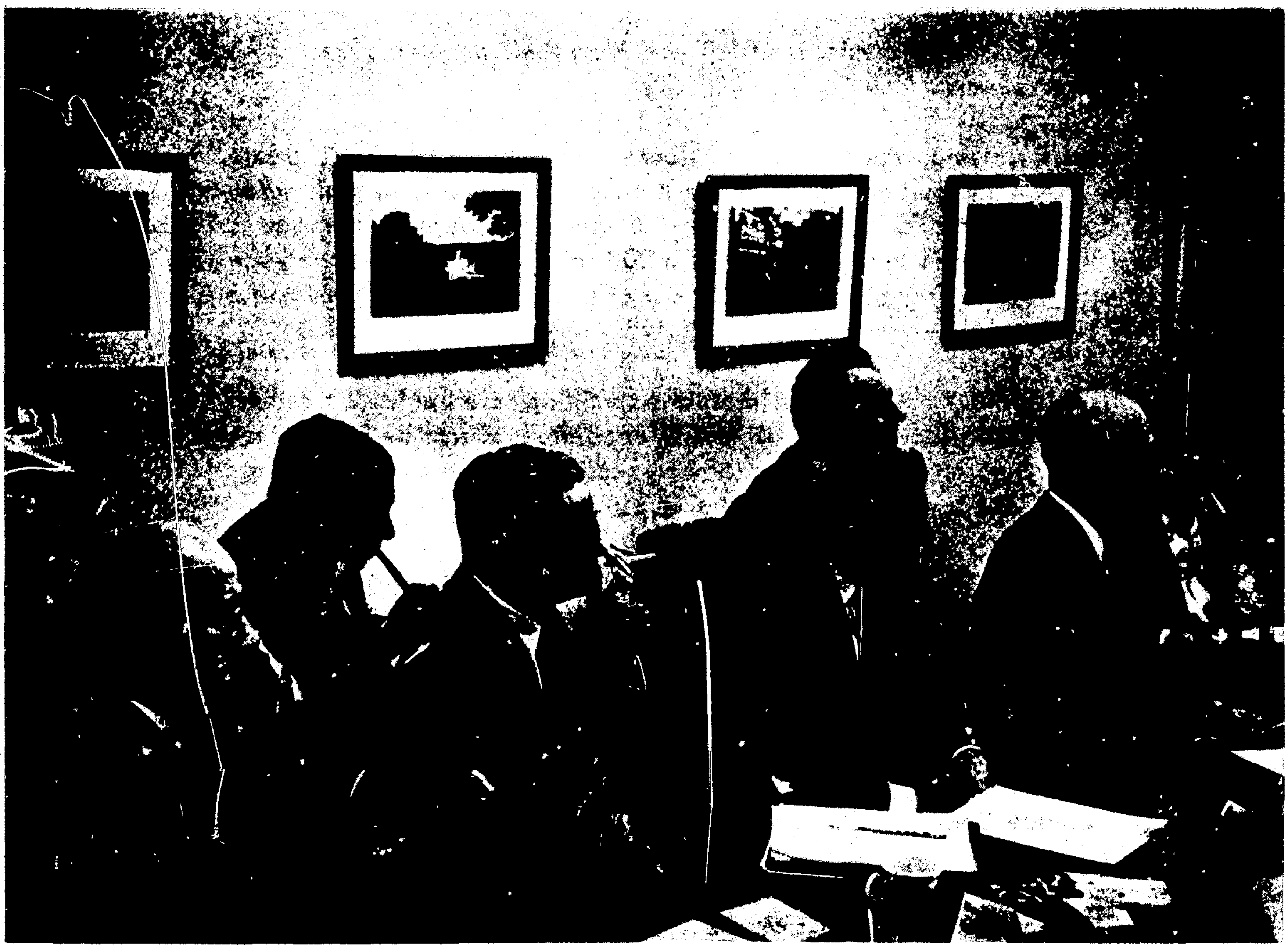
School administrators were quick to respond to the public demand for "more science education." They have added space-age units, incorporated the newly revised science and mathematics curriculums, set up annual science fairs, and dispatched their science teachers to summer science institutes. Through these means they are hopefully achieving two ends: grooming a scientifically literate generation; and revealing scientific talents which will lead their possessors into college and onto science careers.

It is not surprising, therefore, that liberal arts colleges, already pressed to find room for growing enrollments, have felt the tightest squeeze in their science buildings. To make room for this bumper crop of science students, American colleges and universities have been putting up close to 200 science buildings each year over the past several years. This almost tops the list of new college facilities and is exceeded only by dormitories.

Along with the problem of building or expanding science facilities has come another consideration: Should all the science departments be brought together and housed under one roof? Should, in other words, the colleges be building Science Centers? This raises any number of questions. Does the Science Center make good sense academically? Administratively? Would it hold greater advantages for the students? For the faculty? Could it be designed flexibly enough to adapt to the college's changing needs over the next several decades?

To exchange views on these and related questions, Perkins & Will, architects joined with Educational Executives' OVERVIEW to invite twelve college administrators and faculty members, a representative of the American Institute of Physics, and the president of the Educational Facilities Laboratories, Inc., for a day's workshop on the college Science Center.

A transcript of the day-long discussion has been compressed into the following report. We hope the reader enjoys the vicarious experience of sitting down with this group of articulate spokesmen for a spirited exploration of the problem of consolidating our college science facilities.



WHY BUILD A SCIENCE CENTER?

"It may help to put our discussion in proper perspective if we take up the Science Center from the point of view of the learning process. Let's try to identify the methods and the body of subject matter that will lead us to buildings as a symbol of these things rather than buildings as an end in themselves. When we talk about the sciences--in the context of the liberal arts college--are we talking about a unified body of subject matter?"

- "I think most of us would agree to that. And a good way to see this unity is to break down the various science areas and see how they blend together. For example, break chemistry down to inorganic and organic, and biology down to botany and zoology, and you find you have organic chemistry and botany coming together when you take up geology and the study of fossils. You could find many examples like this."

- "And to cite another: study of the molecule involves biology, physics, chemistry and even mathematics."

- "We can even diagram this unity. Putting a general body of knowledge in the center, around it you'd have physics working its way around through inorganic chemistry and organic chemistry, down to biology, and around to zoology and geology, up to astronomy and mathematics, and back again to physics. And with the tie from inorganic chemistry across to geology we have, in fact, a spherical diagram."

"Which science disciplines are commonly provided for the liberal arts undergraduate?"

- "Swarthmore College includes mathematics, physics, chemistry, biology, botany, zoology, engineering, and psychology. Geology could be included."

"Is there bridging among these subjects at Swarthmore?"

- "Yes. The chemistry majors, for example, have four years of mathematics, from two to four years of physics, and perhaps a couple of years in biology. We always bridge them over in this way. There is also a student club on campus called 'Science Integration.'"

- "At Wagner College, we would like to speak in terms of biophysics and biochemistry before we start to separate them. We are experimenting with this new approach to the curriculum, but we are handicapped until we have a Science Center where we can have biology, chemistry and physics all together."

- "New York City Community College now has a rigid separation between the biological sciences and chemistry and physics. We're starting a series of conferences soon to appraise our present program with what we want to have in the future. We are particularly interested in seeing if we can integrate the sciences in the first two years and reserve specialization for the third and fourth years. This is in line with plans to build a Science Center. We would even like to see a visual continuity between the various sciences so students would be exposed to different subjects at one time."

- "We have a committee working on ideas for a new science building at Calvin College. We haven't yet determined just what departments should be included. I wonder if psychology should be part of it, for it is a laboratory science?"

- "This raises a problem because psychology is not a single discipline. Clinical psychology is the biochemists' branch, but there are the experimental, or observational, psychologists whose claim to the use of the word 'science' is strongly resisted by many scientists."

- "Utica College also plans to build a Science Center on its new campus, and we hope it will free us from the science departmentilization we have had. We know that members of our staff are constantly going over from one discipline to another--a philosopher to electronics, a mathematician to chemistry, etc. It's a simple matter of gravitation because these people work together on research. We want to house these people in a building arranged so this interchange of specific scientific knowledge is more easily come by. We think that for a small college of a thousand students the Science Center has wonderful meaning."

"But the small colleges, even if they wanted to, are not able to build great temples, one for physics, one for chemistry, etc., on different parts of the campus."

- "That is true, but the philosophical consideration is the same, whatever the size of the college. Only when you get into graduate school is this degree of separation and specialization warranted."

"What about size? Is there a student body limit--in a liberal arts college--beyond which a Science Center is no longer practicable?"

- "I don't think we need to limit the Center to just the small college of 1,200 enrollment. Wagner College has a projected enrollment of 2,000-2,500 students and we believe that the Science Center is the ideal solution for this size."

"Do the economics of the thing enter here? Is it more economical to build one central building than three separate buildings?"

- "I think it could be demonstrated that it does not cost significantly more to do three or five buildings than it does to do one. A square foot is more or less a square foot no matter how you package it. A building is at most one-tenth the cost of running a school, and the faculties and services are the other nine-tenths."

- "But economics aside, I think we agree that the unity of the sciences certainly exists and that there are advantages for both the student and the teacher-researcher when the science disciplines are brought together. The question the scientist poses to the architect is: How can we translate this synthesis into an educational structure?"

BRIDGING OVER SUBJECT BOUNDARIES

If you bring the science disciplines together and house them in a Science Center, how can you take full advantage of their proximity to each other? In other words, what are some of the provisions for bridging across subject boundaries? The following excerpts from the discussion demonstrate the importance placed on this phase of educational experience.

- "The better students themselves are bridges, carrying what they learn from one class to another. And curriculum requirements insure a degree of bridging."

- "Students are bridges, and dormitories and dining halls are also bridging devices. So are college lecture series and student clubs. The students often generate this kind of thing. Swarthmore's 'Science Integration' club is an example. This is very much a bridging device. The students look over a list of Sigma Phi or foundation-sponsored speakers and find someone who is a Nobel prize-winner and they know this is a top person in biophysics, say, and invite him to the campus. These speakers often stay on for a day or two and the students take full advantage of their presence. This activity is encouraged by the faculty, of course."

- "On the larger campuses there have been fairly rigid barriers between departments--particularly between the chemistry and physics people. In the smaller colleges this has probably never been much of a problem."

- "But there is one fundamental relationship that all colleges might be more concerned with. And this is the relationship of the science-oriented people to the humanities-oriented people. The 'two cultures' that C. P. Snow talks about. This becomes a problem of communication."

- "Well, this again can be controlled to a degree by curriculum requirements. We believe that non-science students should have a year or two in the sciences, and that science students should get a grounding in the humanities. Most colleges have similar requirements unless they offer their catalogs on a cafeteria basis."

"What about science education for the non-scientist? Wouldn't it be a hopeless task to try to pile all scientific facts into him?"

- "We can teach him something of the spirit and methods of the sciences."

"What the non-scientist should understand are the history of science, how certain ideas came forth and were developed, how the scientist does his thinking, what his problems are, and how he goes about solving them. And this can be applied equally to the humanities and social sciences that the <u>science</u> student ought to study."

"Is there a place or a symbol of something which says that all of these science disciplines are fragments of some one thing? The expression of a centripetal force?"

- "This has to come through a desire to integrate things. It can be fostered in the curriculum through seminars on science philosophy and symbolic logic; in this case the seminar furnishes the place where these different ideas can be brought together. But this integration can come about informally, among the faculty, even where there is no particular provision for it. The physical chemist who is working on chrotomechanics may get a fellow from the physics department to come and help him work over some of his problems or even sit in on his classes. We try to impress upon our students that ideas are not departmentalized, that knowledges are old, and that they have to reach out to fill in the gaps in their understanding."

"Then is this integration just a matter of chance? A couple of specialists getting together in a classroom or a laboratory? In other words, you can't find an Aristotle, who has full possession of knowledge in all the disciplines in that circle, and put him in the center!"

- "In lieu of core space for Aristotle, might we consider building into the Science Center, not just another office, but a place where members of this group would tend to congregate? The only place that approximates it now is the faculty club, and many colleges do not have even this."

- "A few chairs around a pot of coffee. Yes. This is generally where the greatest cross-fertilization comes about."

- "And some blackboard space and a door that will close off interruptions."

- "We shouldn't shut the students off from this professional give and take. This cross-fertilization may nurture a seed in the student's brain, too."

"Many students see the professorial life only from the wrong side of the desk. Can a Center's plans be arranged to give the possible future teacher a view of life from our side of the desk? Couldn't we let the students look over our shoulders in some way? This business of attracting people to college teaching is something that we want very much; perhaps the architecture could help."

- "This could be provided through a place where the faculty could congregate and talk things over and where the students could come in and listen if they want."

- "We covet privacy, but we should be willing to abandon some privacy for a good cause such as that of promoting the interest of other people in our profession."

LABORATORIES AND THE STUDENT

It is held in certain quarters that scientific instruction is not thorough unless there is laboratory experience. It is held in others that there is no such thing as scientific method. We assume that it is from the laboratory experience that youngsters get the notion of scientific methods. But C. P. Snow, Bruno, and others say now that the essential ingredient of discovery is intuition and not method. Who is right? The answer makes a vital difference in the design of a science facility.

- "As a scientist, I would say that there is no scientific method per se. If there is a scientific method, it is just the ability of the scientist to take any method at hand and apply it to a particular problem. In courses in philosophy they used to outline the scientific method but it just does not work that way. The mathematician takes any means at hand and solves his problem without following through these steps. But he can do this because he has had experience in doing it. He knows the modes of attack in solving a problem and he gets one to work."

"Does this mean we don't need laboratories for science teaching?"

- "I would say that the laboratory is not essential. Science can be taught pretty well without a laboratory, but it can be very valuable--depending on how laboratory work is taught. The laboratory period can be the busiest part of the day with the instructors continually peering over the shoulders of the students, posing new questions from the answers. This kind of informal laboratory instruction which is tailored to the need of the particular individual can be very valuable."

- "I agree that there is no single scientific method, but this is no argument for eliminating the laboratory. There are many scientific methods. There was the so-called doctor process--the five famous steps that appeared in every textbook before 1940 and in none since, which shows that they were completely false. But there are many methods: the deductions from a theory, the extension of theoretical predictions and, finally, just sheer chance. You could support each of these by discoveries that have been made. Dr. Bacquerel discovered radioactivity perhaps by sheer chance. Davisson and Germer did their experiment on the wave nature of electrons by deductions from a theory. Each of these methods lead to discoveries, but the important point is that the discoveries were made in laboratories. We have to have laboratories because these laboratory experiences are the raw stuff of which we make the theorectical synthesis that we call science. In other words, science progresses by a series of theorectical constructions which were conceived in the laboratory, corrected, rejected, etc. And I believe that the science student must have this experience just as much as the scientist."

- "I think, too, that the very inspiration the students have in working in the laboratory, and the skills they acquire in handling the apparatus, help to reinforce the learning process."

- "There are some students who have the ability to learn in the abstract, to make visualizations and to form concepts without the use of the muscular or the kinesthetic. But others learn best by getting their hands dirty, so to speak, handling laboratory apparatus and conducting their own experiments."

"Isn't this contrary to Oppenheimer's famous stricture against 'cook book chemistry' where we kid the students into thinking they are doing an 'experiment' when we already know the results in advance?"

- "That would depend on how you conduct your laboratory work. If you do an experiment based on some theory and it does not turn out the way you think it should, then you should find out why. And this interplay between trial, explanation, re-trial, and better explanation becomes an exciting laboratory experience in itself."

RESEARCH AND THE PROFESSOR

Laboratory facilities for teaching science to students are one thing. What about the research facilities the faculty members might need, independent of their teaching? This becomes more of a problem in the larger universities where scientists might be working on a government contract, but presumably it is a problem in the smaller colleges as well, as the following comments indicate.

- "It is very much a problem. Nothing eats up space any faster than the faculty member who has research ideas and support behind him."

- "On the other hand, nothing helps colleges recruit able faculty members more than being able to show them some unassigned space, with the necessary services, which they can move into for research programs. If you have some research space which is not rigidly laid out, you have a wonderful talking point for getting a good man."

- "I know this from first-hand experience. One of our building committees reported to us that we had to build a certain facility because a new professor came to the college on that condition. It seems he would come only if he could bring all his monkeys, so we had to build monkey cages at the place."

- "And on the sure knowledge that the next man might bring guinea pigs, you had better build a convertible cage!"

- "Our faculty members see their primary job as teaching. They don't compete for private space for private research. They look on teaching as a cooperative process and the chemists know they can't do it without the aid of the physicists and mathematicians, etc. They all do some research, but it is incidental to their teaching."

- "Colleges can control this to a degree. If they grant promotions to the men who have published research and ignore the fellow who is spending a lifetime teaching and stimulating young people, they are bound to bring on a competition for research space."

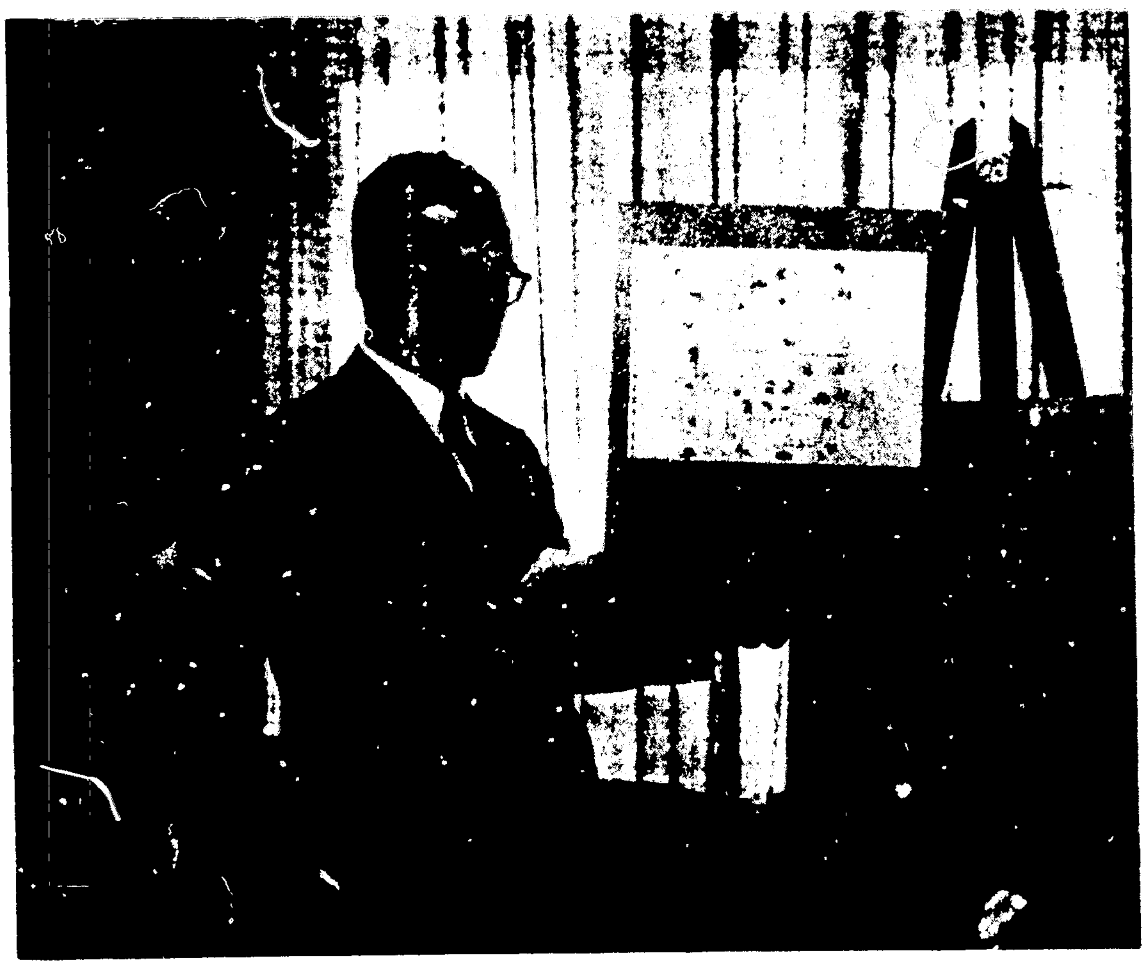
- "Faculty research becomes important to instruction if the students are let in on it. This increases student interest considerably."

"Getting back to the institution that has to provide research space in order to attract top science people, don't we have the tail wagging the dog here? We agree that as far as laboratory space and good scheduling are concerned, the sciences can be housed in one building. But if you want to provide a lot of research facilities for individual instructors you may find yourselves giving over too much space for this function. You have a proposition here that is expensive and unwieldy."

- "Isn't most of the research space in the colleges now underwritten by the government?"
- "Yes, there are seven or eight large state universities in the country whose Federal Government research program provided more than 50 percent of their income last year."
- "That is not true of the liberal arts colleges, however."
- "But even the college that does get a government contract has to provide the space itself."

"Let's turn this problem around. I understand that some colleges are concerned because the professor meets his classes and then gets in his car and heads home. They would like to have him stay on the campus and do his thinking and his work, to be physically present so that he comes into more contact with the students. One college says its men go home because it is too uncomfortable for them to stay. They can go home, sink into a comfortable chair, relax and feel human."

- "And turn on the air conditioner."
- "Yes. This college made a number of changes in its faculty office space. It installed carpeting, comfortable chairs and acoustical privacy. They thought this might induce the professors to stay around the campus longer."



C. William Brubaker
Partner, Perkins & Will

SCIENCE CENTER LAYOUTS--ACTUAL AND THEORETICAL

As part of the reference materials for the workshop, a series of sketches were prepared by Perkins & Will partner William Brubaker.

Florida Presbyterian College, St. Petersburg, Florida (1200 students): "A complex of three or four elements joined together--a central large lecture area with preparation rooms behind it; two general physics labs, two general biology labs, and a chemistry facility; some advanced spaces without specific labels, and then a series of flexible 12-foot-square spaces which can be reassigned for faculty research and for advanced students. This could be diagrammed as general introductory space moving toward more specialized spaces."

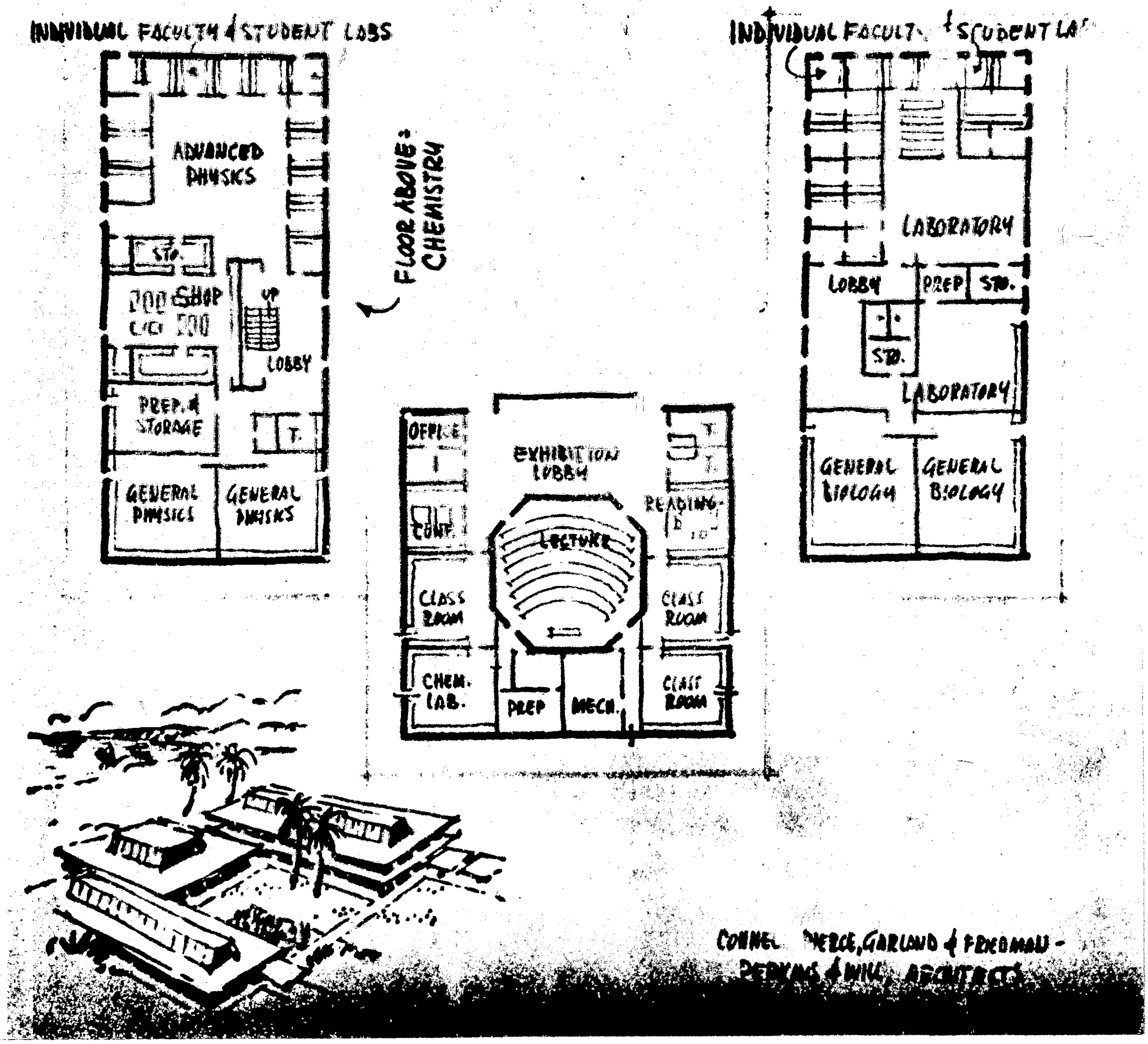
St. John's College, Annapolis, Maryland: "This combines, interestingly, a science center with an art center. The science area is a conventional two-floor plan with central quarters, offices and project rooms along one band, and a wider band for laboratories. A planetarium pulls out of these special buildings."

Lake Forest College, Lake Forest, Illinois (1200 students): "A typical laboratory floor, of which there are three plus basement, consists of a lecture place and service preparation-storage area in the center, and clustered around these are laboratories. One of the special things here is a science library."

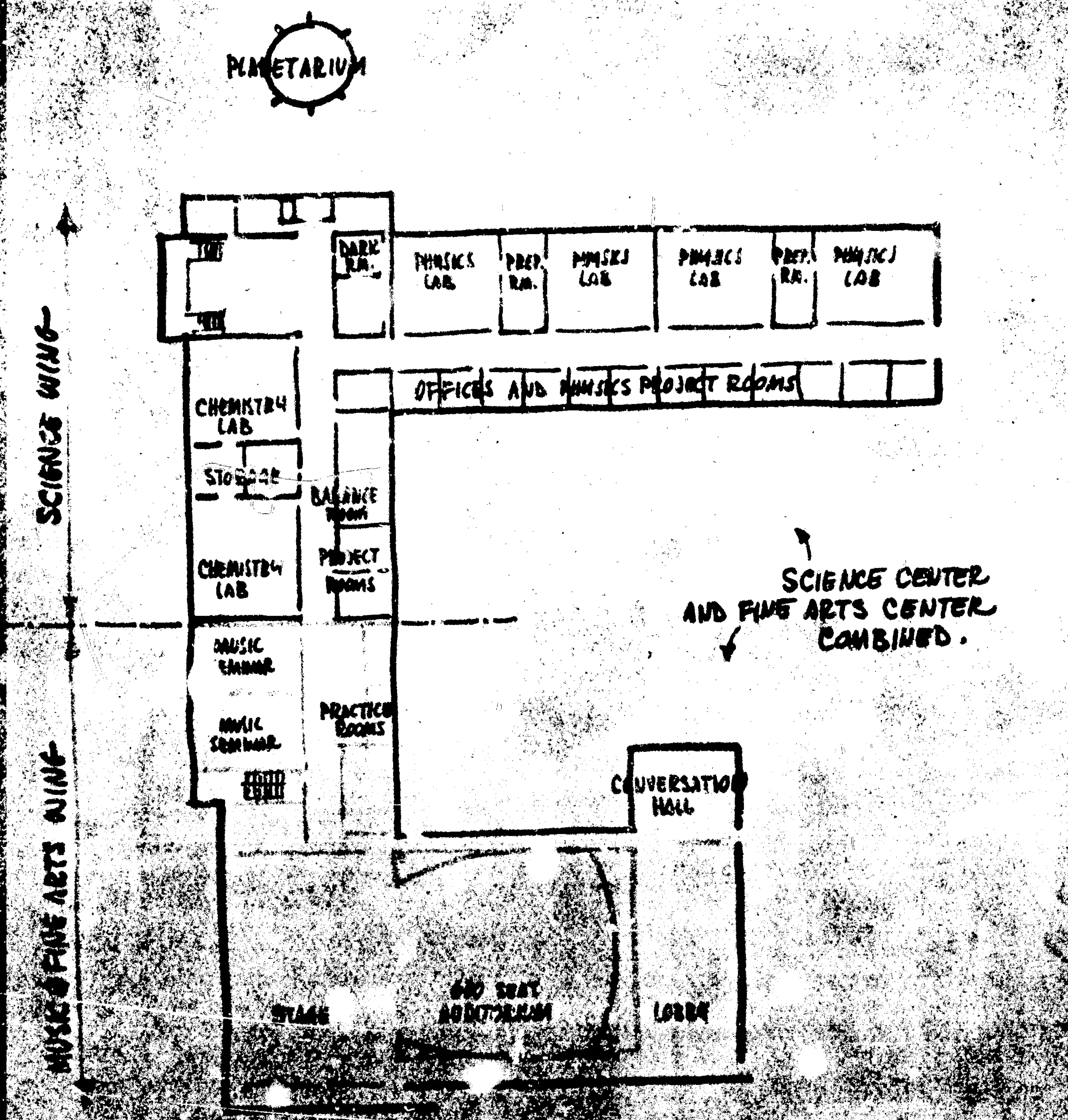
Hiram College, Hiram, Ohio (1200 students): "An expanded 4-story science building. Enlarged ground floor will consist of physics classroom, physics shop, general physics lab, radiation lab and advanced physics space. Second floor will have general and organic chemistry labs, lecture room, storage and faculty offices. Third floor will have more chemistry space, and fourth floor will have biology space."

Grinnell College, Grinnell, Iowa: "A rather typical building with a rather conventional arrangement of spaces for the various subjects. The science library is assigned space on the first floor of the two-story building."

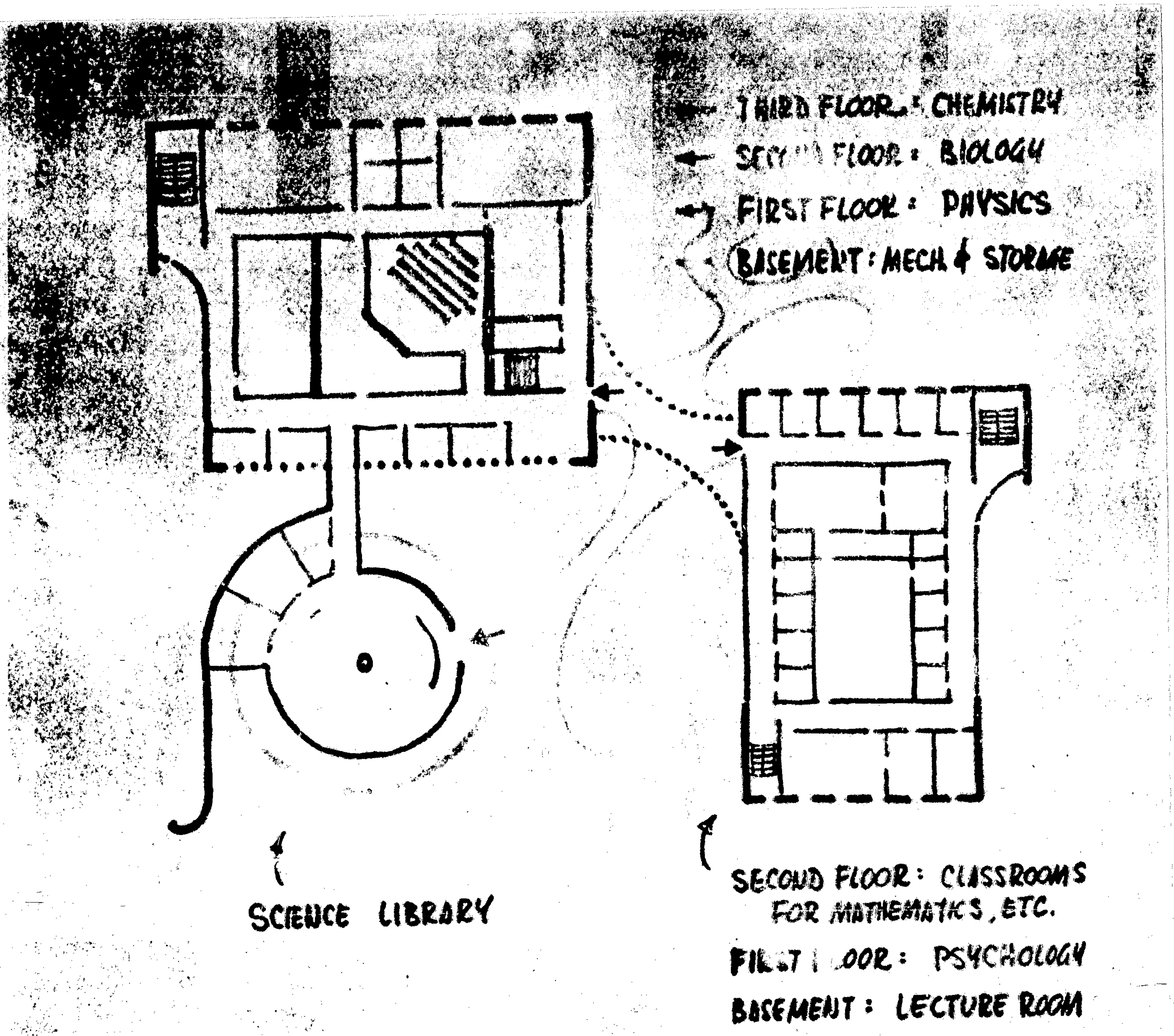
SCIENCE CENTER
FLORIDA PRESBYTERIAN COLLEGE
ST. PETERSBURG, FLORIDA



CONNELL, PIERCE, GARLAND & FRIEDMAN -
PERKINS & WILL, ARCHITECTS

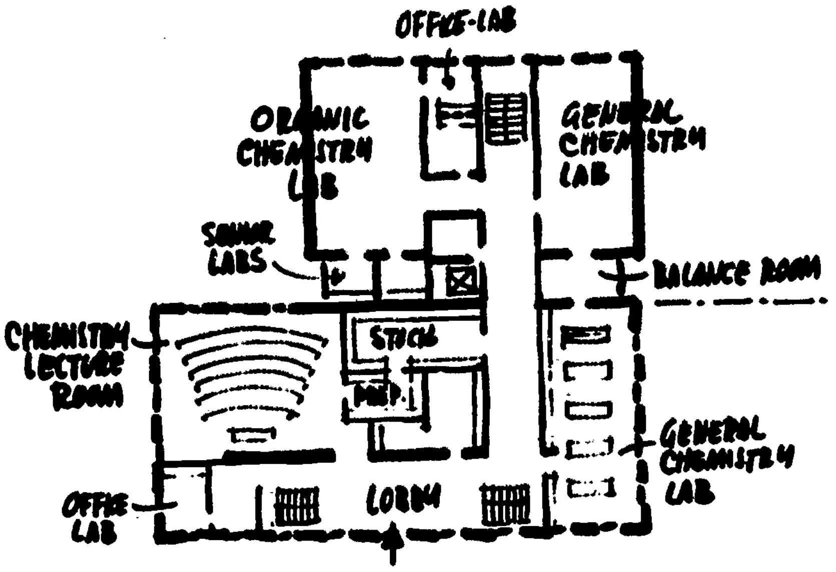


FRANCIS SCOTT KEY AUDITORIUM, MELLON LABORATORY, McKELDIN PLANETARIUM
ST. JOHNS COLLEGE - ANNAPOLIS, MD.

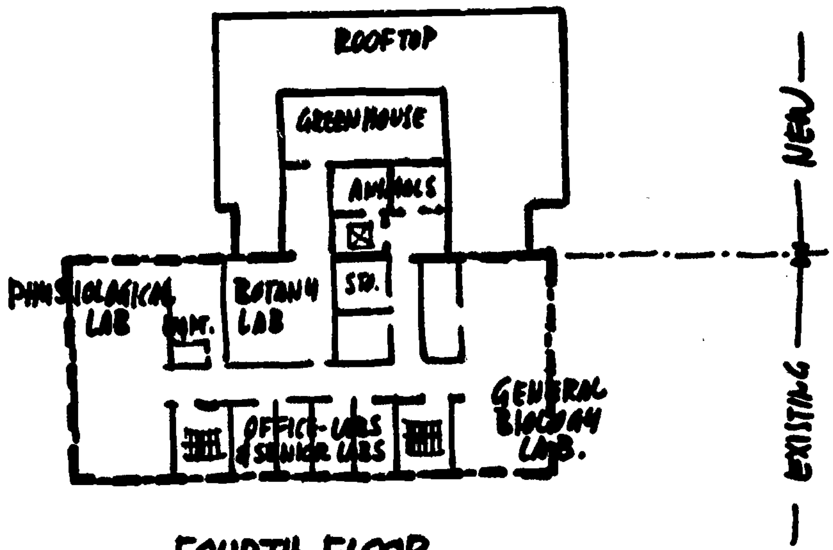


HALLS OF SCIENCE
LAKE FOREST COLLEGE
LAKE FOREST, ILLINOIS

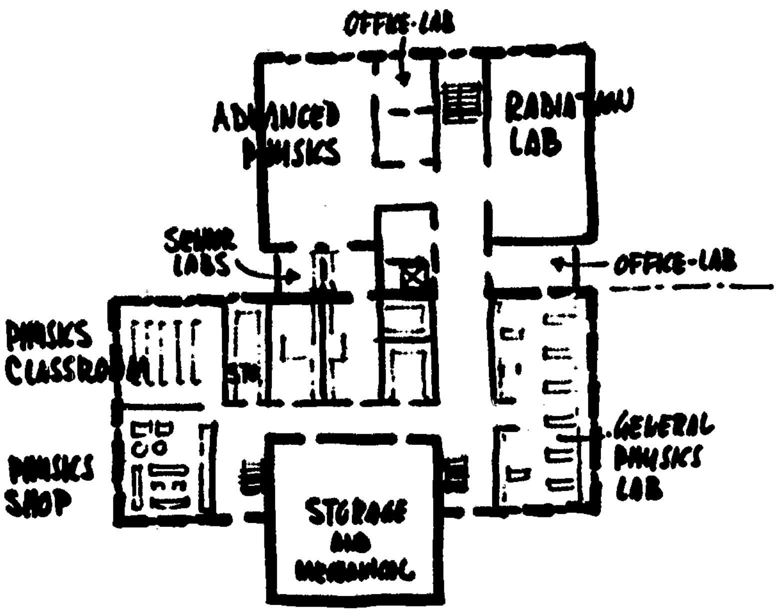
PERKINS & WILL, ARCHITECTS



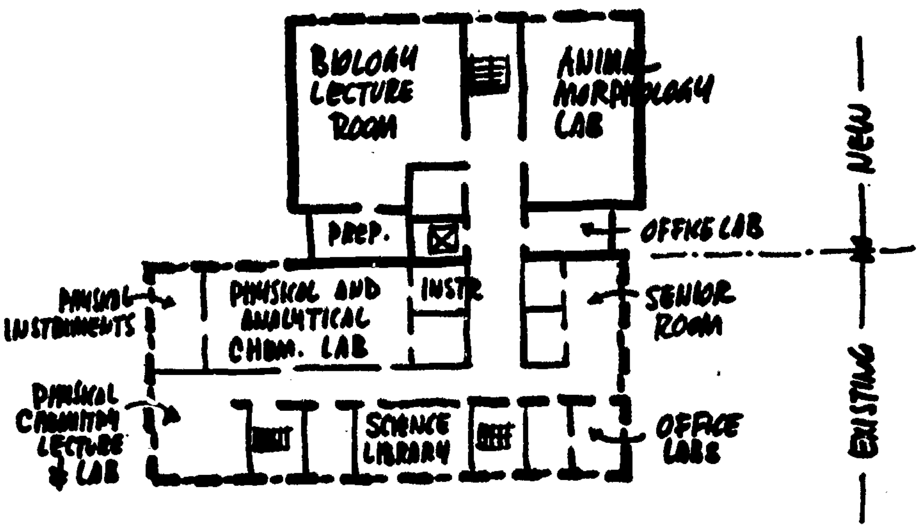
SECOND FLOOR



FOURTH FLOOR



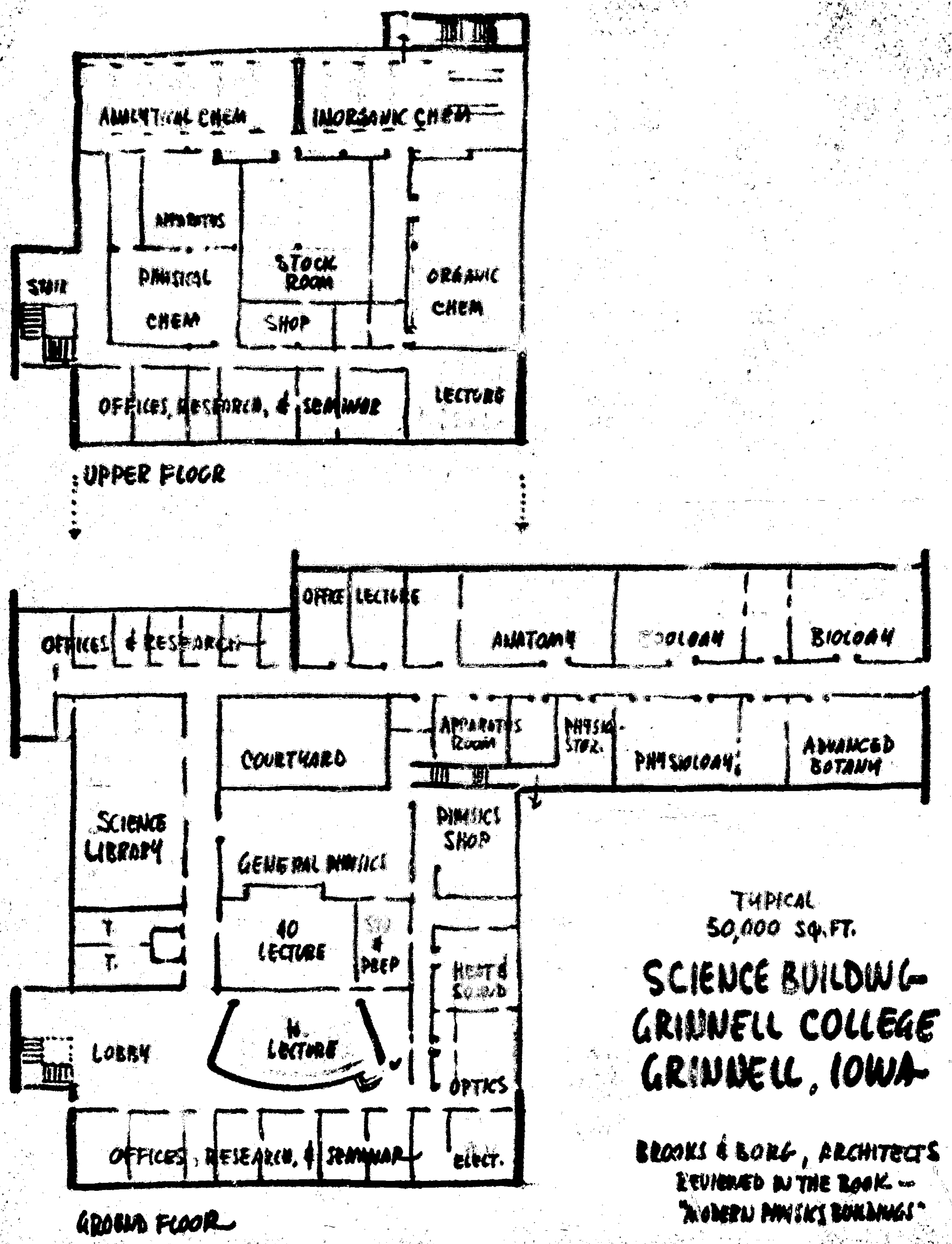
FIRST FLOOR



THIRD FLOOR

PERKINS & WILL, ARCHITECTS

EXPANSION OF EXISTING SCIENCE BUILDING
HIRAM COLLEGE HIRAM, OHIO


ANALYTICAL CHEM
INORGANIC CHEM
APPARATUS
STAIR
PHYSICAL CHEM
STOCK ROOM
SHOP
ORGANIC CHEM
OFFICES, RESEARCH, & SEMINAR
LECTURE
UPPER FLOOR
OFFICE
LECTURE
OFFICES & RESEARCH
ANATOMY
ZOOLOGY
BIOLOGY
APPARATUS ROOM
PHYSIO. STOR.
PHYSIOLOGY
ADVANCED BOTANY
COURTYARD
SCIENCE LIBRARY
GENERAL PHYSICS
PHYSICS SHOP
40 LECTURE
STO & PREP
T.
T.
HEAT & SOUND
LOBBY
LECTURE
OPTICS
OFFICES, RESEARCH, & SEMINAR
ELECT.
GROUND FLOOR
TYPICAL
50,000 SQ. FT.
SCIENCE BUILDING - GRINNELL COLLEGE
GRINNELL, IOWA
BROOKS & BORG, ARCHITECTS
REVIEWED IN THE BOOK -
"MODERN PHYSICS BUILDINGS"

The primary concern of the workshop was to study the possibilities for science facilities at the small school. It did seem appropriate, however, to look at developments in some of the larger schools and a glance at what industry is doing. The following illustrations take us away from the small liberal arts college, but they are interesting developments that may have application.

Earth Science Building at MIT: "Because of site limitations, it had to take a skyscraper shape. It is built structurally with bridge-like trusses to give an absolutely clear floor area. All of the mechanical elements are at one end. A vast lecture hall could use an entire floor, while a typical floor is subdivided into several classrooms and seminar rooms."

Science Complex at the University of Denver: "The problem here was a three-way integration--the basic chemistry, math and physics studies which had been in the arts and sciences school; metallurgic, chemical, electrical, civil and mechanical engineering which had been in the engineering school; and the research institutes which do many government contracts and relate closely to electronics, chemistry, metallurgy, mechanics and physics and which had been utilizing temporary buildings. The new facility is more or less split two ways: chemistry, metallurgy and chemical engineering are one side with fume and special utilities; and physics, math and electronics are on the other side where there is a need for vibration or free space. It is oriented so that the facilities used by the students are closest to the campus while the research facilities for the research client are approached from the other side, though within there is intermixing."

Other diagrammed programs on the following pages are:

Medical Research Building, University of Pennsylvania, Philadelphia

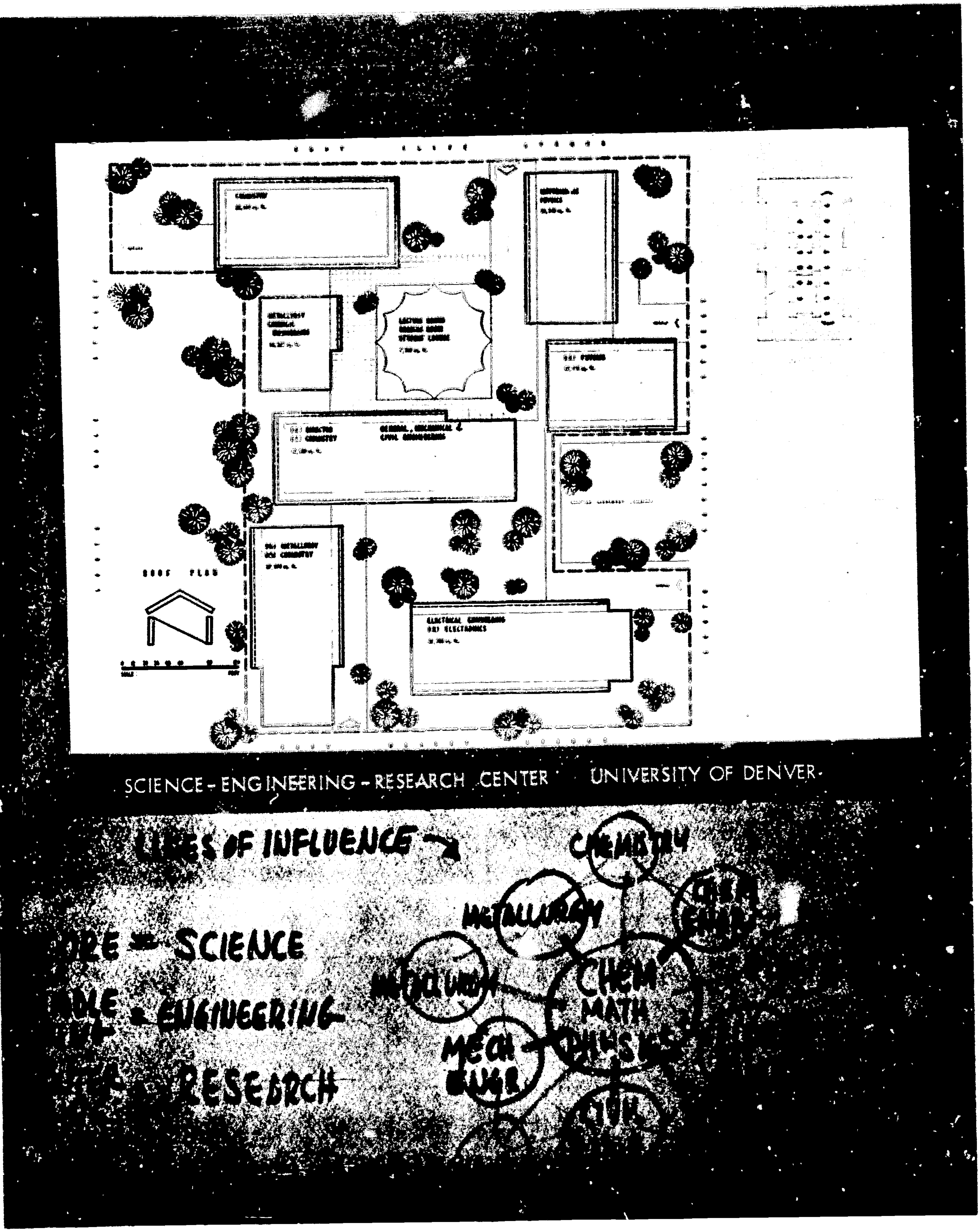
IBM Laboratory, Yorktown Heights, New York

Chemistry Building, Unit I, University of California at Berkeley

Biology and Geology Laboratory, Rice Institute, Houston, Texas

Science and Pharmacy Buildings, Drake University, Des Moines, Iowa


LECTURE HALL
SEMINAR ROOMS
CLASSROOMS
EARTH SCIENCES BUILDING
MASSACHUSETTS
INSTITUTE OF TECHNOLOGY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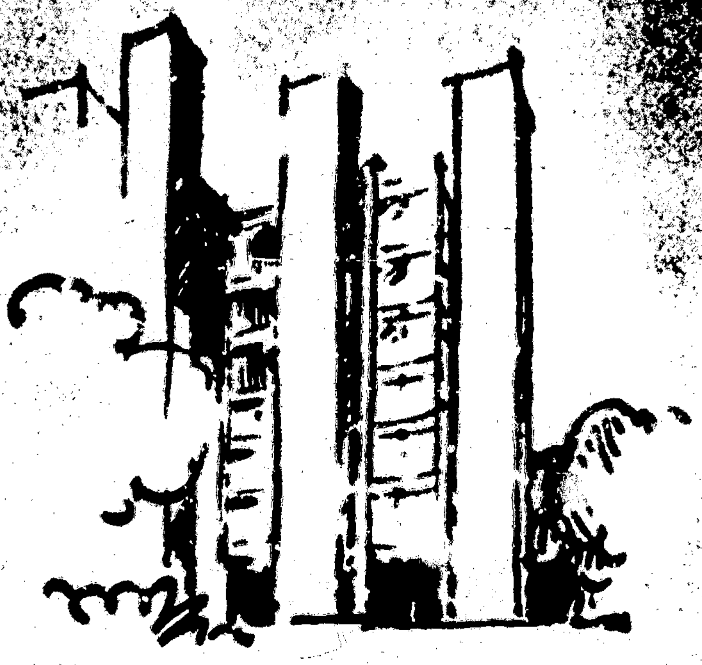
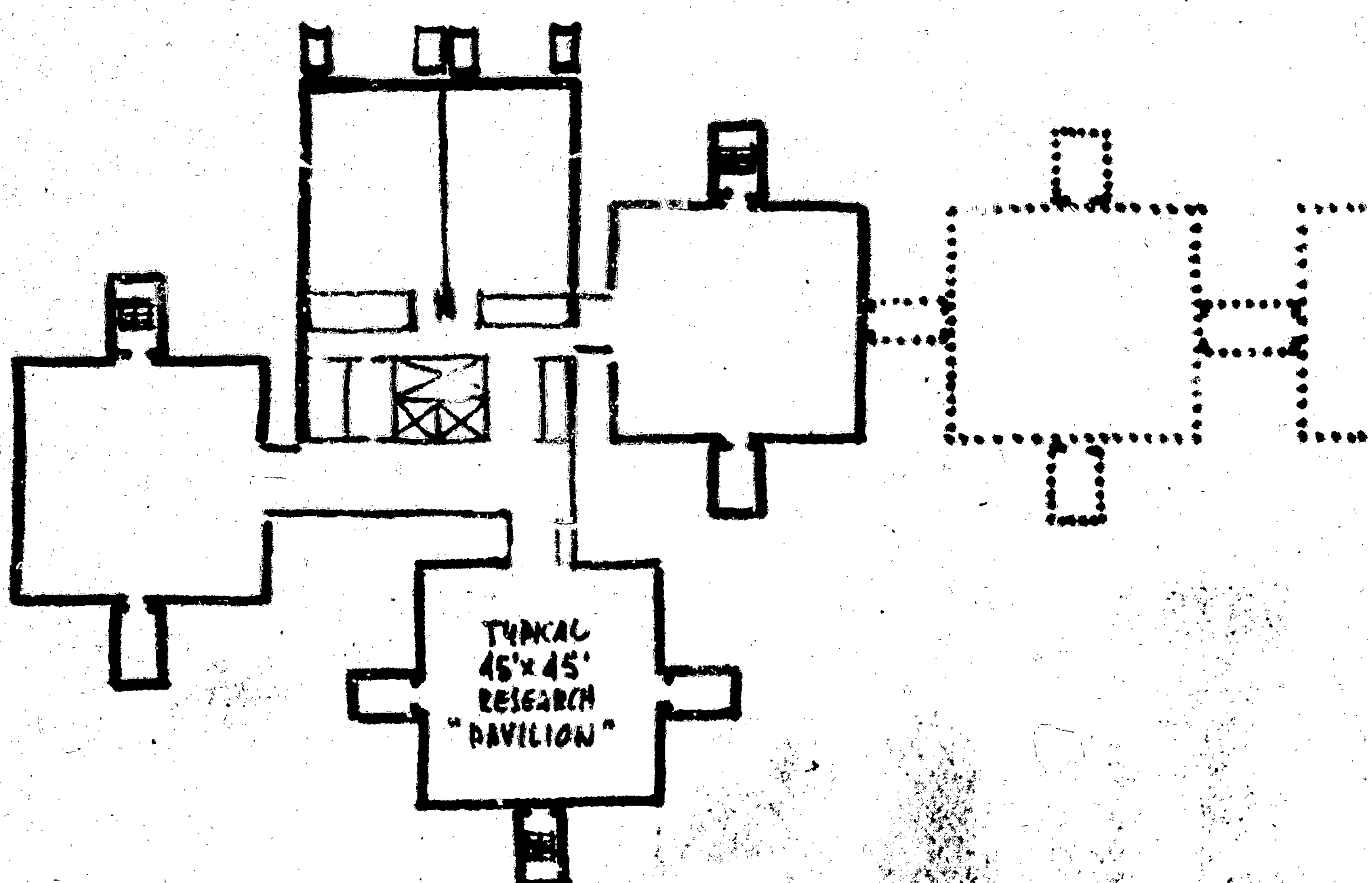
SCIENCE
ENGINEERING
RESEARCH
METALLURGY
CHEM
MATH
MECH

ALFRED NEWTON RICHARDS
MEDICAL RESEARCH BUILDING –
UNIVERSITY OF PENNSYLVANIA –
PHILADELPHIA, PENNSYLVANIA –

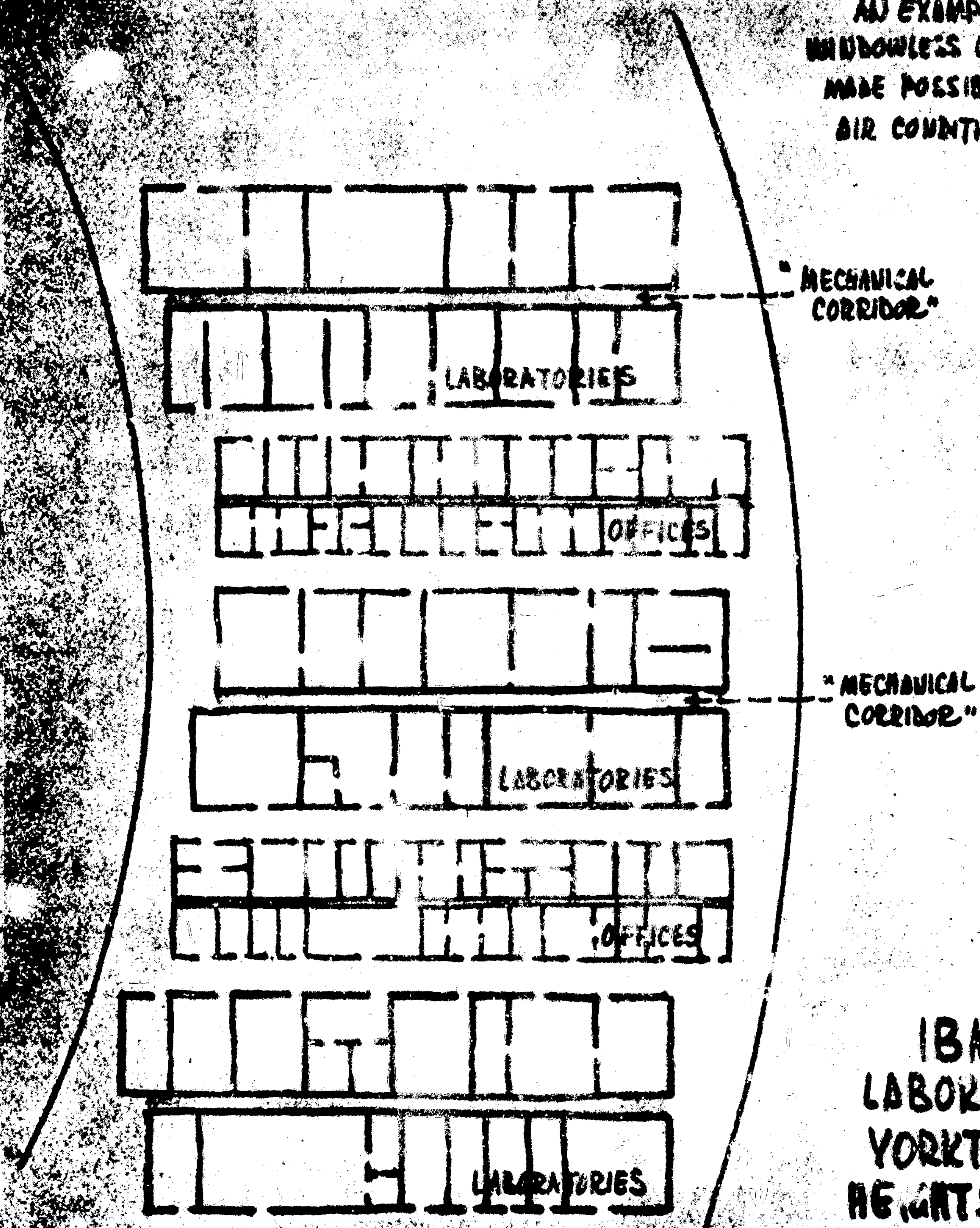
"SERVED AND SERVANT SPACES"
FOR MEDICAL RESEARCH
(ESPECIALLY WITH ANIMALS)





LOUIS I. KAHN, ARCHITECT
ARCHITECTURAL FORUM
JULY 1960

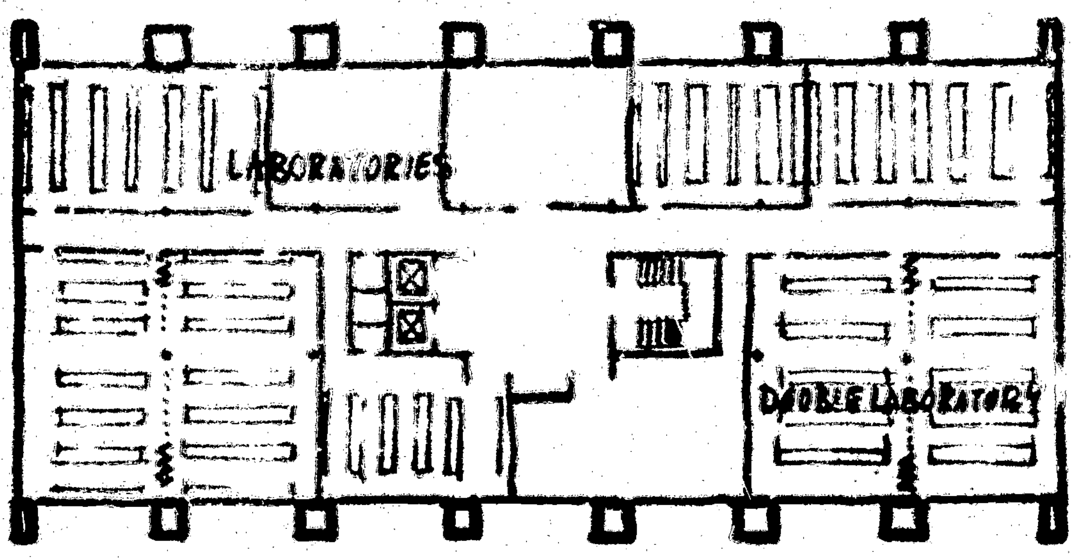
AN EXAMPLE OF WINDOWLESS LAB SPACE MADE POSSIBLE BY AIR CONDITIONING.



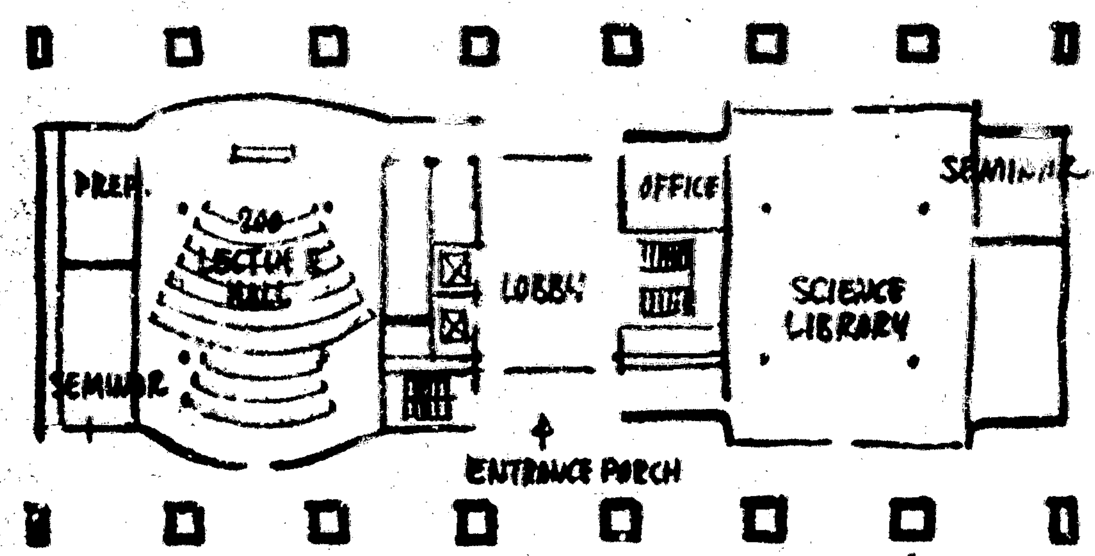
IBM LABORATORY YORKTOWN HEIGHTS, N.Y.

EERO SAARINEN ARCHITECT

ARCHITECTURAL FORUM FEB. 61



UPPER 7 FLOORS

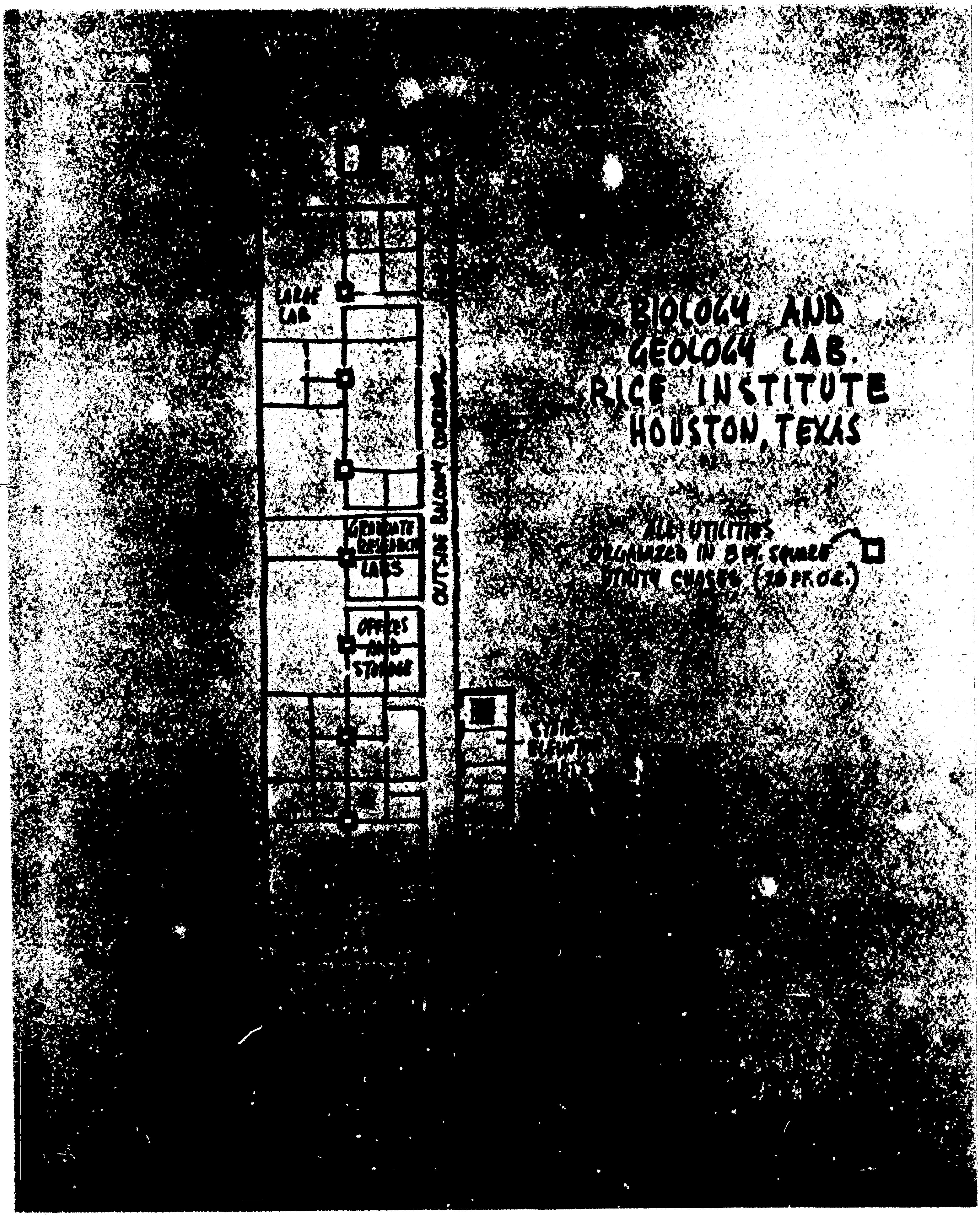


GROUND FLOOR

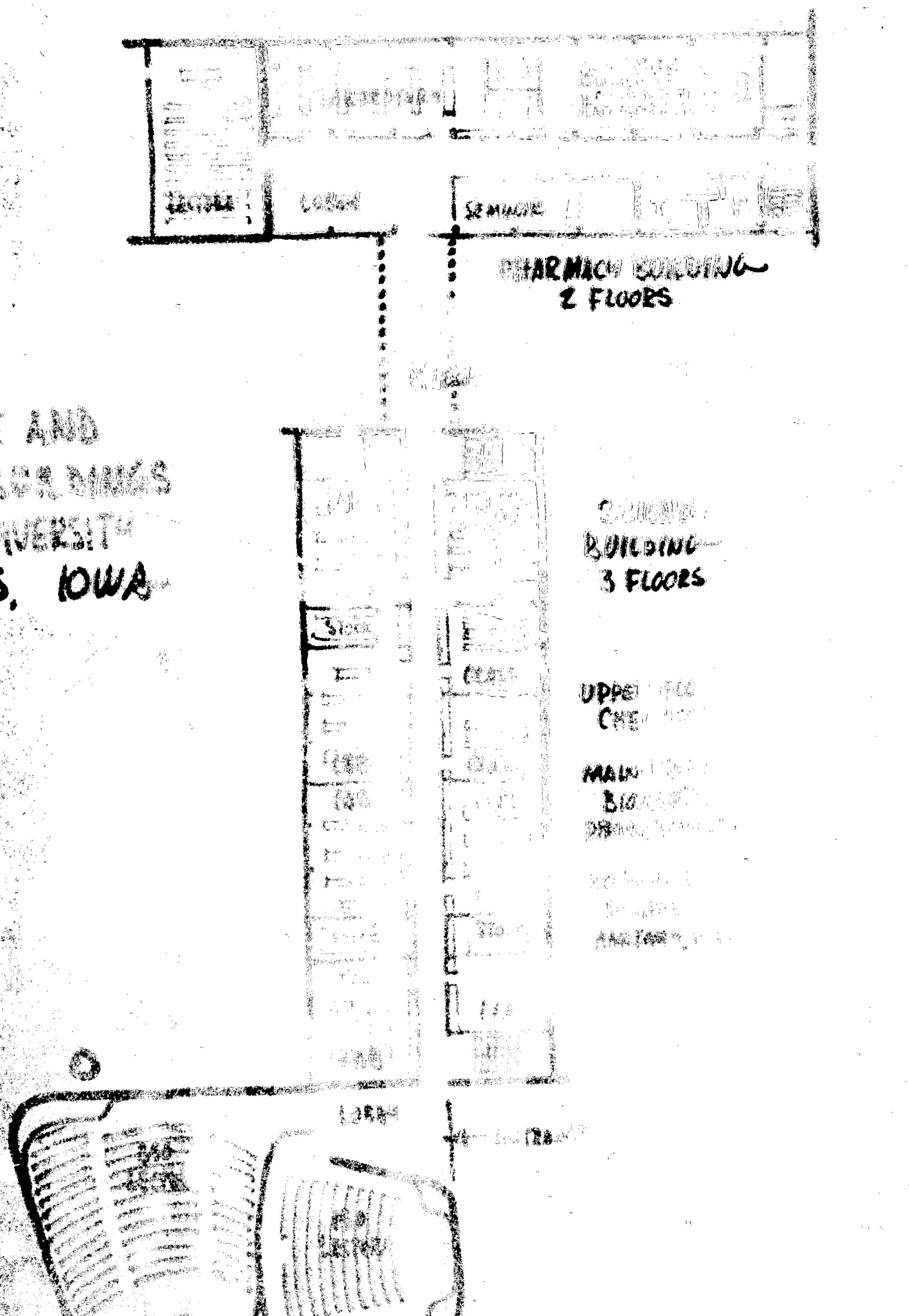
VENTS AND PIPES INTEGRATED WITH STRUCTURAL COLUMNS

CHEMISTRY BUILDING, UNIT I
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA

ANSHEN & ALLEN
ARCHITECTS
ARCHITECTURAL RECORD
SEPT 1960


BIOLOGY AND
GEOLOGY LAB.
RICE INSTITUTE
HOUSTON, TEXAS
LARGE LAB
GRADUATE RESEARCH LABS
OFFICES AND STORAGE
OUTSIDE BALCONY CORRIDOR

SCIENCE AND
PHARMACY BUILDINGS
DRAKE UNIVERSITY
DES MOINES, IOWA



PROGRESSIVE ARCHITECTURE NOV '50

DISCUSSION:

"We'll look at Swarthmore's new Science Center in more detail later. But perhaps these have triggered some general observations or suggestions."

- "Wouldn't a hub arrangement be the most flexible and economical of space? Some hospitals have even begun to experiment with this kind of layout, because in the typical ribbon arrangement they have found that what nurses do the most of during their tour of duty is walk. Would it make good sense in science buildings to put the service tools in the hub and radiate the spaces out from it?"

- "Yes, this might work as well in a large university as in a small liberal arts college. Suppose you put the common facilities in a central core--the faculty offices, some of the common classrooms, lecture rooms, etc. And have the departments of physics, chemistry, biology, etc., branch out radially. Each of these departments would face out to allow for expansion and each would have its own building, yet they'd all be linked to the administrative or coordinating core."

- "This hub could also serve as a communication core--a place for intermingling of students and faculty."

- "There might be an objection here. Many chemists and biologists would prefer to have their offices not in the core but out on the periphery, because they do a lot of experimental work at their desks. They couldn't do much concentrated work if they sat in the middle of a communication hub."

- "This could be satisfied by putting the teachers offices on the periphery and by having only the deans and department heads located centrally."

Dr. Walter Keighton
Department of Chemistry
Swarthmore College

CASE IN POINT: SWARTHMORE'S SCIENCE CENTER

Educational Planning

"Swarthmore College obtained money for the Science Center quite by surprise in December, 1957. The raw plans were approved in April, 1958, and ground was broken in July, 1958. The Center was occupied in the fall of 1959. Despite this quick schedule, the building was carefully and soundly planned.

"The architect asked us what we wanted, how this was related to that, which should be next to what and why, what the traffic problems were, etc. He put our answers into diagrams to show these relationships and we looked them over, criticized and amended them, and finally he drew a rough floor plan. We tore this apart, and based on the faults we found with it he drew another plan. The third plan was accepted, and from there on it was a matter of getting the details onto it. The general arrangement had been worked out.

"A committee, composed of one man each from chemistry, physics and math, a college engineer, and the architect's project manager, followed the whole course of construction. They met one day each week, and occasionally more often, for two years. In planning the details, the architect would make a proposal which the committee would study and then accept or reject. The committee members travelled around to other campuses to see what was done elsewhere. This is the way you come up with a building with which you can find virtually no fault. We had one minor problem of keeping the sun and heat out of a couple of laboratory-offices that faced south (venetian blinds worked but tinted glass did not), but this has been solved through ventilation. Nothing else has troubled us because we worked all these things out as we went along, in spite of the speed of construction. We got exactly what we wanted because of the close cooperation between the architect and everybody concerned. This is a point to remember. The amount of time you can put in with the architect will be well repaid."

Layout of Spaces

"The Science Center is made up of four buildings: chemistry section; physics section; science library which houses physics, chemistry, mathematics and temporarily engineering; and auditorium. These are linked together around a central court. (It doesn't contain the total science curriculum; another building put up some 15 years earlier houses biology, zoology, botany and psychology.)

"Physics Section. This has two floors--ground level and below-ground level (below-ground for temperature stability and because of need for lots of dark rooms).

On the ground floor are two laboratories for general physics with classrooms beside them separated by flexible curtains. This is a convenient arrangement; the classrooms can be in use in the morning while the physicists are setting up an experiment in the laboratory; then in the afternoon the curtains can be pushed back and the classrooms serve as a place where students can work with their notebooks. These rooms are fitted with tables that can be moved around or into any pattern that is desired.

"Chemistry Section. This has two floors plus basement. The basement level has metal and wooden shops, mechanical service and chemistry storage. The ground level has the dispensing room, large introductory chemistry laboratory with balance room and preparation room attached to it, a small lab for advanced inorganic chemistry, and the physical chemistry lab with instrument room and darkroom adjacent to it. On the floor above are analytical lab, chemistry lab, two organic chemistry labs, and laboratory-office combinations for the instructors. These offices face one side of the courtyard. Offices for the physics and mathematics staffs are on two other sides of the court.

"Auditorium. This can be shut off from the rest of the Center so that it can be opened in the evening for general use. But it is primarily for demonstrations and lectures for physics and chemistry, so there is a physics preparation room on one side of the stage and a chemistry preparation room on the other, and a small five-foot cable with all the services (water, gas, electricity, etc.) in the middle. Blackboards are motorized--push the switch and the blackboard goes up--as are the screens and dimmers. There are projection booths at the rear.

"Library. This is one of the advantages of the Science Center. Before the Center was built, chemistry, physics and mathematics each had its own library in its own building. They were unattended except for the faculties looking in and the department secretary checking up on books now and then. Now we have a library for all three disciplines and a professional librarian to look after it. The library can also be shut off from the rest of the building and is kept open every evening until 11, whereas the rest of the Center is closed at about 6 pm. Students who formerly might have spent all their reading time in the chemistry library, say, now check the physics and math shelves which are just as handy to them. There is much more reading across the departments than before."

Questions & Answers

"You say physics, chemistry and mathematics were previously in separate buildings?"

"Yes."

"Has the Center promoted faculty intermingling?"

"Yes. We did intermingle before, but it took effort because we were widely separated. Now it is so easy. Right next to my office (chemistry) there is a physicist. The other day I had a minor problem not worth trotting far to find the answer to, but it was so convenient to be able to walk a few steps to his office and get an answer."

"Your Center houses three departments that may grow at different rates. How will you handle such change?"

"It is possible to expand the building by adding a wing to the chemistry section. The library can also be expanded. However, we don't expect to increase the enrollment much beyond its present size."

"But what if there were a shift in emphasis and one department needed more space and another needed less?"

"It would be possible to juggle space between physics and chemistry. We've had a drop in freshman chemistry and physics and an increase in mathematics, but this increase takes only classroom space. We don't foresee computers. One of our professors uses a computer at Pennsylvania now, and if we installed our own it would probably be put in the engineering building anyway. All of the laboratories, while they're specifically assigned on the floor plan, could be used for mostly any kind of laboratory."

"Do you have the problem of a professor identifying too closely with his laboratory--of it becoming 'his own' space?"

"No. The laboratories are not built in such a specialized way that anybody can lay claim to them. Each professor has his office, but beyond this I think it is a waste to tie up space to a particular person."

"Is your classroom space flexible enough so that a spillover English class could use a mathematics classroom?"

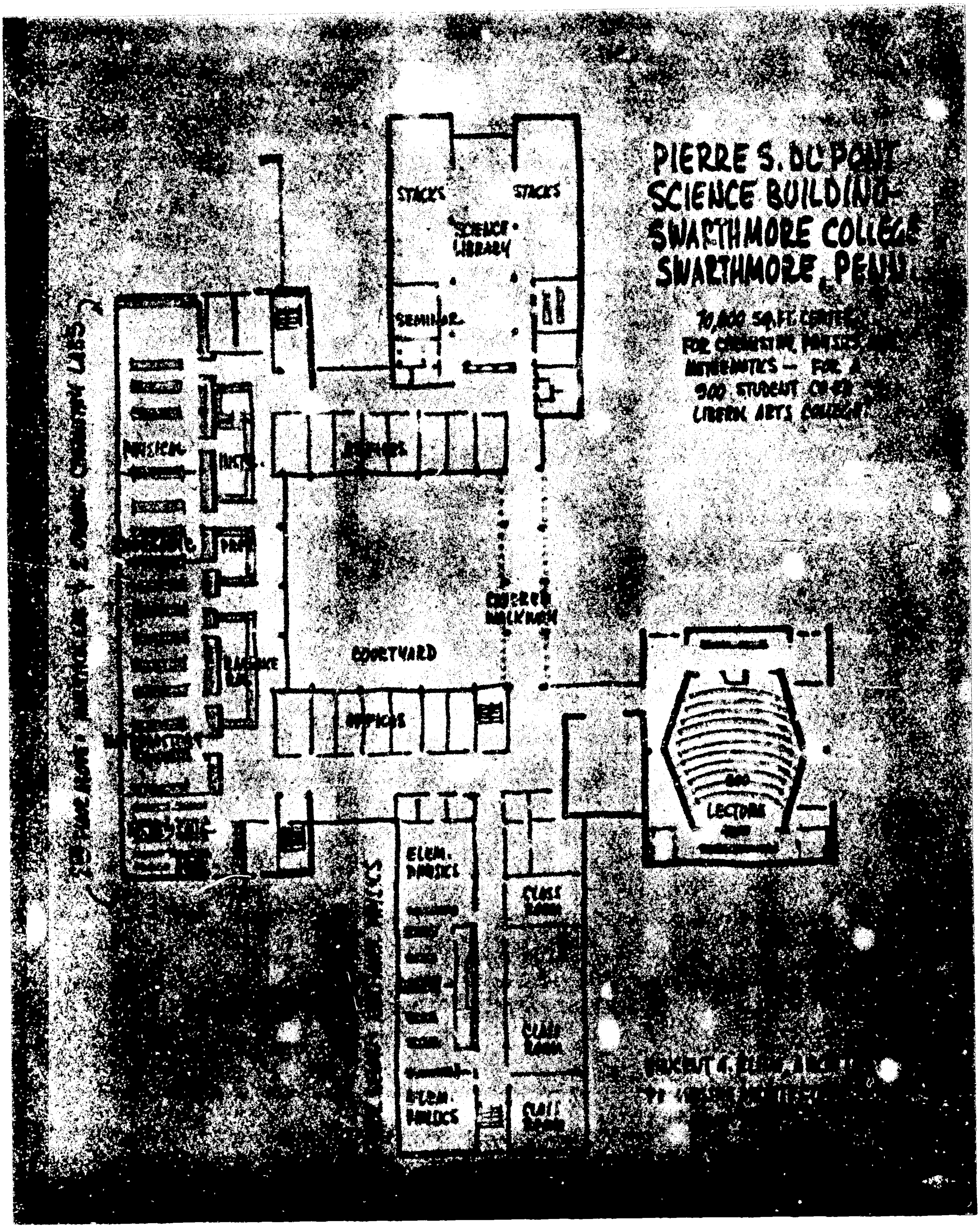
"Yes, it can and it does. The classrooms are all scheduled by the registrant. We have nothing to do with that. We also have four seminar rooms--two in the chemistry section, one in the physics section, and another adjacent to the library, and these are all freely interchanged. Even the history and biology departments use them. They are scheduled through one of the secretaries; when someone wants a seminar room, she assigns it."

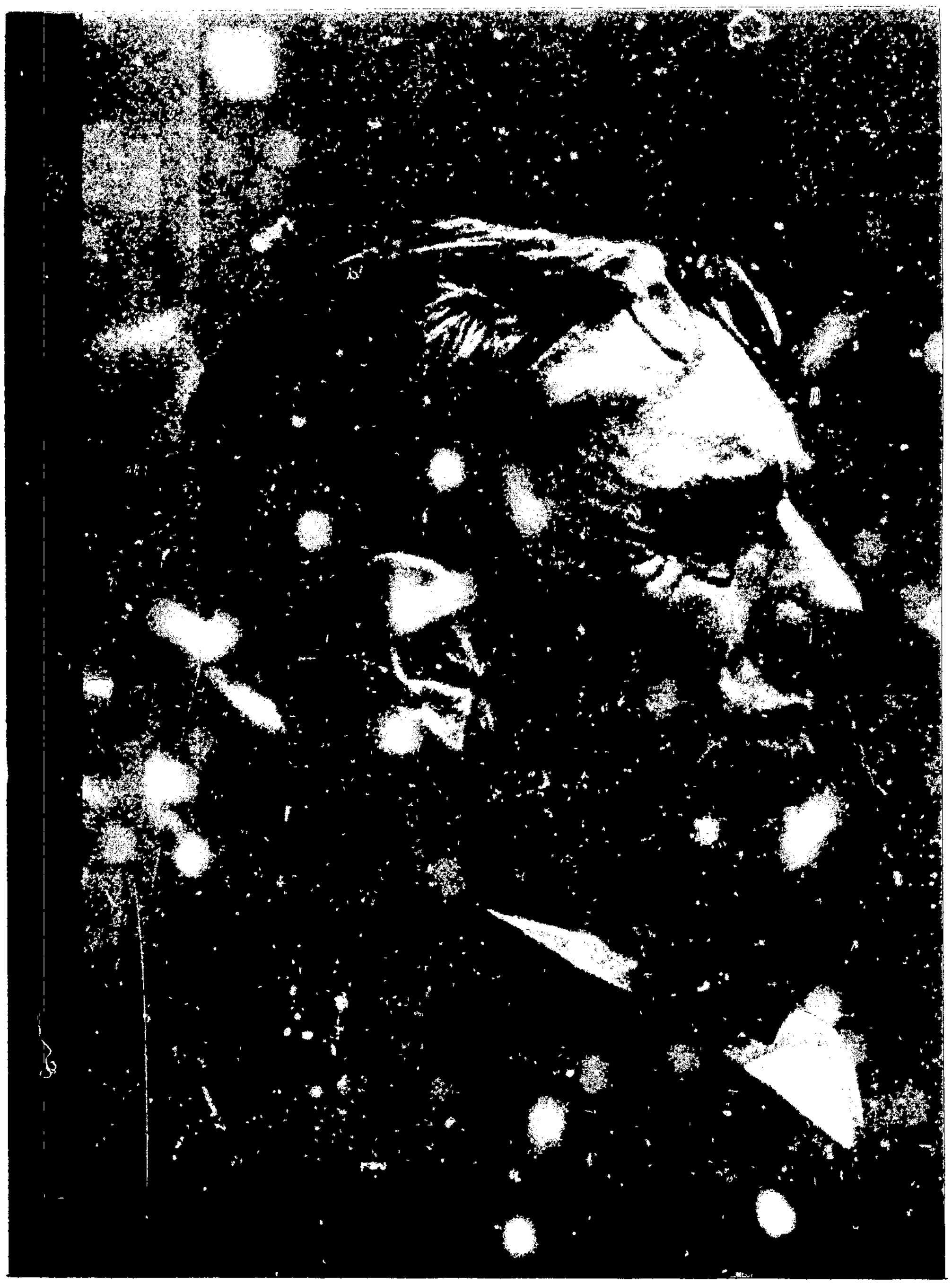
"You said physics, chemistry and math shared a library and a librarian. Do you share any other services?"

"Yes. We use a lot of the services together. We used to have a part-time shopman in each department. Now we have consolidated shops where all the equipment is put together. We have telescoped our secretarial service somewhat and we have a duplicating room."

"What about research space? You mention that one of your professors does his research at Pennsylvania."

"Each man in chemistry has his research laboratory adjacent to his office. But because bigger equipment is used in physics, space for physics research is assigned as needed for a particular project. If someone wants to work with the electronics equipment, he is assigned to the basement-level electronics room. There are several rooms there but they are not assigned to individual persons because we want to keep that space more flexible. In physical chemistry it is a little more varied; the spectrograph, spectrophotometer, and this sort of thing can be picked up and carried from one place to another as needed."


PIERRE S. DU PONT
SCIENCE BUILDING
SWARTHMORE COLLEGE
SWARTHMORE, PENN.
STACKS
STACKS
SCIENCE LIBRARY
SEMINAR
COURTYARD
COVERED WALKWAY
OFFICES
LECTURE
ELEM. PHYSICS
CLASS ROOM
CLASS ROOM
CLASS ROOM



Dr. Harold Gores
President
Educational Facilities Laboratories

SPACE THAT CAN FLEX

General Statement:

Is it possible some school planners aren't uncertain enough of the changes the future holds for education generally and for science education particularly? From our inspection earlier of some science facilities it appears the planners have taken the present-day curriculum and frozen it into blocks which will not be able to roll with the inevitable change. But if we look at Texas Instrument laboratories and research buildings and find that they are so uncertain of the future that what they did was build several layers of generalized space which are serviced by the things that have to be delivered or carried off--water, pressures, gases, etc. This is loose space into which you can sandwich in whatever particular space is currently needed. In educational buildings you rarely find this generalized space.

- "Perhaps we have been afraid of the implication that we don't know what we are building or that we are not sure what education consists of."

- "Let's relate this problem to the question of how much time a student should spend at a laboratory station. Maybe we should place him in a space that we label only as 'general space' which is accommodated by all of the necessary services, utilities, pipes, etc. Then if the curriculum should change to give more emphasis to physics, say, at the expense of one of the other sciences, the institution is not trapped because it has generalized the space."

- "We should move toward generalized space for a generalized solution in order to stay loose."

- "There has been a trend in large institutions and businesses to design general research space and to have multiple occupancy of the laboratory. A lot of services are run in and they are made accessible so that you can put up brackets easily with shelving equipment and tap into these lines. But this is generally not true in the smaller institutions which tend to build small cubicles--impregnable units--with each faculty man having his own private area. I think liberal arts colleges could be encouraged to use their research space more flexibly."

- "There are a number of architectural possibilities now that can be applied to the building of large, flexible, generalized spaces. There's the surge building which is made of units that can be shaped and then stockpiled and then reshaped according to current need; the air-supported building which has been experimented with in France; and the geodesic dome.

It is the duty of the architect to call these technological possibilities to the attention of their clients. The clients know what their space problems are but they probably don't know the range of possible solutions."

- "Say a college wanted to build a Center and keep it loose for future change. Could it ask the architect to build on a basis of 80% permanent and 20% uncertain?"

- "You mean build 20% of it temporary?"

- "Not temporary. Movable, reshapable, redeployable."

- "Wouldn't this compromise the architecture? The 80% would be nicely designed but it might look a mess when you added the prefabricated 20%."

- "Not necessarily. There's no reason why the 20% couldn't be designed with the same loving care and freshness as the 80%."

- "This is an interesting challenge to the architect. And it has a reasonable argument: we cannot afford to throw away that 20% but we can afford to reshape it for a limited period or to stockpile it and not have it rust away."

- "The real argument is that we cannot be sure of the nature of our enterprise 20 or 40 years from today, therefore we cannot be sure of how to build now. What we want is something that will give and grow, that will accept internal change without reconciling."

- "Might this device work: some sort of sandwich arrangement with a planum below and a planum above, which would simply be two planes that would support floor and ceiling. This would be the 80% as well as the 20% and could be extended horizontally and also vertically. The only permanent thing would be the two planes, everything else within would be movable and changeable by just punching a utility through wherever you need it."

- "Raw space in other words. Perhaps the architect should be asked to build open, uncluttered space which can then be sectioned into specific spaces as and when needed. This would be like the New York business firm that leases office space in a new Park Avenue building--it moves into a raw floor and the partitions are part of the equipment contract instead of part of the building contract. Perhaps educators should get in the businessman's frame of mind."

• "I think there is a danger in being too specific in the design of a particular space for a particular function. We have assumed that we must partition our floor space for acoustical privacy, ignoring the rather obvious fact that in any large hotel dining room a hundred people can be having private conversations in groups ranging from 2 to 20. With a carpet on the floor and people arranged in groups with their backs to each other, you have all the subdivision in a room that is needed. This is permissive space, as distinguished from too tailored and too carefully fitted space. I think, too, that the best space for teaching is raw, unfinished space. The most useful wall in the room we are in right now, for example, is the one where some of our jottings and sketches are propped up. The least useful wall is the nicely decorated one hung with prints; you cannot do anything with it, you cannot even lean against it. I would like to see an architectural equivalent to a blank piece of paper or a big chalk board with chalk in the tray--architecture which invites creative response. I think the architect who would reflect good science teaching would be the architect who would sense that there is no learning until effort has been added to comprehension."

Lawrence B. Perkins
Partner, Perkins & Will

CONCLUSION

Before any college can finally conclude that it should build a Science Center, it needs to answer two questions concerning the role and the size of the liberal arts college in a couple of decades hence. Just as the high schools have changed from terminal to transitional institutions preparing an increasing proportion of their students for higher education, so could we predict that the colleges will gradually shift from terminal to preparatory--preparing more and more of their students for graduate study in the universities. This shift would call for changes in program content and instructional methods, and these might dictate changes in the physical plant. As for size, will any liberal arts college be able to retain an enrollment of 1,000 or less when this is becoming the prevalent size of secondary schools? This is in view of the fact that some experts predict that upwards of 80% of our young people of college age will soon be attending college. If we will eventually have to provide for as many college students as we do for high school students now, then we are going to have to reconsider whether every college should be a campus and whether we can hold the desirable college teacher-student ratio of 1-10.

The thing that will tax our thinking most, of course, is how we can plan our facilities to get maximum use of the space. And on the basis of some of the things covered in this workshop, it is predicted that the most flexible and useful facilities will be the result of creative relationships between the college people and their architect.

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