PHOTOSTATS OF STUDY No. 7
FOR NEW TECHNOLOGY

By John R. Freeman.
NOTES ON "STUDY NO. 7" FOR NEW TECHNOLOGY
(and on Various Studies made during the year 1912)
by John R. Freeman, C.E., (Tech '76)

Some General and Preliminary Considerations.

This series of studies followed a series of studies by the Institute Professors for the housing and fitting up of the individual departments and an independent review of what was being done at other colleges.

For this later purpose a careful examination of the buildings and equipment was made at some forty prominent educational institutions comprising almost every college and technical school of the higher grade in the United States and Canada, chiefly by a corps of recent engineering and architectural graduates of the Institute, most of whom had received a preliminary training in the insurance surveys of the Factory Mutual Fire Insurance Companies.

These "Scout Surveyors" worked largely with camera and tape line, photographing and measuring the particular buildings at each college that appeared most instructive for planning "The New Technology". They conferred with instructors, mechanical superintendents and architects of these buildings, secured information regarding cost, reduced the building costs for purposes of comparison to the units of cubic foot of content and square foot of available floor area, and so far as possible secured blue prints from the working drawings from
which the more recent buildings were constructed. (These hundreds of working blue prints will make a valuable addition to the Institute's architectural library.)

This information from faculty and surveyors was then assembled, classified and reviewed by the writer, who also personally inspected a number of the most noteworthy college buildings. The writer had enjoyed a peculiarly intimate acquaintance with industrial architecture during the past thirty or forty years, in the course of professional duties as Consulting Engineer on buildings and repairs for various important industrial structures; and particularly close contact with industrial architecture in connection with his former duties as chief of the Inspection Department of the Factory Mutual Fire Insurance Companies, and had had occasion to critically study and compare the evolution of the latest types for textile factories, machine shops and paper mills in this country and England, as well as opportunity to study the seamy side of architecture. Immediately after the Iroquois Theatre fire, he had devoted much time to study of the construction of large auditoriums and particularly theatres, with a view to safeguarding life from the fire hazard.
The Faculty Plan. (Sheet No. 51)

Reference has been made to the studies made by members of the Faculty in planning the various departments. These reports and plans, with full details and explanations, as submitted to the President on sheets of standard 8-1/2 x 11 size, make up three bulky volumes. The outlines and a summary of their recommendations as to floor space required are condensed on Sheet No. 51.

This group plan was made up by cutting out to scale, pieces of cardboard of the dimensions called for in the Faculty reports, for the several departments and placing all these pieces in the most compact logical relation to one another, so as to economize the area of the load to the greatest practicable extent and reserve space for dormitories and future buildings.

It is of interest to compare the area of the present Institute buildings with that of the proposed buildings, and to note from the table that in planning for an increase of about 20% over the present number of students in all departments, an increase of 200% in the floor area is called for.
Efficiency and Economy of Modern Factory Types.

Increasing keenness of competition in all that pertains to lessening the cost of production and improving the quality of product has led to a keener study of detail in window lighting, ventilation, and elimination of lost motion in factory design in the three classes named above, than in any other type of architecture. In many cases, conditions of mechanical efficiency, safety against fire and particularly window lighting, have been regarded as paramount and such scant attention has been given to exteriors that college architects would hardly look to factories for their inspiration. The point of view of the industrial engineer and mill architect has been so focussed on the interior, and on the perfection of a single detail which should be repeated a hundred or a thousand times in a building group, thus reducing the construction cost to the lowest possible terms, that it has been fundamentally different from the point of view of the architect designing monumental buildings, particularly colleges, where too often beauty of outward form has been the paramount consideration and the interior and efficiency have been largely left to take care of themselves.

Difference Between American and European Group Plans.

The grouping of buildings and departments on the campus of the typical American college is remarkably different from that found in the most prominent European institutions. Here we find buildings of widely different architectural types scattered over a campus, each department, so far as possible, isolated and housed in a separate
Fig. 3. Situation des Gebäudes der Technischen Hochschule.
Hauptgebäude, chemisches Institut, mechanische Versuchs-Anstalt, Maschinenhaus.
building, so that the professor in charge of a department reigns undisturbed, largely in a little kingdom of his own, and the undergraduate student in particular, spends some valuable time and runs much risk of colds in our northern climate, in passing from one lecture to another, and in many cases must hurry so to cover the distance and climb the stairs within the allotted five minutes or seven minutes, that all opportunity for personal contact with the lecturer or for asking him some question, is lost. True, he gets the benefit of filling his lungs with fresh air, which becomes of greater importance by reason of the wretched ventilation that commonly prevails in college lecture rooms and laboratories, but the process or lack of arrangement involves a waste that could hardly be tolerated in commercial life.

On the contrary, in the most noteworthy European schools, for example in the great engineering school in the suburbs of Berlin or the great Polytechnikum at Munich or the new group of buildings for the study of applied science at the University of Birmingham, England, one finds the departments so far as possible housed in a single connected group, closely resembling the arrangement of the best modern factories. This plan has been followed on this side of the ocean in a few instances, notably in the recent buildings of the college of the City of New York.

The reason for this fundamental difference in ground plan is easily found in the fact that our American colleges have been mostly built up one building at a time, this one building being often provided for by some rich friend, in a way that naturally led Trustees
and architects to express their gratitude by making the building first of all a fitting monument to perpetuate the memory of the donor. It would be ungracious to criticize by name some of the college buildings in which I have been most hospitably received and where the troubled instructor has confidentially shown me how poorly suited the building was to the work done inside it and how, in disregard of his protests, it had been designed primarily to look well from the outside, and chiefly in order to give it what was imagined to be a proper dignity and harmony with its surroundings. This trouble is not confined to one part of the country, for I recall three very striking examples of this, one near the Atlantic seaboard, another in the Middle West, and the third on the Pacific Coast.

In one of these, the building honors the name it bears by being, as seen from the campus, one of the most beautiful monumental college buildings in America, but its interior is almost the despair of the men who have to work in it. Altho the professor in charge of this department at the time of building its new home was a man of exceptional ability, his expressed desires for abundant window light and convenient arrangement were not heeded. The monumental motive was paramount.

In another example, the professor in charge, when he protested that better light was needed than was promised by the plans in rooms where much work of dissection and microscopy was carried on, was told in effect by the architect that, "What you ask for would upset the whole architectural unity of this campus. Can't you see that it is impossible to have anything other than Tudor-Gothic windows of moderate size in this place?"
In the third example, the devotion of the architect to a particular type of exterior and window setting within arcades has so darkened various lecture rooms that the lecturer cannot see into the faces of his class, an effect which is increased by the placing of windows, so that he must face them while lecturing; and in another room some of the windows are so set that a reflection from them occurs upon the blackboard behind the rostrum so as to preclude a large part of the audience from seeing what he has written thereon.

As a fourth example, I might cite a very recent large college building, devoted to the teaching of Chemistry, where all provision for ventilation was omitted until after the structure was otherwise complete, and where apparently the one leading motive was a beautiful exterior which should harmonize with adjacent buildings. The advice and protests of the professor in charge of the department, made before the work was far advanced, as he tells me, received scant notice. Of course a most eminent professor of physics, biology or chemistry may sometimes not be an expert in how to achieve structurally, the effect which he plainly perceives is necessary, and only those experienced in the building arts can tell from a drawing just what the final structure will be like and even with much experience surprises sometimes come.

I will not multiply examples, they are painfully plenty, both in America and abroad. They can be found indeed in the present building of our Institute, notably in the Rogers and the Walker buildings.

About ten years ago, President Crafts asked me to critically examine these buildings. I spent afternoons for some weeks on the problem and I soon found unit stresses, fire hazards and lack of
sanitary precautions sadly at variance with what it is presumed is taught to the students in those buildings. Thanks to Professor Lanza's alertness, numerous truss rods, not contemplated originally, were added to the Walker Building before occupancy, and the fire hazard in the Rogers Building to life and property was remedied so far as practicable, altho the conditions of fire hazard today are such that insurance companies experienced in the study of fire hazard, well understand that nine-tenths of the better grade of cotton factories are far safer against having their use and occupancy interrupted for six months, than are our present college buildings.

The writer has long had a curious fancy for inspecting college buildings and educational appliances at home and abroad, and has seen the inside of many of the most notable in the United States, East and West, in Canada, Mexico, England and Germany; and after having studied the problem now in hand as above described, he became impressed with the belief that there was opportunity for a vast improvement in the efficiency of college architecture, and that after all, in items of first importance to the work to be performed, and using the term Architecture in its narrow, popular, modern sense, tho not its true sense, the problem was about one-fifth 'architecture' and four-fifths a problem of industrial engineering.

The best factories, with their painstaking attention to details for increasing efficiency and cutting down cost, are rarely built by architects in ordinary practice but are the work of specialists, like Main; Lockwood, Green and Co.; Makepeace; Brill; Coffin; Hardy; Ferguson; Steele; Dean and a few others, classified commonly as Industrial Engineers.
First an Efficient Interior; Then a Beautiful Exterior.

The writer, therefore, undertook these studies largely from the standpoint of the industrial engineer, to whom efficiency is a paramount consideration (but to whom beauty of form in every part should also appeal as worthy of most scrupulous attention, tho subordinate to efficiency) and in the belief that the problem must be worked out from the inside.

First of all we must obtain a flood of window light;
Second, a flood of fresh air under perfect control;
And, third, an efficiency and avoidance of lost motion by student and teacher, equal to that which obtains in our best industrial works.

Fourth, the consideration of the psychology of student life, the cultivation of the social instincts, the development of personal contact, must strongly control the layout of the very masonry. (Some fruits of this consideration will be found in the serious attention given to cloisters, cloister garden and to unusually ample corridors and entrance halls.)
NOTES ON THE FOLLOWING DRAWINGS.

A selection of the drawings made under the supervision of the writer made with the intention of bringing out the salient features and the principal motives, is presented in the following photographic copies, which have been reduced to about one-fourth the linear dimension of the original drawings, in order to bring them within convenient compass.

The writer started out to provide a million square feet of floor space for the sum of two and a half million dollars (or @ $2.50 per square foot), thus meeting on the one hand the desires of the members of the faculty, as expressed in their detailed reports to the President; on the other hand keeping within the limit of the generous gift of the mysterious "Mr. Smith", and meanwhile conserving our ground space to the utmost.

Floor Space Needed.

At first review of the faculty's studies and estimates of floor space required for the several departments, these appeared excessive, largely because they called for about 200% more square feet of floor area than is found in the present Institute buildings, while the number of students to be accommodated was nominally only about 20% greater than the present number; but a closer study of the present actual conditions at the Institute plainly shows that many departments are now crowded beyond all endurance and that quality of instruction and the comfort, as well as the best interest, of the
students are now suffering.

The tendency everywhere in the laboratories and designing rooms of industrial establishments is toward more generous elbow room and better conditions for exhibits and special apparatus, and the same tendency is plain when one studies the latest college laboratories. The writer, therefore, soon became convinced that if it were in any way possible to find the where-with-all, that floor areas substantially in accordance with the recommendations of the faculty should be provided.

It became equally plain after studying the costs of some of the most interesting recent college buildings in various parts of America as given in the reports of our "Scout Surveyors", that this could not be accomplished in buildings of the monumental type for the sum in hand and it was equally plain that buildings of the monumental type were very far from being best adapted to the work of the Institute.

It also became plain that our problem was first of all to give our two thousand students in their daily surroundings a good example of efficiency in housing and construction, and that the buildings must be substantially "fire-proof" or non-burnable in quality. We have no statement as to whether any college carries "use and occupancy" insurance (like most factories) but it is plain after studying the prevalence of disastrous fires in college buildings and their results that certainty of use and occupancy, as regards interruption by fire should be even more of a paramount consideration in college building than in a factory.
Permissible Cost Per Square Foot.

To obtain a million square feet of floor space for two and a half million dollars calls for an average cost of $2.50 per square foot of floor.

The writer has had occasion to follow the development of reinforced concrete construction very closely in its application to factory building and many cases are within his knowledge where excellent buildings of this type have recently been built for prices varying from $1.20 to $1.59 per square foot of floor, but built with a rougher quality of finish and with a closer spacing of columns and therefore cheaper floor plans than would be best for our lecture rooms and laboratories.

It was plain, without much study, that by far the greatest economy in cost of buildings could be obtained by following the methods of construction found in the best designed factories and office buildings, wherein a unit section is worked out with great care and most thorough attention to detail and then this one form repeated as many times as possible in the final structure. The cutting of a thousand pieces of steel or of a thousand "forms", all to the same dimensions and the making of every door casing, every window casing and every sash, so far as possible, of precisely the same dimensions, of course greatly lessens the cost and quickens the work of erection.
Adaptability for Changes in Occupancy.

One of the first studies therefore was to work out a standard unit section, somewhat on the same idea as the modern sectional bookcases, so that we would have a shell made up of windows, piers, columns and roof, within which curtain walls of light weight could be put up in any convenient position so as to take into a room either one, two or three windows, as might be required for a particular use, or so that these partitions could be readily shifted during the next hundred years as new developments come.

Flexibility for change and extension of departments must be a controlling feature in the type and arrangement of buildings to be constructed forthwith, and no man can today tell at just what part of the organization the greatest change will come.

In the days when the writer was a student at Technology, educational departments for Electrical Engineering, Electro-Chemistry, and for Biology as applied to public health, were not dreamed of. Nor had Chemical Engineering and Naval Architecture been thought of as giving scope for separate departments. It would be short-sighted to assume that the developments of the next thirty-five or forty years will not be equally great, and it is plain beyond all doubt or question that this lot of less than fifty acres, which to begin with is far smaller than the campus of many of our American colleges, must be scrupulously conserved and the type of building should be selected with a view to economizing the area of this land to the utmost.

It is plain, also, that one present great deficiency of student life at the Institute is a proper dormitory system, and that space for this must be reserved from the beginning; and that so far in the future as any large piece of land can be left unoccupied by buildings, it is desirable to utilize this for an athletic field of
A Possible Future Summer School.

It is the belief of the writer that this magnificent plant should not remain mostly idle and useless during the third of the year covered by the long summer vacation.

He was greatly interested when studying conditions at the University of Chicago to learn of the great success of its summer session and was told by certain of the professors that their most studious and receptive pupils were found in the summer courses and in much larger proportion than during the ordinary term. The reason being that many of these were teachers who made use of their own vacations for further study in the branches of education in which they were particularly interested.

Boston has all the good qualities of a summer resort, with its frequent summer East winds and its convenience to marine excursions and its beautiful park system, but thru its historical associations is attractive above all to thousands of teachers and others, and by reason of its great libraries and art galleries and its many matters of scientific and educational interest.

The writer, therefore, has been led to believe that the time will come when a great teachers' summer school for science can be established at the Institute, located at the very center of educational and historical interest, to which teachers and others of mature mind will come from all over the country, and that this school with lecture courses and laboratory courses in turn would be of great advertising value to the Institute in carrying the story of the excellence of its new laboratories into preparatory and intermediate schools all over
America, which in turn would encourage attendance from among the bright boys whom the returning teachers instruct.

By reason also of this summer school, special emphasis is laid upon the features of cloister and cloister garden, upon the superabundance of ventilation and the possibility of cooling the air on exceptionally hot or humid days.
such character as will minister to the daily life of the greatest number of students. (For example, ample tennis courts and running track are of more importance than a stadium for football.)

Moving Vassar Street.

In order to economize the site to the utmost and preserve continuity of the Institute grounds I believe it much the better plan to make a slight change in the location of Vassar Street as shown on following drawings, but I would preserve enough space along the railroad siding to permit of building a large four-story, three-compartment fire-proof storehouse of the factory type into which freight cars could be run; and also conserve the opportunity to run railroad tracks into the back campus and alongside the engineering laboratories.

A General Store House.

Only one section of this store house need be built at first. It would surely prove of great utility for the storage in bulk of certain supplies and for housing such specimens, records and exhibits as are not often referred to, and would be particularly useful for housing apparatus that is used only for a few weeks out of the year or special apparatus that is temporarily discarded but appears to have parts of sufficient value to be worth preserving for some possible future use.

By thus removing to the storehouse such material and apparatus as is not in active use and depositing it here with the same system and order and availability for quick access that is found in the best factory storehouses and houses of machine works, much that commonly encumbers laboratories, class rooms and halls would be put out of the way, without having its future usefulness impaired.
Bonding of Additional Land.

The new Institute site is so admirable in location and so certain of retaining this special advantage that as in the case of Harvard, Yale and the ancient universities abroad, it should look forward to occupying the site for centuries, but this is so small relatively to the grounds of many colleges that lack of room for expansion will at some future time, say twenty-five, fifty or more years hence, so cramp the growth that it is well worth while to see if some plan cannot be worked out for progressively bonding the land title to the whole area between the parkway and Main Street, easterly from the present site.

It would appear feasible to work out some plan by which deeds to the several lots of land underlying these buildings could be secured with the definite agreement that present tenancy would not be disturbed for twenty-five, fifty or more years, at the end of which time the Institute should have authority to take possession and occupy the lands. Meanwhile a continuation of the tenancy could be granted under appropriate rental. Land titles and ground rents are safe and attractive investments, and it would seem that some scheme of purchase or real estate trust, with various stipulations to protect the convenience of the tenant, might be accomplished at moderate annual cost. A sinking fund maturing at the end of twenty-five or fifty years, does not require a large annual outlay.
NOTES ON DRAWINGS OF UNIT SECTION (SHEET NO. 13.)

(Portions of this sheet on a larger scale are given in the three following photographs.)

Many sketches were made and discarded during the evolution of this particular design. First of all it was determined there should be a flood of light and a flood of fresh air in every room; that there should be no dark corners or concealed spaces to lodge rats or dirt; that the corridors should be uncommonly spacious, so that each might be a sort of "hall of fame" or picture gallery, hung with photographs and drawings of the world's best work and with frequent photographs, paintings or bas reliefs of men notable for their achievements in pure science and applied science, and in which students might meet in a way to promote better acquaintance and friendships, hence also the generous provision of seats and ample windows.

The Height of Building.

Four stories permits the young and active to use stairways without the expense of numerous elevators, a feature of great importance, considering that once each hour half or two-thirds of all the students pass from one to another, all simultaneously. Possibility of another story was given much thought, also the possibility of increasing height in future, but these did not work out well.

The first floor, nominally a basement, is placed four feet above the general surface level of the surrounding streets, so as to always insure the best of drainage, but the ground is banked up outside the building on a gentle slope, for architectural effect and to give cover to passageways on the inside for janitor service and on the
outside for heating pipes, etc., and better opportunity for the Naval channel beneath the building, and for the athletic boat house.

**Width of Unit.**

After an examination of many class rooms and many commercial buildings, a fifteen foot bay was adopted, together with a type of construction which would permit setting the light, non-supporting partitions a foot or more off center, thus giving to a single unit room a possible width of seventeen feet, which appeared to be more than ample for the size of class which is today believed most efficient and economical for instruction. (I might today make this unit width 15 ft. 6 inches, but not more.)
The standard unit section, 14 feet 6 inches wide by 36 feet (or 32 feet) in length, will give good accommodation for the size of class which in the experience of the Institute and other schools of science has been found most efficient, namely, for a class of about 24.

The opposite drawing shows a seating plan of such a class room, arranged so that from any seat, one can pass to the blackboard without crowding past the knees of one seated beside him. Within this room there is seen to be also ample space for a roll-top desk, which the instructor can occupy outside of class hours, and also for a drafting table at the opposite corner. The blackboards along both walls can be so arranged as to provide nearly three linear feet for each of a class of twenty-four. A projection lantern and a permanent screen would be made part of the outfit, the lantern being adapted also for projection by reflection from a printed page with an electric arc lamp powerful enough so the projected image could be seen in daylight of moderate intensity.

Up and down the inner face of every interior column would run a complete equipment of pipes for water, electric conduit, vacuum cleaner and sink waste, so that however partitions were changed in future there would always be a convenient connection for heat, light, electricity or exhaust, close at hand.

Should it be desired to add a few more seats, or if for special purposes this room were thought too narrow, its width can be increased one, two or three feet, by shifting partitions off center, as already described.
Width of Unit (Cont'd)

The photograph preceding shows a class of 24 students seated in one of these unit rooms, 15 feet in width. Sheet 13, two pages back, also the photograph eight pages forward, shows a lecture room seating sixty-six, occupying two bays. Three bays would give a lecture room large enough for any but a few lectures where it is desirable to have all the students of a year assemble, and these are provided for in the corner pavilions.

The fifteen foot unit also serves admirably for a professor's study. To the head of a department would be given the sole occupancy of one of these rooms, which is really far more capacious than it looks at first view on this plan.

Study has been given to dividing this for his protection from interruption, virtually into three rooms, by a partition, seven feet tall, mostly of glass, between his inner sanctum and the room occupied by his stenographer and clerk or secretary, while the secretary and the head have the further protection against callers, of a railing topped by a narrow desk or counter.

Uncommonly abundant space for bookcases, specimen drawers or filing cases is found along the two walls, and I have sketched these as fitted with the type used for very extensive files in my own office with great satisfaction during several years of testing out.

Four or more junior professors, or instructors, with a clerk in common, could be comfortably accommodated in one of these unit rooms, 15 by 36 or 15 by 32 feet.

By adopting a unit type of room throughout the buildings, standard unit type of furniture in desks, bookcases and filing boxes could be
provided with much greater economy and readily added to from stock, as
the demand grew.

Length of Section = Depth of Room.

For depth of room, 36 feet on one side of the corridor and
32 feet on the other were adopted, after studying plans of many class
rooms and after inspection of a degree of window lighting found in cer­
tain typical structures where due consideration has been given to hight
of story and to raising the top of the window to the full hight of the
room.

It is certain beyond all doubt or question that excellent
window lighting can be given to the inner side of a room of this width
and it is plainly of the utmost importance that neither student or in­
structor should be seated so as to face the window light.

It is also plain that the average student is given better
opportunity to see and hear in a class room where the speaker stands
at a side rather than at an end.

It will be noted that every pupil here receives his light
for writing over the left shoulder.

Height of Story.

The hight of story is based largely on the very latest prac­
tice in textile mills. By means of the sixteen-foot clear story and
windows of the type here shown, it is found possible to secure light-
ing sufficient for very exacting kinds of manufacturing to the center of factory buildings 120 and even 150 feet in width.

Here for a school room the requirements are believed to be still more exacting, or may be if the room is used for certain laboratory purposes, and therefore, altho our total width proposed, including the corridor is only about 95 feet, or two-thirds that of many recent factory buildings, the height of story is made about one foot higher than in the most advanced factory practice.

The height of window has been given most scrupulous attention, as in the best factory designs, and the top of the glass is carried even to a height three or four inches above that of the general level of the ceiling.

This feature of carrying the glass to the very top of the room or even a little above it, while of the utmost importance, has hardly yet been appreciated outside of the most advanced factory designing, but it will be noted that it can be worked in for our college rooms, without detriment to the exterior effect. A square foot of glass window, 15 or 16 feet above the floor, is practically say three times as valuable as at the mid-depth, the added value coming from the angle more than from the area.

Over the entire top story a light of the so-called saw-tooth type, facing the north, is everywhere provided.

This agrees with the most advanced textile factory design, where broken threads have to be promptly detected and neatly knotted. The saw-tooth roof in factories seldom presents a pleasing appearance, but here for our college buildings it has been hidden behind a deep
classic entablature.

Meanwhile, a pleasing view outward from those in the room is secured by windows which look small in the elevation but are in fact six feet in height.

The scale of this window lighting has to be tested out by actual measurement in comparison with large windows in some existing building, before the size or scale is appreciated by those not in every day contact with factory design.

**Vertical Ventilation Ducts.**

Particular attention is called to the ventilation ducts and to their great size, one at each of the four corners of the unit room and any of them large enough for a man to pass from top to bottom for purpose of repair.

Those in the outer wall are mainly designed for exhaust, an electrically driven suction fan above the roof on one of these would give all necessary exhaust for the most befumed laboratory. The ducts on the inner side communicate directly with the great main duct beneath the bottom corridor floor, shown in a later drawing.
Before adopting this type, the writer from time to time found opportunity to walk thru a large portion of the business sections of New York, Boston, Chicago, Seattle, San Francisco and some other cities, in order to find the best that had been developed in the adaptation of the lines of the classic Greek architecture to the modern requirements of office buildings.

The problem of obtaining greater window area in combination with beauty of outward form has been receiving study from many eminent architects and many examples can be found. In some as, for example, in the engaged columns of the New York Stock Exchange or the Knickerbocker Trust Company, it appears that setting the windows so far back has interfered with the quality of illumination, and in his travels the writer found few, if any, better examples than in the recent building of the Metropolitan Life Insurance Company in San Francisco, which gives evidence of far more attention than common, to the great importance of conserving the diagonal light, which often is sacrificed with too great a depth of reveal at the window, or by too great a projection of the columns. A photograph of this is presented on the following page.

The type of window sash here shown would be built with fixed steel sash, but each window would have at its four corners small sections of two large panes each, set in a sliding frame, for purpose of usefulness in ventilation in summer if ever needed in addition to the circulation thru the ducts.
Illustration of use of White Enamel Terra-cotta for Type of Architecture proposed for New Technology.
This type of exterior may be built of a special quality of white Portland cement concrete, or it can be built of white enameled terra cotta, as in the illustration on the following page, which is of a particularly beautiful building.

A massive building of white masonry is a far more impressive object in the landscape than one of darker color and the fact that windows appear almost black as seen from a distance, helps to increase the character of a building of this type and to emphasize the colonnade.

The question of the feasibility of obtaining good-looking concrete will be discussed more at length on a later page, therefore at present I will only state that I am of the opinion that it is highly probable that good-looking, impervious, durable concrete can be had, if one will only study the subject faithfully, and will give a building at lower cost than any possible building material that would give equal architectural effects.

A special white Portland cement is suggested (Sandusky or Atlas), mixed with crushed limestone aggregate (marble quarry grout), and the whole tinged with a very faint cream-like tint, worked into the mixture so evenly that it would merely serve to give a sort of "old ivory" effect as the building aged and weathered, the faint yellow tinge being used to neutralize the coldness and harshness of the plain bluish-white.

The writer is well aware of the defects of ordinary concrete for a monumental exterior, but I believe that some faithful, earnest study would greatly advance the "state of the art". Concrete is pre-eminently the building material of today and the white, glazed terra cotta might be found most expedient for the exterior. I would most certainly adopt concrete in combination with structural steel for the interior.
The photograph preceding presents on an enlarged scale the lower right-hand quarter of Sheet No. 13, and shows the ground plan of several of the unit sections and their relations to the main corridor and to the cloister, which forms a very important feature of this "Study No. 7".

The social feature is believed by the writer to be one of those which should most of all control the design, being next in order of importance to abundant light, abundant ventilation and a general rigidity and unburnable character of structure.

The corridor, it will be noted, is uncommonly wide, or fifteen feet and eight inches in its narrowest part, while over all, from back to back of the sides which border it, the open space is twenty-one feet.

This corridor is designed to serve both as a highway for travel and for a general place of meeting and mixing of the student body and as a sort of hall of fame, on the walls of which would be hung hundreds of photographs of famous engineering structures, portraits of the leaders in Chemistry, Metallurgy, Geology, promotion of public health and engineering. It would serve as a place where, during the five minutes allowed between consecutive class or lecture hours, the young men could comfortably gather in small groups, sitting or standing, for a few cheerful words with one another.

This width was determined on after a study of the hallways in many noteworthy office buildings, college buildings and particularly the corridors in some of the great hotels.

For example, the width of this corridor at its narrowest point is about eight inches wider than the main corridor of the New Willard Hotel in Washington, along which in the height of the season a
score of groups will be found, seated, in conversation while there is ample space for passing up and down.

The corridors are of this pattern and width throughout the entire length of the buildings and in all stories. On the preceding page a perspective sketch is presented, showing the arrangement a little more clearly.

The professor's study is also shown with some detail of plan, as fitted into one of these unit sections. This particular one being as designed for the head of a department and his secretary, and with a view to economizing his time to the utmost and to giving him an abundance of filing cases, sufficient for the most inveterate collector and statistician.

The size of this room was tested out in real life by comparing it with the ante room of the Secretary of the Interior at Washington, which happened to be of about this size, and into which the several desks, partitions and cases needed for our present purpose were fitted by visual imagination.

It is my belief that to far greater extent than is now common, professors and associate professors should be provided with such ample facilities for work at the college in close proximity to their class rooms, that they will thereby be encouraged to spend the hours from nine a.m. to five p.m. there, much as a professional man does at his business office, thereby bringing them into the most intimate contact that is practicable with what is going on at the college throughout the business day. Obviously, this cannot be practically, and much waste of nervous force will be incurred, unless he is shielded from too intimate contact with every chance caller, by such barriers as are shown and by means of a secretary who can answer many of the callers and hold all at proper distance while her chief is particularly busy, just as is done in business life in the large establishments.
Incidentally, it may be remarked here that, as in commercial life, it is true economy to provide any officer of instruction who has reached the stage of assistant professor, with a stenographic clerk, who can greatly increase his capacity for work by relieving him (particularly after a term or two of training) of much of the daily routine and drudgery.

Cases are not unknown where professors have greatly increased their time available for research and other work of a high order, by training some bright young woman, with a high school education and who had studied stenography, to make the preliminary corrections of examination papers and attend to details of a great part of their routine and statistical work.

The device indicated, of a narrow counter and gate to serve as a barrier by which unimportant callers can be kept a proper distance and quickly disposed of when their question is answered, has had its value proved by test in many business and professional offices.

These single unit rooms when measured off in space or tested out with some room of this size in an office building, will be found amply spacious for accommodating four instructors or junior professors, who can share in the services of one stenographic clerk.
PERSPECTIVE OF CORRIDOR
NEW TECHNOLOGY

PLANNED BY
JOHN K. FREEMAN

H. F. KEBBON
Upon the opposite photograph is shown the grouping of these unit sections that I finally adopted for obtaining the aggregate floor area called for in the Faculty's reports.

This, it will be noted, in most parts presents merely a skeleton of external walls, floors and columns between which light, non-bearing partitions can be placed or removed at will, thereby giving the greatest possible flexibility for the changes in floor area that are certain to be called for under the developments and changes of the next few score years, and all without in any way affecting the integrity of the structure as a whole.

It will be noted that the arrangement of columns in the three rear buildings results from the adoption of another type, namely the so-called "mushroom" floor and column system, which appears best suited for those laboratories containing heavy machinery and where the requirements for distributed ventilation are less exacting than in lecture rooms and laboratories and do not demand a hollow floor for ventilation at present or after future changes.
The preceding photograph, Sheet No. 47, shows the proposed ground plan more in detail, with the general location of the several departments in outline, arranged in what appears to be the logical order.

First, it is to be noted that a great boiler plant and power plant occupies the central position. This location being dictated by economy of distribution of heat, power and ventilation, as well as by the purpose of making this one of the most important practical laboratories of the technical school and one which shall be always a reminder that a boiler plant can be made clean and beautiful.

In close proximity to this, in a lower story, would be located the great ventilating plant, from which filtered fresh air in most ample volume, could be distributed thru a great underground chamber, beneath the main corridors, to every part of the building.

Those departments likely to be noisy, dirty, or to present the jar of machinery, are kept in the rear, as far away as possible from the departments of physics, chemistry, biology and the class rooms where the fundamentals of mathematics and drafting are taught and where the cultural studies are presented.

Close on either side of the main central entrance are located the administrative offices of Registrar, Bursar, President, Dean, etc., and also as close as possible to the center is located the general reading room, with an open doorway so broad and inviting that no one who passes by, having a few moments of leisure, can escape its attraction.

The two great courtyards are made to appeal, one to the sense of beauty and the scholarly tradition; the other to the intensely practical.
PERSPECTIVE VIEW OF
CLOISTER
NEW TECHNOLOGY
FROM NEAR LIBRARY DOOR
H.E. KEBBON
The westerly court yard presents a cloister garden, which is much larger than one would appreciate from his first glance at these plans or until he has paced off within the quadrangle of some other college. Around this is the cloister, shown elsewhere in a perspective sketch, located at the second story level, for several good reasons, rather than on the ground. One reason being that this gives a better distribution of day light in the several stories; and a second, that it gives to the garden as seen from the cloister level, the well-known superior beauty of a sunken garden. Moreover, one corner of the cloister opens out directly from the general reading room.

Great care has been taken that the farther side of neither of these courts shall be completely shut in, because the beauty of such an outlook is greatly impaired by complete enclosure. On the contrary, a beautiful colonnade is planned to invite attention and add to the interest of the distant end and thru this colonnade, in the distance, would be had glimpses of the athletic field and the dormitories, as will be seen in a later drawing.

The court yard to the right is devoted largely to the Department of Naval Architecture and is in intimate connection with aquatics purely for pleasure and recreation, the two forming a continuous channel, deeply cut in the ground and with its surface level with the Charles River Basin. The middle portion, extending also beneath the front building, serves for a boat model testing tank, like that in the Navy Yard at Washington or that at the University of Michigan, while at the northerly end is located two great tanks and a hydraulic laboratory that is planned to be superior in capacity for research to any yet built.
Perspective View from Harvard Bridge.

The drawing that should in logical order be next examined, altho it was one of the last to be drawn because of our working from the inside outward, is a perspective indicating rather crudely how the units already described would be clothed in classic outlines to form a massive group, which as seen from either of the neighboring bridges, or from across the Charles River Basin, would dominate the landscape far more than scattered buildings.

In all of the perspective drawings made, impossible viewpoints have been avoided, save in the isometric drawing of Sheet No. __, which is not strictly a "view" but rather a diagram for illustrating the positions of the buildings in relation to their surroundings, particularly to the bridges and the main lines of transportation.

The drawing opposite is carefully constructed to scale from the most natural and convenient view point upon the Harvard Bridge.

In order to give the building a still more dominating effect, it is proposed that the surface of the ground at the site be raised by additional filling, so that the lowest or "basement floor" would everywhere actually be about four or five feet higher than the grade of the surrounding public streets.

For many years the building would stand much as is here shown, with a broad, open, vacant lawn between it and Massachusetts Avenue.
MOTIVES

1. An abundance of window light and a flood of controlled ventilation with tempered and filtered air.
2. Maximum economy in energy and time of students and instructors.
3. Maximum economy in cost of efficient service in heating, ventilating, janitor service, and general maintenance.
4. Maximum resistance to fire, decay, and wear.
5. Maximum economy in cost of buildings for square foot of useful floor space.

Architectural details and outlines derived from the Greek Classic style which have satisfied the human eye for over 2000 years. Modifying the windows as needed for science study as well as admitting the dim religious light of a temple.

A simple dominating mass with uniform average height which will make a stronger impression from the many thousands who daily cross the bascule over the two great bridges.

NOTE

It is believed possible to bring the cost of such a building within the appropriation by the use of stone and brick aggregates. It should progress in the art of cladding, piers, and towers with an inexpensive surface; without a cladding that this material can be made fully as permanent as marble or granite with a century or more of atmospheric durability; and that by use for exterior finishes of whole cement selected marble aggregate giving a jointed surface that is as resistant to smoke as the ultimate "olive" base will be more pleasing than of cut stone.
The Rogers Building.

At the extreme right of the perspective, the present Rogers Building has been drawn to scale, on the theory that the shell of this building might for sentimental as well as practical reasons be carefully taken down and erected on the new site and a new interior of fire-proof construction be built inside it, the whole to serve as the beginning of the industrial and technical museum which it was President Roger's dream should ultimately be an integral part of the Institute of Technology.
Grand Entrance Motif.

The opposite drawing shows on a larger scale the central portion of the same building presented in the perspective of the previous page and is believed to demonstrate that although we started with the factory method in order to obtain the utmost of light, ventilation and efficiency of floor space, this does not preclude a beautiful and dignified exterior.

The entrance most frequented by the students would not be that up the exterior grand stairway, but as in State Houses and similar monumental buildings, would be by an inconspicuous side entrance to the ground floor, immediately beneath this grand stairway, where they would go into a great locker room where hats, overcoats and other impedimenta could be left during the day's work.

The upper central building, seen above the pediment, covers the proposed architectural museum.

All along the front, the top of the entablature forms a parapet behind which there is a broad platform, easy of access and presenting a most excellent view of the Charles River Basin and whatever in the way of aquatic sport is taking place upon its surface.

The Institute should invite visitors and should in every possible way cultivate the acquaintance of the public from which it draws its support. It must have features of interest to the average man and woman, parent or friend, which they can be shown and to which they may have access without interruption to the serious work of the students and instructors. For this purpose also the entrance hall is made a special feature.
Study of Entrance Hall.

Passing from the outside again to the inside, the main entrance hall is shown in a perspective sketch on the preceding page. Attention is here again called to the broad entrance to the general reading room and principal library.

In order to enhance the inviting view of this reading room, a peculiar construction for the grand staircase was made necessary. All of these staircases and balcony were worked out with much care as part of a plan for making this main entrance hall the most dignified and impressive room possible and one which should also be useful in many of the Institute functions, receptions, scientific conventions, commencements and the like, and which at the same time should be thoroughly useful.

The stairways are worked out to rise by gentle stages to the main auditorium, which is over the reading room and at the same time this serves as a sort of grandstand for observing whatever function may be taking place upon the main floor.

At the right is seen the outline of part of a large counter, behind which is the Bursar's office and in front of which fifteen or twenty men could simultaneously be registering or paying their term bills on the first day of the month.

Opposite, there is a similar long counter in front of the ample doorways to the Bursar's office, and in fact this main entrance hall is worked out with a view to economizing everybody's time on the first day of the new term and permitting the simultaneous gathering of two thousand men on the opening day and the shaking of the whole mass down to working bearings without delay.
Second Story of Entrance Hall.

On the opposite drawing is given another view of the entrance hall to more clearly illustrate its possibilities for architectural display and artistic decoration.

It is to be noted that the overall dimensions of this room and its balcony are about 69 feet in width by 89 feet in length, with a height of about 35 feet from floor to ceiling.

This gives a room larger than the grand ball room in some of the great metropolitan hotels. Still I can conceive many uses for such a central meeting and mixing room and believe that its space and cost would not be wasted.

The ground plan of this room and its relation to the administration offices is shown in the next two photographs.
The relation of the grand entrance hall which is located on the second floor to the administration offices, to the main corridor and to the reading room and library, is shown on the drawing opposite so fully as to need little further explanation, save to call attention to certain small rooms for special services to the administration, such as the photographic room for the quick, cheap duplicating of manuscripts, maps and diagrams, the preparation of such lantern slides and photographs as may be required by any members of the instructing staff, or by the librarian, this room being placed as near the center as possible.

Immediately below it is placed a room for quick printing service, in which a linotype machine and a medium sized power press run by electric motor, would give out printed announcements, rough as lecture notes, examination papers, etc., almost quickly as duplication by mimeograph or typewriting and in much more useful form.

On these drawings is also shown the relation of the entrance to and from the cloister, both from the main hall and from the reading room.

Place is made for two passenger elevators of a large and rather slow-moving type, in view of the requirements and in order to lessen cost of attendance, only one of which need be installed at first.
The present arrangements for taking care of winter clothing while the student is in lecture or class room are very defective at the Institute as at most other colleges and there is continually the incentive for the student to invite colds and chills or perhaps pneumonia, by going about with insufficient outer clothing, because there is no convenient place to deposit it, and the petty thieving of things loosely laid down about the Institute's corridors is notorious.

Here it is proposed that the students' entrance to the main buildings would be thru the four ample doorways at the ground floor level, which tho nominally a basement is four or five feet above the grade of the street.

This locker room it will be noted, contains more than 1,500 lockers, everyone of which is of nearly double the ordinary cubical capacity provided in gymnasiums.

Adjacent to this are check rooms for special students, who are not provided with lockers.

Toilet rooms and pay-station telephones are convenient.

A doorkeeper or two would be constantly in attendance to preserve discipline and prevent the entrance or exit of sneak thieves.

Across the corridor, room is given for a students' co-operative store, at which text-books, drafting materials, and students' stationery and laboratory supplies would be sold at lowest practicable cost.

Also directly opposite this and in convenient proximity to the administration offices is a large room that could be used as already mentioned for a printing office for the quick printing of the many circulars and blanks required in the service. It is assumed this would contain, say, one four-bank Linotype machine in charge of a
mechanician-operator, and one or two small-size presses, the whole being designed for quick service on standard sizes rather than for larger, less hurried work which could be more cheaply done outside.
Much thought was given to the placing and arrangement of this room and some sacrifice had to be made to give it a central location and to bring it in convenient proximity to the cloister and the administration, and also close to the Departments of History and Modern Language, the stack room, the seminar rooms and to arrange all with the greatest possible economy in cost of stack room service, for the number of attendants must be economized and requirements for quick reference met in a way different from public libraries.

It will be noted that an alcove type has been adopted in the reading room, rather than a single large, open, undivided hall. This was done primarily for the purpose of the greater quiet and lessened distraction possible with the alcove system. This arrangement was planned also for the purpose of permitting the development of one of the most important ideas in college libraries, that of placing the greatest possible number of books directly under the student's eyes, so he can look at a shelf-full and select the one or two in which he is most interested, very much as he would do from a book shelf at home. There are many books, such as can be readily replaced, which can be thus shelved in the open without too great risk.

With modern indirect electric lighting it is possible to give to a room of this size and shape a perfection of illumination and a freedom from eye-strain that would not have been possible ten or even five years ago. The writer studied several college libraries while planning this room and noted particularly the arrangement in the library in the new Engineering Societies Building in New York. Efficiency of service is of more importance than the architectural ef-
fect sometimes chiefly sought in monumental reading rooms.

The stack room is shown in the drawing at the right. Separated from it by a narrow corridor are shown four seminar rooms.

It is believed that this arrangement here shown would to a considerable extent avoid the additional cost of too many independent departmental libraries and at the same time would help along the general purpose of promoting acquaintance and the bringing together of students of similar tastes. Indeed, here, as everywhere else in this design, great emphasis is placed on so designing the building as to promote a wise good-fellowship and conversely to prevent the opposite tendencies of the large colleges under modern conditions, where men often fail to make even the acquaintance of their own classmates. A wise good-fellowship may do more during student life than high scholarship in making a man of the most use in the world later on.
Much thought and repeated re-arrangement was devoted to providing an auditorium within which the entire student body and Faculty could be comfortably seated at one time and which should have good auditory and visual qualities and the very best of ventilation, and which might either serve as a lecture room in which lantern projections or motion pictures were a prominent feature, or which by the lifting of a curtain screen would reveal a stage, ample for commencement purposes or any grand function or even for the famous Tech. Show.

The writer happens to have been called to an extended investigation of theatre construction immediately after the disaster at the Iroquois Theatre in Chicago, some seven years ago and in his studies directed toward the safeguarding of life in theatres, had occasion to study many of their other problems. He also happened to be an official of one of the national engineering societies at the time the Engineering Building in New York with its great auditorium was planned and was familiar with the motives which led to its design, and has critically studied its performance, therefore he worked over this particular problem with special interest, and after having studied the altogether admirable series of papers on architectural acoustics written by Dean Sabin, is led to believe that good hearing could be had at the back seats in a room of this size, with small or large audiences, if walls and ceiling are thoroughly made sound-absorbent by proper coverings.

Particular attention here, as in the class rooms, has been give to avoiding the facing of direct window light by either lecturer or auditor; and for evening sessions the lighting is also so disposed as to avoid irritating the eye. The main light, except for the bal-
conies, comes in thru a most ample area in the dome and for the portion beneath the balconies the electric bulbs would be in inverted bowls in the ceiling.

The corridors on either side on all floors permit easy access by a late-comer, or early exit with the least possible disturbance, and permit, as at the auditorium in the new Engineering Societies Building in New York, groups not interested in a paper which is at the moment being presented in convention, to gather outside and discuss some topic which to them is of greater interest.

Stairways.

Particular attention was given to these stairways from the auditorium because of its location, like our present Huntington Hall, upon an upper floor, and the designer knows of no large hall or auditorium in America or abroad presenting more ample means for quick exit, altho this hall would be of fire-proof construction throughout.

Virtually, there are six independent stairways, for the staircases at the rear both resemble double-threaded screws, so that in each rear corner there are virtually two independent stairways, one entwined with the other, but entirely separated.

At the front stairways, the problem has been so worked out that those going to the main floor, to the first balcony and the second balcony each travel in a separate path, so that a ticket taker at the door can readily direct and control the line of travel.

The general relation of the auditorium to the adjoining rooms is shown best in Sheet No. 17, on a previous page.
For this particular design the writer called to his assistance an expert in modern power plants, from the engineering office of his classmate, Charles T. Main.

It follows closely the lines of the most recent and perhaps the best of the great modern electrical power stations for public service, that recently built in South Boston, a particularly excellent feature of which is the skylight and ventilating louvres over the central firing floor. These are found to give a particularly gratifying supply of light and fresh air, just where both are most needed.

It will be noted that automatic stokers are provided and that coal is fed from elevated bins, holding about a week’s supply and that ashes fall by gravity into ash bins, from which they flow by the simple opening of a gate into the cart or car which takes them away. This construction costs more than for hand firing from the floor or than for boilers set on the ground level, but it is intended that this boiler room should be one of the chief laboratories of the Institute.

Only half of the floor presented is required for regular service. The other half is intended chiefly for the temporary installation of apparatus under experiment or for illustrating certain prominent types of coal-burning mechanism.

For the architect to place the boiler room somewhere out of sight at the rear of the lot, because of an idea that it must be dirty or its chimney unsightly, would be past forgiveness in a great engineering school.

The chimney is made exceptionally tall in order that the gases may be taken well away in murky weather and in order that a large space between the inner and outer shell may be utilized to carry off fumes from any temporary work in metallurgy or organic chemistry which might otherwise be a nuisance.
The Saw-Tooth Roof. (Sheet No. 12.)

An incomplete detail of the type of skylight by which would be lighted the entire top floors of all of the group of buildings, with the exception of the Architectural Museum, the Auditorium and the Boiler House, is shown in Sheet No. 12.

This in its best form is practically unknown outside of the latest factories, but has justified itself beyond all doubt or question in more than a score of recent establishments, as giving by far the best illumination for work room and laboratory of anything that has ever been devised.

The angle at which the glass faces the source of light lessens the tendency to polarization and reflection, as compared with the vertical glass in a monitor.

As ordinarily applied to factories the saw-tooth window is more or less unsightly, but in these building as shown, for example, in Sheet No. 29 and elsewhere, it is concealed from the view of the man in the street within the deep entablature or parapet.

Sheet No. 39 also shows the top view looking down on these skylights.

Position of Sun and Shadow.

The following original diagram was prepared in the preliminary stages of studying these saw-tooth windows and other windows and also is useful in properly orienting the athletic fields. It shows direction and percentage of length of shadow for any day and hour, at a glance.

The angle of the glass in the saw-tooth was for other
reasons made a little more inclined than would exclude totally the highest sun.

By this diagram one can work out the limiting position of the sunshine in the cloister, winter and summer, and satisfy himself that at this height below roof-line and for this width of court the cloisters will be far from sunless.
Large Lecture Rooms.

It is plainly important that there be a few lecture rooms of large size, one or two of which shall be available, now or in future, simultaneously for such purposes as the Lowell Institute lectures on scientific subjects or for meetings of the Institute Society of Arts.

Two types were worked out with much care, one favoring the amphitheatre type is shown in Sheet No. 28. This appears the best type for lectures on chemistry, biology and certain subjects where a large audience is best accommodated by looking down upon the demonstrator's table, somewhat as in a surgical amphitheatre, but with a somewhat less steep banking of the seats than I have found in the latest medical school buildings.

In certain other lectures in physics and engineering for example, a view more nearly horizontal serves as well or better, and this type has been worked out on Sheet No. 29.

It will be noted that a little greater head room than the story height was here obtained by depressing the floor immediately in front of the speaker's desk below the general level.

Either of these lecture rooms would hold all of the largest class of undergraduates, and would accommodate as many students as gather in any but the most popular of the Lowell Institute courses.

Considering future needs it does not seem prudent to lay out new buildings without providing at least two rooms of the capacity here shown.

That on Sheet No. 28 is particularly adapted for popular lectures to others than regular students and to other than the meet-
ings of the Society of Arts and for that reason it is provided with an independent entrance, an independent coat room and a folding fence by which it could be shut off from the regular activities of the Institute.

It is proposed that each of these main lecture rooms would be provided with an ante room, in which the apparatus for a lecture could be set up on tables at leisure, and wheeled in immediately prior to the lecture, upon a small industrial railroad track, much as is now done in one of the Institute lecture rooms in the Lowell building.

It is proposed to avoid the disadvantage to a lecturer or to students in facing a window, in these corner rooms by the use of prism-glass for glazing those windows that would otherwise be objectionable. This glass can be chosen with such an angle that most of the light from sun or sky will be deflected onto the white ceiling and thence diffused, leaving the horizontal view of the glass from the lecturers stand mostly robbed of its glare of light by the series of dark narrow bands at the base of each little prism. Many specimens with various angles were obtained and some preliminary trial made.

This arrangement permits one lecture to immediately follow another on a different subject and provisions for ventilation are made so ample that one audience could immediately follow another indefinitely.
In all of those rooms that will not require to be instantaneously darkened during the lectures, for lantern slide projection or in those not exposed to the direct rays of the summer sun, it will be feasible to use the recent type of tilting sash, pivoted around a central horizontal axis, but in all lecture rooms it is proposed to provide the windows with two sets of curtains,—a single white curtain of plain bleached cotton cloth, which will stop direct rays of the sun but diffuse the transmitted light, about 10 feet in width mounted on a roller at the top, and a single black curtain mounted on a roller so at the bottom, each can be instantly closed and as quickly opened again to facilitate the daily use of the projection lantern, by the use of a simple special fixture to the design of which some attention was given.

The writer has for many years used in drafting rooms curtains of the ordinary draftsman’s transparent tracing cloth and found it to give a beautifully diffused light under direct sunshine.
These drawings, Sheets Nos. 28, 29 and 30, also illustrate one of the difficult minor problems, namely, that of avoiding dark corners at the internal angle and of providing ample stairways, with short runs and no winders, and spaces in which elevators can be introduced at any future time. The arrangement shown also serves to separate the women's lavatory and water closet satisfactorily from that for men.

(In the arrangement of lavatories shown on Sheet 28, the drawing was inadvertently left incomplete, before incorporating upon it an arrangement that had been worked out for giving each of these rooms direct access to outside windows.)

There is not a dark corner to collect dirt or a built-in closet anywhere or a retreat for rats and vermin, anywhere about the buildings as here planned.
Ventilation and Heating.

The plans showing the details of the proposed ventilation system had not been inked in upon drawings of the regular form at the time when these sheets were turned over by Mr. Freeman to the Architects, but the problem had been worked out on sketches and computation sheets in preliminary form, so as to make sure that the flues and main conduits were everywhere ample for the most difficult service.

It was proposed to use ventilation under moderate fan pressure, from large blowers driven by electrical motors; the air to be taken from about the roof level, down thru a large vertical shaft to the fans located on or near the main floor and in convenient proximity to the power house.

Provision is made for filtering the air thru a vast area of cloth bags, but so arranged that this filtration apparatus need not be applied in the near future. (This particular drawing is diagramatic rather than exact. In working form the filter cloth would be cleaned by a modification of the well-known vacuum cleaner, and the cloth itself very likely disposed in form of a vast area of "W" frames.) A similar filtration of air has been in practical use for some years past in several manufacturing establishments. The writer has examined installations in the Telephone building in Boston, the Eastman photographic supply works at Rochester and in a large paper mill on the lower Thames in England.
6 15 ft. fans, 100 H.P. each, to deliver total of 360,000 cu.ft. per min.
6 Heaters at 10 lbs. steam pressure, each 14 to 16 tubes deep. Total heating
surface = 14, to 16,000 sq.ft. Velocity thru = 1800± f.p.m.
Space for Cooling Coils.

By-pass from outlet of this end fan for Auditorium ventilation,
73,000 c.f.m. This allows the air to be introduced as cool as
desirable, being independent of remainder of plant.

PRELIMINARY STUDIES FOR HEATING & VENTILATING
PLANT - FIRST FLOOR OF NEW TECHNOLOGY.
Planned by John R. Freeman  Jan. 1913
The pipe coils over which the air would be forced by the fans for warming up to about 65 or 68 degrees Fahrenheit, are so spaced that double (or perhaps treble) the ordinary area of pipe to a cubic foot of air, can be put in service whenever in future desired, and by circulation of a refrigerating solution thru these added coils, the temperature could be lowered in extremely hot weather, or surplus moisture extracted from the air in "dog days". While it is not proposed to at first incur the expense for either filtration or cooling the air, it is believed wise to plan the buildings so that the additional apparatus could at any time be very cheaply added, or so, at least the processes can be tried out experimentally.

For supplying the additional heat required in class rooms, it is proposed to use a forced hot water system, made effective thru radiating coils placed immediately beneath the windows on the outer walls.

The main arteries of this heating system would be carried in underground passage ways, as shown just outside the basement walls, on Sheet No. 13 and Sheet No. 52.
Hollow Floor Details. (Sheet No. 11.)

The opposite drawing illustrates certain studies of the floor unit system, which were made with a view to obtaining rigidity for supporting laboratory apparatus while at the same time providing for the exceptionally long spans needed under the deep rooms required for the adopted system of unit bays.

This floor also was designed to permit of ventilation thru either floor or ceiling, and for permitting a change in connection to either of the great ventilation ducts, as future occasion might require.

The peculiar form of the concrete arch was designed to give the utmost rigidity and at same time give open unobstructed space into which a small-sized man could enter for cleaning or repairs.

The system of structural steel work was designed to facilitate rapid erection.

As stated on Sheet No. 13, the main outside columns of concrete would be cast in horizontal molds and hoisted into place, and connected to the steel skeleton by projecting irons forming an integral part of the column.
The Soft Foundation.

Sheets Nos. 5, 6, 7, 8, and 52 relate particularly to the foundation problem, which presents many interesting questions.

As is shown on No. 5, buildings in the neighborhood have settled very seriously but generally without cracking their walls.

For example, the Metropolitan Storage Warehouse, opposite the northwesterly corner of the site, is said to have been settling at the rate of about an inch per year, steadily for more than ten years past, and the Metropolitan Sewer, a hundred yards northerly from the Institute site, with no great weight of neighboring buildings on the ground, has settled more than two feet during the past eighteen years.

Curbstones and sewers and buildings all about this region have settled more or less and to an extent which in the case of buildings is mostly uncertain, because of no sufficiently definite measurements or levels having been recorded when the structures were built.

The reason for this settlement can be inferred from a study of Sheets Nos. 7 and 8, showing the soundings made on the Institute site when it was beneath the waters of the tidal estuary. The filling of twelve to fifteen feet of sand has added half to three-quarters of a ton per square foot to the natural load on the substrata.

Soon after making these studies of adjacent buildings, the writer suggested that his classmate, Professor Crosby, be called into the consultation, to direct the location of test borings into the substrata and to study the geological cause for this settlement, which appeared most probably due to the slow squeezing out of water from the pores of the fine, soft clay by the added weight.
Sheet No. 6 represents the results of the borings so far as completed up to December 29th, but subsequently to that date several additional borings have been made and some are still in progress under Professor Crosby's supervision, to test his hypothesis that this settlement is perhaps due, not so much to the soft, blue clay, as to a stratum of peat, deeply buried beneath more recent deposits of soft, waterborne sediment, and lying largely in proximity to or outside of the old shore line, indicated upon Sheets Nos. 7 and 8.

If the presence and limiting position of this peat along the ancient shore line are borne out by the later borings, it will tend to show that the settlement directly over the Institute site, will be materially less than in the region immediately north and northwest outside the Institute's land, where, according to Sheet No. 5, the greatest settlements have been observed.

In general, it may be noted from Sheet No. 6 that the bedrock is from 120 to 130 feet below the present surface of the ground and that the top of the slate ledge appears to be remarkably level and that the deposits are very uniform in their character, all thus tending to indicate a uniform and gentle type of settlement, which will not be likely to cause serious cracks, if the foundations are properly planned.
These classifications of material penetrated are from the field record and are subject to revision by Prof. Crosby.
A Floating Foundation. (Sheet No. 51.)

This study was made for the purpose of demonstrating the feasibility of floating the entire group of buildings upon a foundation designed to stand uplift like the bottom of a ship, and thus competent to support the entire weight of the structure, however soft the substrata might be.

It will be noted that there would be no serious difficulty in thus floating the structure and that such work would not be exceptionally expensive and need not in any way lead to a rejection of the site or control the location of the buildings.

It will be noted that in this study of the extreme case, an arrangement was worked out whereby the exterior and interior columns which support the floors would have their bottoms supported upon continuous foundation walls, built in the form of gigantic girders of reinforced concrete. These girders beneath the outer walls are 26-1/2 feet and those beneath the internal columns are about 18-1/2 feet deep, thereby serving to rigidly support the superstructure and distribute the load over any uneven softness of ground.
Many studies and sketches for a dormitory plan were made with a view of obtaining something that could be built so cheaply that any room could be profitably leased at $100. for the eight month term, and to obtaining at the same time an arrangement in which so far as practicable one room would be as good as another so that all might be leased on a level basis without distinction as to price, and promote the democracy of student life.

The best results in dormitory life appear to be obtained when not more than fifty, or at most seventy-five men occupy one building.

The problem here on the Technology site was particularly difficult, because of the restricted area available, but it is believed that the arrangement here shown would serve the purpose well and that within the two groups shown on the ground plan and in the following perspective sketches, that a thousand or possibly twelve hundred men could be comfortably housed, in rooms everyone of which would give an abundance of light, space and fresh air and all with excellent social facilities. They are placed bordering the north and easterly ends, partly for economy of space but mainly with a view to the future and to providing an interesting border for the back campus, on which the engineering laboratories also front. The rule of no entrance except across the campus would be enforced by simply having no doors on the outer side, and by means of a tall ornamental iron fence all along the street line with a 10-foot margin of grass between the fence and the face of the building, so there could be no temptation to use the windows for doorways.

The ample porches, which would be banked around their edge with permanent seats and with their roofs also available in pleasant
weather, are designed particularly to invite social intercourse; but with no possibility of the groups being too large.

It will be noted that an ample, cheerful reception room is provided on the ground floor and that above this a common room extends the entire width of the house, covering about the same space that is elsewhere occupied by four chambers.

This design was worked out with the deliberate intention of frowning upon luxury and encouraging simplicity, and of taking the model for chambers rather from the United States military academy than from the too luxurious and inefficient room plans of certain well-known college dormitories.

It is proposed that reinforced concrete construction would be used for all floors and interior partitions but that the outside would be made of a deep red brick, with trimmings of white moulded concrete, the whole being somewhat on the Philadelphia colonial type. This, the writer believes, would give a beautiful background to help set off the white mass of the main buildings as seen from the river and would also add variety and interest to the back campus.

A roof garden is provided on top of each building, which would be comfortable for some weeks, Spring and Fall, and would serve well in the project for a future summer school. The covered portion gives a retreat to which chairs and tables can be taken on rainy days, and a good place for those who like sleeping in the open air to place their cots.

The tennis courts are purposely given the greatest possible number, convenience and accessibility, for purpose of promoting wholesome exercise in the open air, by the greatest possible number of students.
PERSPECTIVE SKETCH:
STUDENT DORMITORIES
NEW TECHNOLOGY

Planned by John R. Freeman.
Assignment of Rooms.

Altho various preliminary studies of these had been made, using plans like Sheets No. 36, 37, 38 and 39 as a basis and marking out individual lecture rooms, class rooms, Faculty offices, etc., along the general order indicated on Sheets No. 41 and 47, this work was still in progress and hardly more than two-thirds completed when the drawings were turned over to the architect, and only outlined in pencil upon skeleton floor plans like those which follow.

The arrangement of skeleton construction and non-supporting partitions permits great flexibility and readjustment in this arrangement.
Fire Walls.

It will be noted from Sheets No. 36, 37, 39, etc., that careful attention has been given to the subdivision of the buildings by fire walls into floor areas of moderate size, notwithstanding it is proposed to build entirely of unburnable material.

These fire walls, as indicated most plainly on Sheet No. 47, are so placed as not to interfere with the general flexibility of adjustment and change of partitions, nor do they in any case cut off the broad corridors in an unsightly way.
Front Elevation Electrical Laboratory.

The opposite drawing shows the central rear building, which these plans assume would be devoted primarily to the great laboratories of Electrical Engineering, Mechanical Engineering and Naval Architecture. Here, again, it is believed we can have all of the efficiency of the factory type, with its abundant illumination, combined with classical outline and a dignified beautiful exterior.
The rear elevation of the entire group of the Institute buildings as seen from the back campus is shown in the opposite drawing.

In the center is the building described on the previous page. Immediately to its left the tower, surmounted by clock and observatory dome, houses the tall steel tank of the hydraulic laboratory. In the center behind the chimney, is the dome over the great auditorium. Between the rear ends of the wing buildings, one housing the laboratory of Mechanical Arts, the other the Metallurgical laboratory, is seen the open colonnade already described, beyond which are located at the right, the cloister garden, and at the left, the outdoor laboratories and the tanks belonging to the Department of Naval Architecture and Hydraulics.
The Naval Tank and the Hydraulic Laboratories.

The writer, who happened to have been Chief Engineer of the preliminary investigations and plans for converting the tidal estuary of the Charles into a lake at constant level, filled with water more or less fresh and from the information thus obtained and from these later studies, is confident that a design can be successfully worked out, in which boats can be tested in the tank and then in the open basin, but the water in the fall is too salt and possibly with too little free oxygen to be well adapted for use in the hydraulic laboratory, altho it would serve in the spring.

A boating house for athletics and exercise can be worked into the project in a very satisfactory way as outlined on Sheet No.
The Hydraulic Laboratory.

Since the writer soon after leaving Technology had the good fortune to become principal assistant to Hiram F. Mills, and worked for many months on his hydraulic experiments at Lawrence and for many years also enjoyed the friendship of the late James B. Francis, it is not strange that special interest was taken in the design of a laboratory intended to contribute to the advance of hydraulic knowledge as well as give instruction to undergraduates in the manipulation of hydraulic measurements.

The plans, tho nearly completed in pencil in their preliminary form, are not in shape to photograph and so only a brief specification can be given here.

It is planned to give facilities for testing the discharge over various shapes of weir crest with great precision with direct measurements of volume in the large tank, and depths up to five feet over a crest fifteen feet long, the same water being circulated over and over, lifted by an electrically driven propeller pump. The long channel leading to the weir is adapted for current meter testing in variable disturbed currents, and a grant venturi meter, molded in the concrete foundation, serves to give a constant check measurement on the water returning thru it to the pump.

Propeller models and various types of pump and turbine, the Humphrey Gas Pump for example, could be tested and have their discharge measured. The tall tower contains a steel standpipe, 20 feet in diameter by 130 feet high, for use in pump and model turbine testing, and its top is made available for geodetic and astronomical work.

The precision of tank measurement is obtained by a swinging gate connected to a chronograph for timing the flow.
DIE EISENBEТОONHALLE
AUF DER INTERNATIONALEN BAUFACH-AUSSTELLUNG
LEIPZIG 1913
Die Eisenbetonhalle
auf der Internationalen Baufach-Ausstellung Leipzig 1913.


Aus den diesem Büchlein beigegebenen Abbildungen, läßt sich die Lage der Halle und ihre Gliederung gut erkennen. Das Gebäude wendet seine Mittelfront der Lindenallee der Ausstellung zu, diese wirkungsvoll abschließend, und zeigt in der Architektur des Vorbaues, in der Säulenstellung des Haupteinganges mit Architrav, Hauptsims und Giebeldreieck künstlerisch vollendete Formen in Betonausführung, die mit der breiten Freitreppe die Schönheit des

Von der Vorhalle aus gelangt man durch die weite Mittelöffnung in den Repräsentationsraum des Baues, die 30 m weite Kuppelhalle. Die lediglich von 16 Eisenbetonwandsäulen getragene Eisenbetonkuppel ist frei auf den eingefügten Verbindungskonstruktionen, dem Architrav mit Sims und Fries aufgelagert und kann so allen Volumenänderungen bei Temperaturwechsel ungehindert folgen.

Die Herstellungsfest der Kuppel bis zur völligen Entfernung der Holzschalungen und Gerüste währte vom 13. November 1912 bis Anfang April 1913, also insgesamt 4 1/2 Monate, eine Leistung, die bisher nirgends erreicht wurde und allgemein anerkannt wird. Die Kuppel selbst besteht aus 16 Rippen, die sich unten gelenkartig gegen einen Zugring stützen, während sie oben mit einem Druckring starr verbunden sind.

Zwischen die Rippen sind Zwischenringe gespannt, auf denen eine Eisenbetonplatte von nur 8 cm Stärke gelagert ist. Die Innenansicht ist ohne jeden Putz und so gelassen, wie sie aus der Schalung kam, die Architekturelemente des seitlichen Aufbaues sind steinmäßig bearbeitet.

Rings um den Kuppelraum gruppiert sich die Rundbauten im Erd- und Obergeschoß, in denen die 7,0 m weit gespannten Decken mit ebener Untersicht bemerkenswert sind, die im Erdgeschoß teilweise als Hohldecken, im Obergeschoß als Decken mit Eisenbeton-Oberzügen ausgebildet wurden. Zu beachten sind die inneren Oberlichtkonstruktionen, die im ganzen Bau als gekreuze Eisenbetonrippen ausgeführt wurden.

Ihren Abschluß finden die oberen Rundgänge im Vorbau in dem architektonisch reichen Hauptaum mit 11,0 m weit gespannter, profiliertter Eisenbetondecke besonders charakteristischer Form. Der andere Abschluß der oberen Rundgänge wird durch den Rückbau gebildet, der die gleichen Decken wie der eben erwähnte Vorbau besitzt, und in dem die geräumige, mit Brüstungen, Pfeilern und Nischenausbildungen sehr gefällig wirkende Haupttreppe liegt.
Das gleiche ist bei der rechten Seitenhalle der Fall, wo beim Eintritt der Blick auf die hübsche Betontreppe gelenkt wird. Die rechte Seitenhalle ist unterkellert, 24 m breit und in dem 10,5 m weiten Mittelschiff eingeschossig, in den beiden Seiten Schiffen zweigeschossig ausgebildet. Die kontinuierlich ausgebildete Decke fügt sich mit ihren gefälligen Bindern in der Halle entsprechender Dreiteilung zweckmäßig in die Gebäude dachform ein.

Die linke Seitenhalle ist frei mit einer einzigen Decke zwischen 24 m weiten ZweigelenkBalkenbindern über spannt. In den Seitenpartien wieder zweigeschossig, ist die Ausbildung der Galerien so erfolgt, daß später eine Verschmälerung um die Hälfte erfolgen kann, und die verbleibenden Teile ausschließlich durch die aus den Binderstielen vorgestreckten Konsole getragen werden.

Die Bausumme der Eisenbetonhalle beläuft sich auf etwa M. 800000.—. Die Halle bleibt für Ausstellungs zwecke, für Abhaltung von Festlichkeiten usw. ständig erhalten, sie ist von der Stadt Leipzig übernommen worden, die sich mit M. 300000.— an den Baukosten beteiligt hat. Das Entstehen des Werkes ist außerdem durch folgende Beiträge ermöglicht worden:

Verein deutscher Portlandzement-Fabrikanten, Platzmiete von M. 25000.—, Zementlieferungen seiner Mitglieder im Werte von M. 50000.—.

Deutscher Beton-Verein (E. V.) und seine ausstellenden Mitglieder, Platzmieten von zusammen ca. M. 100000.—.

Außerdem zahlt die Internationale Baufach-Ausstellung Leipzig eine Entschädigung für die jetzige Benutzung der Halle und gewährt auch die Internationale Ausstellung für Buchgewerbe und Graphik eine solche für die Benutzung im Jahre 1914.

fügt, und das Hydrosandsteinwerk Schulze & Co., Leipzig, führte die Kunststeinstufen für die drei Freitreppe in Muschelkalkbeton zum Vorzugpreise aus.

Während der Internationalen Baufach-Ausstellung gruppieren sich die in der Eisenbetonhalle veranstalteten Einzelausstellungen wie folgt:

**Vorhalle:** Portland-Zement-Fabrik „Stern“, Toepffer, Grawitz & Co., Finkenwalde bei Stettin.

**Kuppelraum:** E. Schwenk-Ulm (Fußbodenplatten und Brunnen in Kunststein).


**Rechte Seitenhalle:** Ausstellung der Stadt Leipzig.

**Linke Seitenhalle:** Ausstellung des Preußischen Staates.
Ausführung der Kellerdecke des Mittelbaues
Aufstellen der Rüstungen für die Kuppel und den Vorbau
Die Einschalung der westlichen Seitenhalle und des Rückbaues, Sparren auf der Kuppelrüstung fertig verlegt
Einschalung der großen Binder der östlichen Halle, Verlegen der Holzlunetten auf der glatten Kupfenschalung
Die Einschalung der östlichen Seitenhalle und des Rückbaues
Die Armierung des Zugringes am Fuße der Kuppel mit Schuh zur Auflagerung der Rippen.
Armierung des Druckringes an der Kuppelkrone
Armierung der großen Binder der östlichen Halle
Äußere Schalung der Kuppelrippen, Architrav des Vorbaues in Schalung
Draufsicht auf die Dach- und Oberlichtkonstruktion der westlichen Seitenhalle
Fertige Kuppel nach Entfernung der äußeren Schalung
Vorbau während der steinmetzmäßigen Bearbeitung
Blick in die westliche Seitenhalle
Blick in den Kuppelraum
Blick in die östliche Seitenhalle
Außenansicht der Eisenbetonhalle