

PERMANENT EXHIBITION HALL FOR TRADE AND INDUSTRY IN PRECAST
PRESTRESSED CONCRETE

Submitted in partial fulfillment of the requirements for the degree of
Master of Architecture at the Massachusetts Institute of Technology

June 1963

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June 25, 1963

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Dear Dean Belluschi:

In partial fulfillment of the requirements for the degree of Master of Architecture,

I hereby submit this thesis project entitled,

PERMANENT EXHIBITION HALL FOR TRADE AND INDUSTRY IN

PRECAST PRESTRESSED CONCRETE

Respectfully,

Dragoljub GJ. Vukovic

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ABSTRACT

"Nobody who has paid any attention to the peculiar features of the present era, will doubt for a moment that we are living at a period of most wonderful transition, which tends rapidly to accomplish that great end, to which indeed, all history points, realization of mankind....."

The distance which separate the different nations and parts of the globe are rapidly vanishing before the achievements of modern inventions, and we can traverse them with incredible ease.....

Thought is communicated with the rapidity and even power of lightning. On the other hand, the great principle of division of labour, which may be called the moving power of civilization, is being extended to all branches of science, industry and art.

The products of all quarters of the globe are placed at our disposal and we have only to choose which is the best and the cheapest for our purposes....."

Words used by Prince Albert in his speech at the Lord Mayor's banquet given in 1850 to win the city over to the idea of the exhibition.

EXHIBITIONS AND FAIRS

It is commonly believed that the origin of modern exhibition lies in the fairs which were to be found in so many parts of Europe during the Middle Ages and which played so indispensable a part in the economic system of the time. Such a belief is natural since fairs and exhibitions have a great many points in common, and, moreover, the history of the one largely begins where the history of the other breaks off. So closely linked are the two that in America the word "fair" is commonly used as a synonym for "exhibition," and the English themselves treat some fairs - but not others - as exhibitions.

Nevertheless there is a difference between them, a difference which may perhaps be expressed thus. The essential thing about a fair is that things should be sold there, although it usually, but not inevitably, happens that what is for sale is also displayed. The essential thing about an exhibition is that things should be displayed there, although very often, but not always, the purpose of displaying them is to stimulate sales. There is a great resemblance and a considerable area of overlapping, but not an identity.

The point may become clearer if we take a glance, through the eyes of Daniel Defoe, at an example of the medieval fair. Writing of his visit in 1723 to Sturbridge Fair, on the outskirts of Cambridge, which was the greatest medieval fair in this country, Defoe said:

This Fair is not only the greatest in the whole Nation, but in the World; nor, if I may believe those who have seen them all, is the Fair at Leipsick in Saxony, the Mart at Frankfort on the Main, or the Fairs at Nuremberg or Augsburg, any way to compare to this Fair at Sturbridge.

It is kept in a large Cornfield, near Casterton, extending from the side of the River Cam, towards the Road, for about half a Mile Square....

It is impossible to describe all the Parts and Circumstances of this Fair exactly; the Shops are placed in Rows like Streets, whereof one is call'd Cheapside; and here, as in several other Streets, are all sorts of Trades, who sell by Retale... Taverns, Brandy-Shops, and Eating Houses, innumerable, and all in Tents, and Booths, as above.

In another Street parallel with the Road are like Rows of Booths, but larger, and more intermingled with Wholesale Dealers, and on one side, passing out of this last Street to the Left Hand, is a formal great Square, form'd by the largest Booths, built in that Form, and which they called the Duddery. Here are the Clothiers from Halifax, Leeds, Wakefield and Huthersfield in Yorkshire, and from Rochdale, Bury, ets., in Lancashire.

I might go on here to speak of several other sorts of English manufacturers, which are brought hither to be sold; as all sorts of wrought Iron, and Brassware from Birmingham; Ed'd Tools, Knives, &c., from Sheffield; Glass-Wares and Stockings from Nottingham and Leicester; and an infinite Throng of other things of smaller value, every morning.

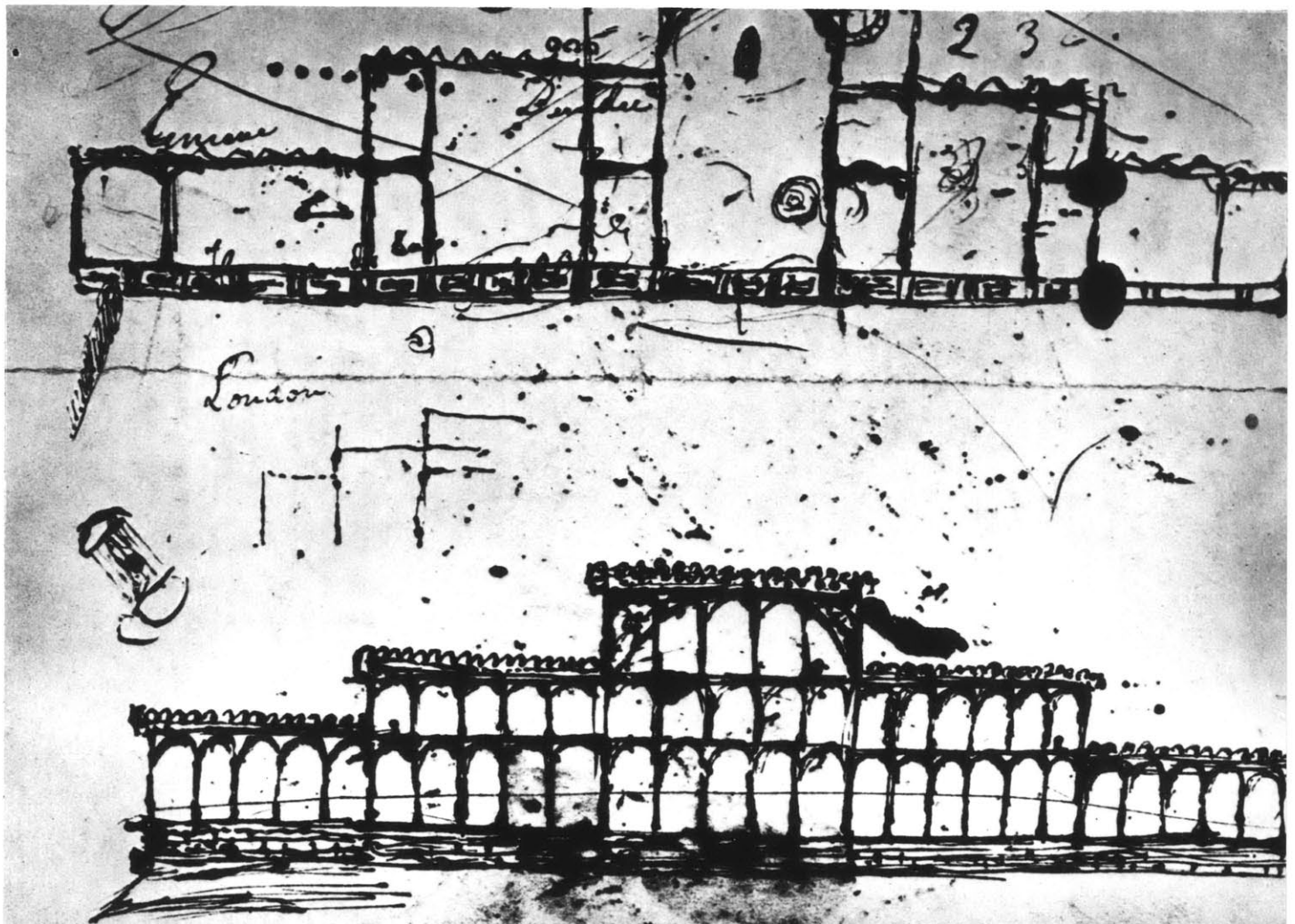
Towards the latter End of the Fair, and when the great Hurry of Wholesale Business begins to be over, the Gentry come in, from all parts of the Country round; and tho' they come for their diversion; yet 'tis not a little Money, they lay out; which generally falls to the share of the Retailers, such as Toy-Shops, Goldsmiths, Brasiers, Ironmongers, Turners, Milleners, Mercers, &c, and some loose Coins, they reserve for the Puppet Shows, Drolls, Rope-Dancers, and such-like, of which there is no want, though not considerable like the rest: The last Day of the Fair is the Horse-Fair, where the Whole is closed with both Horse and Foot-Races, to divert the meaner Sort of People only, for nothing considerable is offered of that Kind: Thus Ends the whole Fair, and in less than a week more, there is scarce any sign left that there has been such a thing there....

The Story of Exhibitions

by Keneth Luck Hurst

The Studio Publication

London, 1951



Manchester, Buxton, Matlock, and Midlands Junction Railway. 13

No.

MEMORANDUM

o'clock Train.

Overland to *Nottingham* STATION.

day, the

15 day of

1845

Immediate.

TELEGRAPHIC DISPATCH

From Mr. Nicholson to Mr. Paxton Chatsworth
I have the pleasure to say that
Mr. Paxton's plan has been approved by the
Royal Commission

THE GREAT EXHIBITION OF 1851.

2. Exhibition Hall covered nineteen acres on the south side of Hyde Park. The original sketch was made by Paxton, the architect, on blotting paper.

INTRODUCTION

The permanent exhibition hall for trade and industry is a new interpretation of several known ways of trading and marketing combined together. Through the centuries the fairs existed as by necessity. They were a natural way to exchange the agricultural, manufactured and other consumer goods. The East, in the middle ages and renaissance, was famous for its big cities with markets and business districts. Yet not until the end of the eighteenth century, was there a beginning of big state organized exhibitions, and the appearance of especially designed buildings and other covered spaces to serve the purpose of the exhibit.

In the past, the spaces where the Greeks or Romans displayed their goods, the well organized markets were in the form of agoras and basilicas. Many open area markets existed in the past, but also many cities just formed a business district with separate manufacturing or selling spaces. They were the core of what was to come later - commerce, housing and financing.

Looking at the big marketing spaces, one can say, that the great "exhibitions" were created in order to promote the trade or industry of one, or of many countries, depending on programme. The big exhibition buildings are the creation of the technical revolution at the beginning of the nineteenth century.

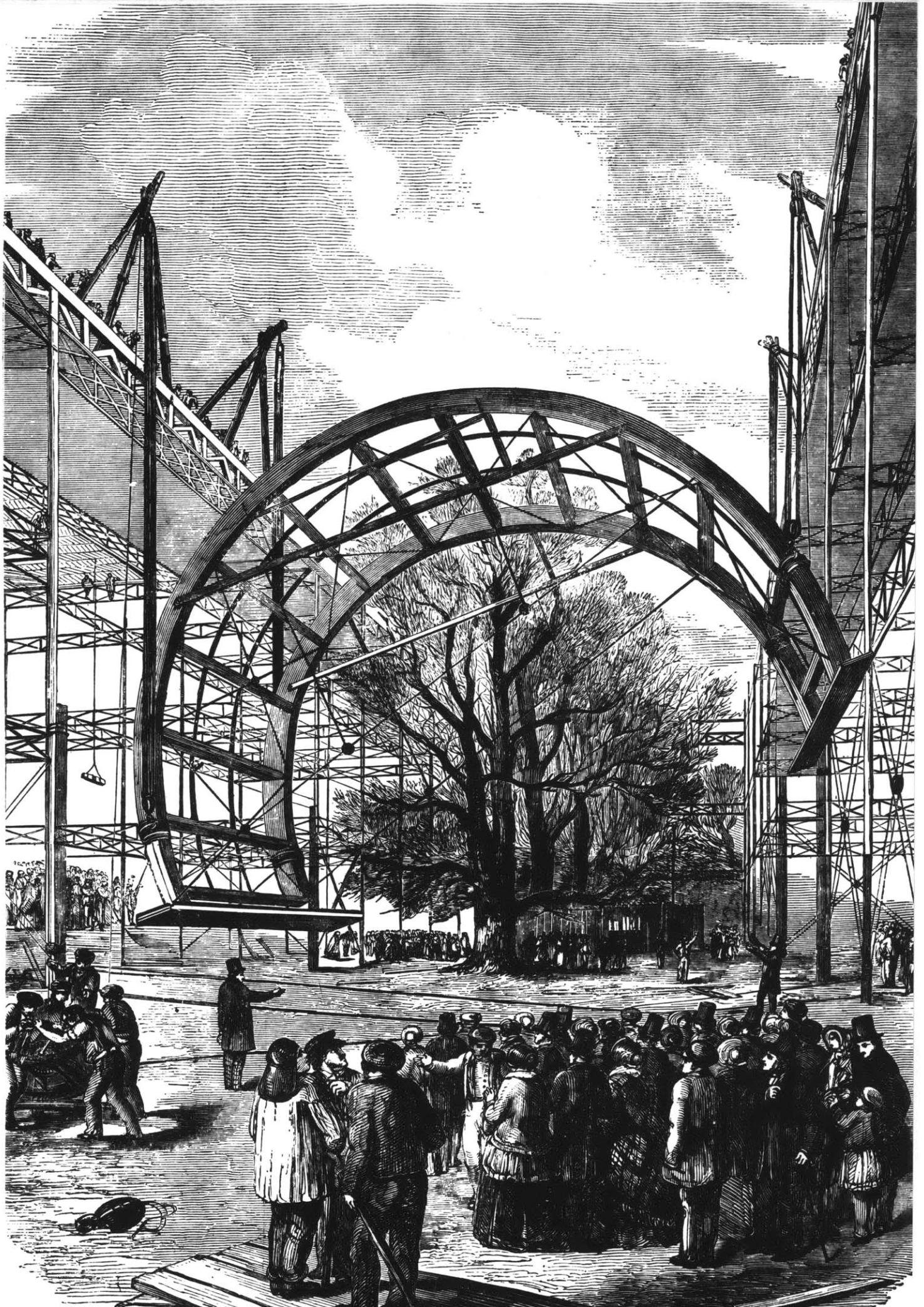
The series of exhibitions were opened by the French in 1798 who really started the modern exhibition movement. At the beginning, the exhibitions were held in



different buildings, borrowed for the occasion and only later acquired their own land and buildings especially made for the purpose. The most important exhibition building in the nineteenth century was the exhibition hall for the 1851 Exhibition held in London. The huge building which sheltered the International British Exhibition was constructed of iron and glass and was soon called the "Crystal Palace," the name given by "Punch" and later officially accepted.

The designer of this building, Joseph Paxton, was a man who had already studied and built, on a small scale, using a new system and new materials. His preceding experience was work on a conservatory building (greenhouse) for the Duke of Devonshire. In a competition which was already closed, he entered and presented the new architectural design of an exhibition hall, with exact description of the building, elements to be employed, method of fabrication, and the way of assembling, and, above all, the construction schedule (see picture #1). In his proposal, Paxton showed the complete superiority of his work. He designed, rather the principle, the system of the structure and the technique of application, and, in all, the universality of it.

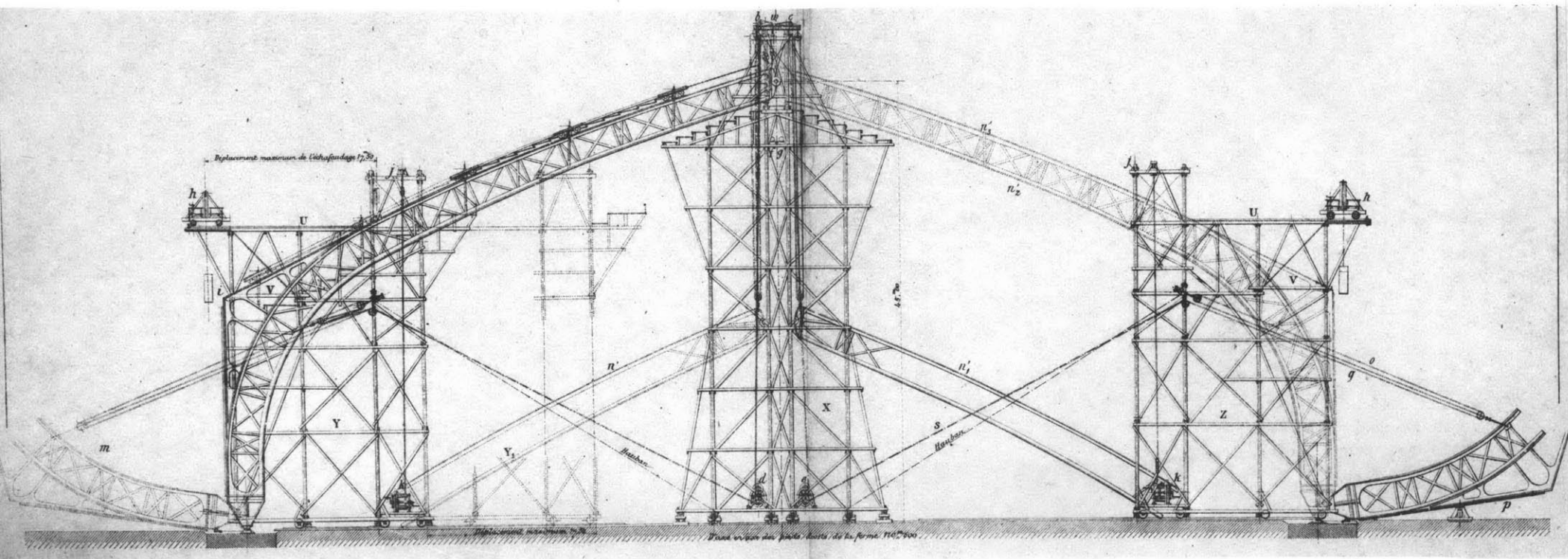
The columns for each bay were cast iron hollow tubes of constant outside diameter. The thickness of the column wall decreased with the height, as the columns support less in the upper parts. Each girder or beam or any other element was checked on the site (see picture #1), but everything but erection was done in the factory. It is one of the best examples of prefabrication in the early days of modern technology. The building was erected in six months, the record time for such a big space. The



building covered some nineteen acres on a site of some twenty-six acres. It was 1,851 feet long and 408 feet broad. Nearly every measurement in the building was a dividend or multiple of 24. Height of the nave was 63 feet, of the transept 108 feet (see picture #2). It had three entrances, seventeen exits, and ten double staircases in galleries. There were 293,655 panes of glass 4' x 12". The space occupied by exhibits was 338,714 sq. ft., (horizontally) and 653,103 sq. ft., (vertically) a total of 991,857 sq. ft. There were many steam engines running and there was a separate boiler room to supply necessary steam for machinery in motion. The exhibit needed 100,000 - 270,000 gallons of water a day.

From the pictures one can see the general idea of Paxton. The big success for the progressive movement was the great impression obtained through the use of glass and lightweight iron - elements which allowed a good visibility and sense of refinement and elegance.

Thirty-eight years later another exhibition, this time French, created a building with a huge space which was for the French government to celebrate the 100 years of the French revolution. They opened an exhibition in 1889 in Paris and built for the occasion two exhibition features, a big hall so-called "La Galerie des Machinas" (see picture #3) and the Eiffel Tower. The Galerie des Machines, designed by architect Dutert, was a masterpiece of metallic architecture and its erection was also very mechanized in a sense, to secure great efficiency. Already, in this period, heavy gauge metal sheets and angles were



FRENCH EXHIBITION 1889 PARIS LA GALERIE DES MACHINES

available for the first time. The big frame of a nave was treated as an arch on three points. The span was 264 feet and the height of a ridge was about 150 feet above the floor. With all galleries together, the surface was about $(80,400m) = 895,960$ sq. ft.

Again, in 1900 the French government built two smaller permanent exhibition halls which exist until the present time "Le Petit Palais" and "Le Grand Palais" respectively done by Gerault, and Deglane, Thomas, and Louvet.

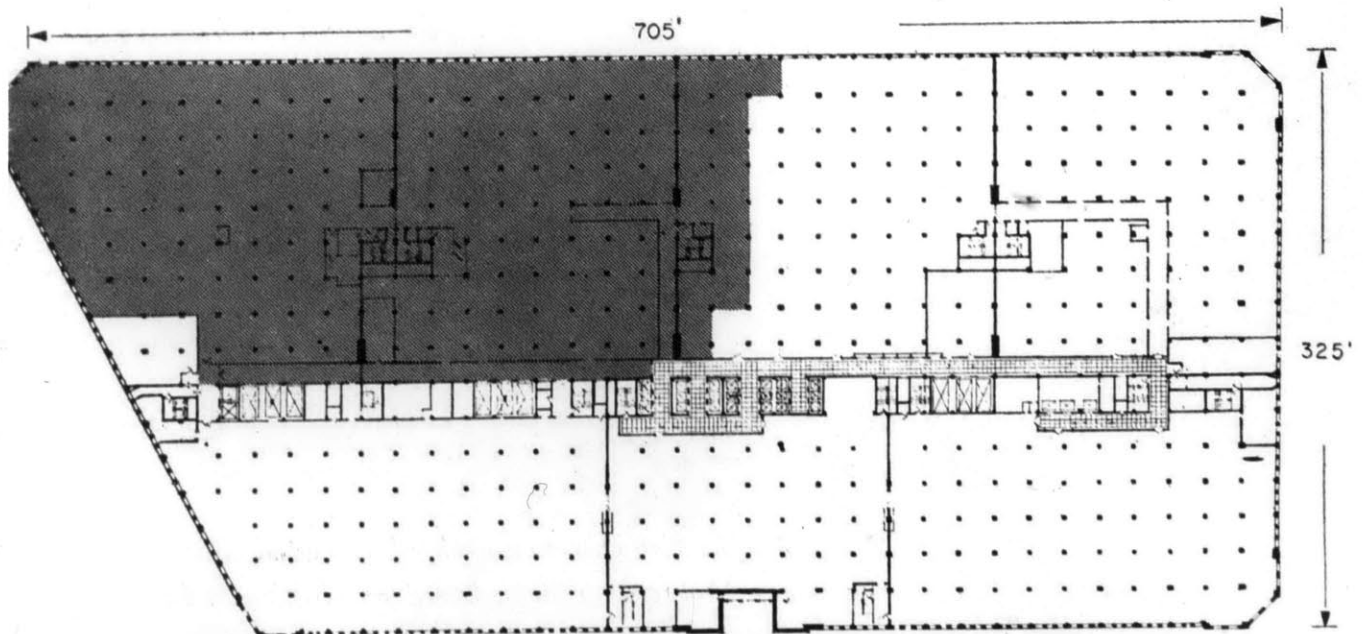
From 1900 on, many countries organized exhibitions and built different types of buildings to shelter groups of exhibits. Many of those buildings did not have the flexibility or the great features of a multi-purpose hall, and the architecture was also a reason why many of them did not survive.

In recent history one could recall another kind of a big space containing building. This was a loft building built in Chicago in 1928 - 1930 and is said to be the biggest commercial building in the world. The Merchandise Mart was designed by architects Graham Anderson, Peobst and White. This huge building stands 18 floors high and covers an area with sides 325×725 ft. Gross floor area is 4,003,400 sq. ft. and net floor area is 3,040,700 sq. ft. See picture #4).

Prior to 1945, when the building was remodeled, 40% of the occupants of the building were department store offices and warehouse operations. Thirty per

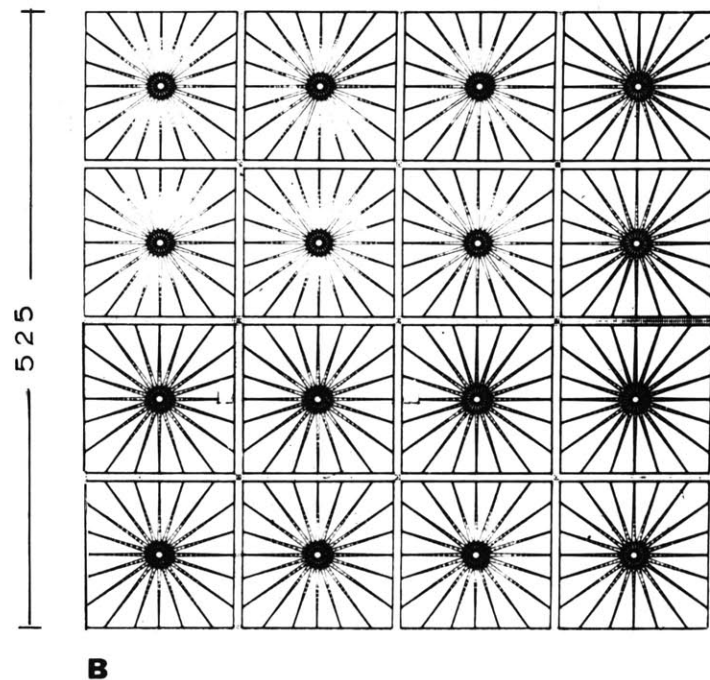
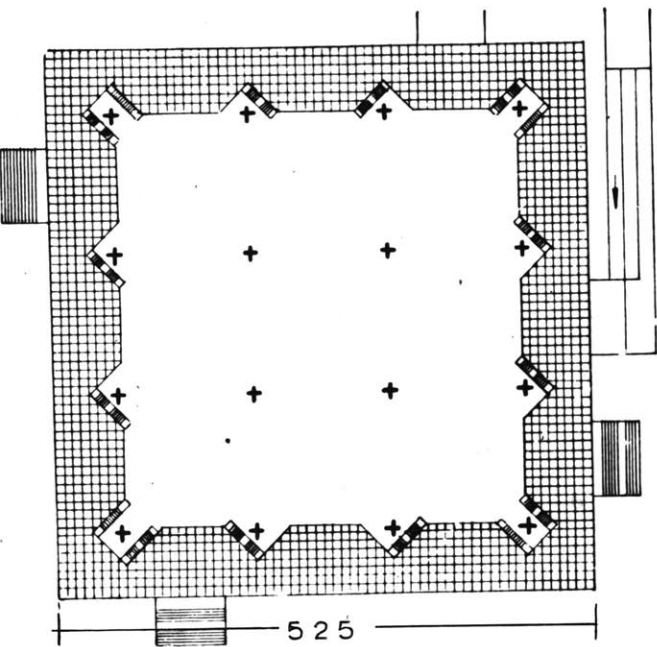


Night view of Mart across the river front plaza shows promotional lighting of exterior. Use of new sealed-beam lights for this purpose is part of the Mart's comprehensive modernization program. Radio and TV studios occupy much of the tower which extends seven stories above the 18-story building. Floor plan, below, shows typical third floor with Quaker Oats' space in gray.

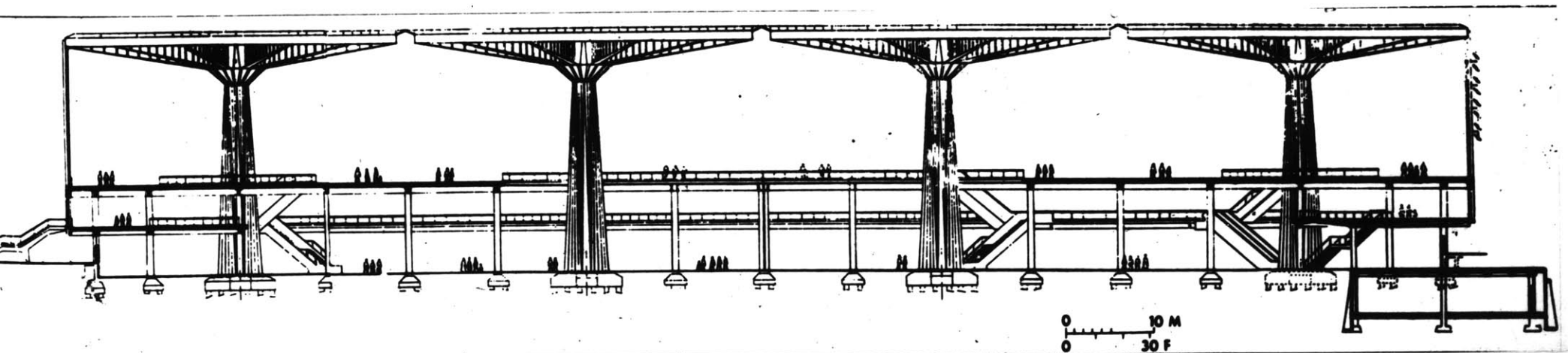


cent of the space was occupied by exhibitors and 10% devoted to light manufacturing, and the rest rented to the Federal Government. In 1945 the new owner and manager changed the character of the building and converted most of the area to offices. The floor construction was calculated for heavy line loads. The building is well located on the edge of Chicago's Loop, the economical and business downtown center area and lies on the canals which are directly connected with piers. In the basement are six railroad sidings and 50 truck loading platforms. The Merchandise Mart provided space for permanent exhibitors of different trades and is very convenient for that purpose. The lack of a central space which would unify the spaces in an integral visual entity architecturally as well as psychologically, does not make this building fit to serve as a successful prototype for a permanent exhibition hall.

In 1953 the French government commissioned a new building for temporary exhibitions. Demands for more exhibit spaces found an answer in a big triangular shell building on the outskirts of booming Paris, "Le Centre National des Industries et de Techniques." (C.N.I.T.) Plans, were completed in 1953 and it opened in 1958. The equilateral triangular plan of the building has a side arch of 715 ft. span. Total area is 970,000 sq. ft. of which approximately 755,000 can be used for display purposes, which represents three times the space of the Grand Palais. Only the ground floor is subdivided by columns. All other floors are free of obstructions and therefore completely flexible.



industrial labor exposition turin



The site of the C.N.I.T. was chosen again as always in the past on the outskirts of Paris, far from any other actual exhibition area, and is the part of the city where future and actual expansion of the business district of Paris is expected. The site is near a railroad track, has a surrounding area for additional parking lot for 10,000 cars and connections to several main roads.

The structure is partially precast, prestressed and posttensioned. Functionally, the space is well organized and also the visual effect of the spaciousness is dominant, which makes a very agreeable sense of open space.

Treated as an exhibition space this building perfectly responds to the increasing demand for good exhibiting.

Recently in 1960-61 in Turin, Italy, P. L. Nevri designed an exhibition hall (see picture #5) with a double purpose. This exhibition hall, after the exhibit, will be converted into an industrial school. The building is now housing the Industrial Labor Exposition and represents a huge box of 525 feet square and 90 feet high. It consists of 16 entirely independent columns each tapering from 18' to 9' in an 82 foot run and capped with prefabricated steel umbrellas. The covered surface is 250,000 square feet and the exhibit surface is about 450,000 square feet. On previous pages I have tried to schematically outline some of the buildings which fulfilled the function of an exhibition hall. They were not designed to carry out any other function and they did not have incorporated office

spaces. None of these buildings would meet today's necessities. A permanent exhibition hall must combine the function of an office building with that of an exhibition hall and it must have above all, flexibility of space usage.

The trend to create this new type of building is only several years old. There were many attempts to establish exhibition halls in big cities such as New Orleans, Boston, and New York. New Orleans is operating the so called World Trade Center which is located in a building adapted to serve this new purpose.

New York is also building a World Trade Center in its downtown area - near Wall Street and on the East River side with all facilities for good transportation and handling and not far from the New York Stock Exchange which is building a new house in the vicinity.

PROGRAM RESEARCH

P.E.H.* is a result of ever expanding needs of a growing industry and national and international trade make a constant effort to keep up with the competitive prices and inventive spirit of contemporary production. Relatively large and strongly industrialized economically growing cities are capable of affording such a building which should amortize itself in short time and bring up the efficiency of trade and business to new peaks.

Today's population explosion, fast cars and air transportation, a growing demand and production, with export and import increases, advertising through exhibitions, marketing and new ways and means of persuasion, constant changes and improvement in models and promotions of new products are causes for a need of a P.E.H. But the possession of a P.E.H. building by itself is not enough. All other conveniences must be on hand to the businessman pressed by shortage of time and experience. So the office area must be near the exposition area, and also if possible within a very short distance in the same building, also all other facilities. The representative, of commerce and industry, and their customers must find all banking facilities in the building through the branches of banks on credit consultations, international marketing, etc.

* P.E.H. - Permanent Exhibition Hall

The fast tele-communications with the exterior must be included and also the interpreters. The spaces for gatherings and catering, public conveniences, services, transport and handling of exhibitions and stock and storage of goods in the building should be possible as is the Merchandise Mart.

SITE

Building must be sited in downtown or near downtown area where the business district is located. The convenience of a nearby water front and a railroad, or other connecting roads or great commercial capacity should not be neglected, but considered as a vital part of a site.

The water front of a river, lake or sea could bring an appropriate scale to the building and it should be arranged as a park and partly as a dock for barges and ships.

It would be convenient to have the buildings clear on all sides of other buildings. The free area around should serve as an outdoor exhibition space for temporary or permanent exhibition of heavy or bulky samples, and give the proper scale and importance to the main structure. It is desirable to have one of the sides of the building considered as a main entrance and to have, if possible, a large esplanade front of it. This esplanade could be also the roof of a large underground garage.

The connecting roads to the esplanade or plaza or to the garage should be arranged through a circular type pattern which will not allow congestion and bottle necks even in the peak of traffic.

BUILDING

The building should be capable of offering spaces and functions for:

- 1) Offices of trade and industry representatives of all branches with all necessary facilities and public conveniences such as; restaurants, snack bar, lounges, conference rooms, auditoriums, information booths, etc.
- 2) Adjacent exhibition areas, and
- 3) Bigger exhibition areas for permanent and temporary exhibitions, etc.

The offices should represent about $1/4$ of all net required area, and another ($1/4$) of net area should be devoted to permanent exhibit areas. The rest ($1/2$) of the space should be considered as an area for bigger permanent or temporary exhibits, or several smaller held simultaneously.

It is advisable to avoid columns in exhibitions area, or to permit a minimum of them on the perimeter or edges of it. The flexibility of all floors should be arranged for the possibility of conversion of office spaces into exhibit spaces and vice versa.

The air conditioning should allow good working conditions in all areas no matter what the purpose of a particular area. There should be provision for easy connections and flexibility of office spaces according to needs. The floor height minimum in the offices ought to be 8'0" and a minimum room size ought to be 9'0" x 9'0".

CONSTRUCTION

The whole building construction should take advantage of recent technical improvements in reinforced and precast concrete. All building must be with precast, prestressed concrete elements. The system of the building thus should tend to solve the problem of the fast and economic carting and assembling the elements (columns, beams, girders, slabs, stairs, etc.). Adequate consideration should be given to the heating and ventilating and the system should be chosen according to specific needs of a respective area and should be integrated with the construction. The necessary spaces for a machine room and ducts should be provided for each floor.

Lighting: There should be provided chases and spaces for electrical ducts, conduits, and other equipment as connection boxes, switch board panels or transformer vaults for each floor. Electrical race ways should be laid in the constructive height of the floor system.

There must be public facilities for office and general use for each floor. The necessary toilets, powder rooms, stairs and elevators should be in accordance

with the law minimum requirements. The fire stairs should also enter into this category. The janitorial spaces must be big enough to shelter cleaning machines and other necessary cleaning equipment for a part of the floor area attended.

The number of bigger and smaller types of service elevators must be distributed evenly over entire floor area.

Telephone rooms and adequate connection boxes for each floor must also give good flexibility to each area.

The main entrance should have good and easy horizontal connections with rest of the areas and should be large enough to handle considerable numbers of people attending the building. The vertical ways (stairs and elevators) should be near to the main lobby hall or in it. The areas should have a flexibility to be shut off when an exhibition is in stage preparation without disturbing people attending the exhibitions or other events in progress. There should be provided facilities for general use for dining rooms and snack bars, larger area for rest and conferences, and also for special purposes of the people working in the offices. They will need auditoriums for big conferences and lectures, social gatherings and general smaller conference rooms. In the main floor there should be rooms for police station, fire department representative, ambulance and services. In the cellar the necessary storage space area for the bulk of the exhibitions coming, leaving and the handling of other material, as well as storage. The necessary

area should be equipped with a dock for loading and unloading all the exhibit materials and should be located conveniently to the service elevators. The service elevators should be provided for each part of the floor area. Provide areas for sprinklers and water mains as well as fire stand pipes as required by law. Heating and cooling (systems) in the basement area and adequate feeding pipes for all ventilating units.

DESIGN

The main objective for this project of P.E.H. are the flexibility of the areas and the exhibitional character of all area (75%). The submitted design is one solution for attaining these objectives having in mind the technical development and practical possibilities of precast concrete. The design of the P.E.H. building is a plan of a square form with sides of 470' 0" in length (square donut). A typical floor consists of two floor surfaces 170' x 470" each = 79,700 sq. ft. Hence each floor plan has an area of $79,700 \times 2 = 160,000$ sq. ft. These two floor surfaces are parallel and staggered to make, where they do not overlap each other, spaces of a double height. The succession of small (a), larger (b), and largest (c) spaces is the main feature of the building. The entrance hall is in direct connection with central hollow core which goes through the entire height of the building, and visually and spatically connects all floors into one entity. The four open stair cases (which could be closed if law requires) connects all vertically floors (8) of which 6 are above and two below the grade. The core (open area) gets the natural light through a double glass roof and ceiling in between which are concealed a light sources for all general and spot lighting and hoists for different hanging advertisements. The entrance floor is a main floor area from which one can go to all four stairs or elevator groups. The service elevator serves each floor on opposite sides of the stairs. Each floor surface has one big 10' x 20' elevator and one smaller 6' x 10' elevator. Each floor is connected with another floor by 12' passenger elevators of dimensions

8' x 8' each. The elevators are distributed in the groups of three. The 8 fire stairs are placed evenly through all floors. Under the grade level there are two floors. The basement floor is split leveled into an exhibition area and a big hall from which are entrances to several meeting rooms, conference rooms, auditoriums etc. In general, most of the social activities are done on this floor.

The cellar is a space which is under a basement and is provided with complete services for handling the exhibitions. The boiler room is also in the cellar as well as the cooling plant for the whole building. The independent power plant is in reserve in case of outside electric failure.

CONSTRUCTION DESIGN

To facilitate the organization and production of precast and prestressed elements a 30' -0 foot square module was chosen and, accordingly, respective spans as multiples of the same, 30', 90' and 150 feet. The problem was also to choose a ceiling and floor construction height which will give the maximum flexibility and yet be economical. Two spans, 90' and 150', were dominating in the final decision of the height of floor construction. The 30' span for the offices has also 6'0 depth of floor construction which on first sight does not look necessary. But having in mind that the complete flexibility of the area could need removal of the offices so that the space could be used for exhibition purposes, this

height is kept and used for necessary service space. The minimum height of the office space which could be 8'0" is flexible, and could be transformed into the big office space or conference rooms with total width of 30' x 90'. In that case the height of 8' is not recommended. The ceiling can be raised to 10' feet which is about the minimum height for this space. To satisfy all those conditions the clear height of the office floor is 10' - 0' feet.

The office spaces are grouped around a bigger and larger space without columns, dimensions 90' by 90' square. This space is bridged over by means of a two way girders supported on eight columns two girders are precast and pretensioned and two others, which cross, are precast, post-tensioned in order to allow the H & V as well as electrical equipment. The depth of the girders is calculated with 6' height as a vierendeel truss. This area and office space areas are treated for possible flexibility of expansion.

The third, kind of exhibition spaces which will be only generally speaking, an exhibition space is a void created by staggering two floor surfaces.

The girder which opens the big exhibitions space is calculated as a T beam, 10' - 0" on center and 150' - 0" span and rests on supports which are columns and short beams with shelf. The height of the girder is 6'0" and at appropriate places has an opening in the web for passage of ducts and other utility ducts H. & V. and electrical conduits. The live load for all flexible office or

exhibition area is 200 p/sq. and with additional charges of dead load 100 p/sq. ft. These girders will be precast, prestressed and partially post-tensioned and will have necessary openings in the web to permit a passage of ducts and other pipes and to permit housing of necessary spot and general lighting equipment.

In order to provide good secondary and more private connections to the office areas, a cantilevered post-tensioned beams create a corridor on the periphery of building. This cantilever serves as support for facade elements, in the details, a sample is shown of the front elevation precast element. The element has a deep profile in order to screen lighting fixtures for advertising and illumination of the building. All columns are calculated with a spiral steel armature and made in steel forms with a little prestressing for better handling. They are octagonal and have brackets for beams which are tapered off toward the base. The stirrups are extended in all brackets and calculated to take all shear of beam loads. In order to get a rectangular uniform grid which will serve as an electrical raceway, partition stop and visually from a distance, make a ceiling grid 10' - 0 high, the precast through beams are suspended over office and low height exhibition areas

CONSTRUCTION PROCEDURE

Because of the different length of the precast elements involved in construction, only the most heavy and long elements will be cast on the site. These elements are columns and 90 and 150 ft. girders. All other elements should be cast in the factory and transferred to the site according to building schedules. After the piles are driven into the positions and capped, first columns should be erected. The first part of the columns will go from the foundations to the first floor. Then the cellar and basement floor construction will be erected. When this is finished, the upper part of 1 - 6 floor columns will be shored and fixed to them. The fixing will be done by means of flush base plates with the recessed anchor bolts in both cases. This will provide connection in a compact manner. However, the splice will be made at the floor level as shown on details, and will be concealed in the floor slab thickness. The elements 150' feet long will be cast at the ground of the basement, then lifted in place by use of two cranes one over each side of the elevators.

For all precast prestressed elements calculations concrete of 5000 p.s.i. and wire of 240,000 p.s.i. strength were used. Cables in the web are to be bent, those in the bottom layer to be straight. The 150' foot girders are to be precast at the building site and to be lifted into place. All steel units shall be accurately placed in the position shown in the plans, and firmly held during the placing and setting of the concrete. The maximum stirrup spacing for beams and girders

shall not be more than three fourths of the depth of the beam. The minimum spacing both horizontally and vertically shall be three times the diameter of the wire or strand measured center to center.

All indicated beams, girders or posts are supported by means of steel plates, over concrete brackets and there the plates are welded together. Only the expansion joint is left out one side of the 150' -0 space T beam. The neoprene gasket between the plates will assure its smooth functioning.

The wind bracing will be assured by elevator walls and other mechanical room enclosures which go through all levels to the roof continuously.

Some elements as indicated (beam, girders) will be grounded to the columns by means of a structural steel anchor hooks which fit into premolded holes. Over precast concrete beams, vierendeel type and all other beams, the 10 x 10 feet 6" thick slab is laid down and anchored together forming a continuous surface.

The precast concrete slab element 10' x 10' and 6" thick is prestressed in two directions. The slab is calculated to carry 200 p.s.f. live load and 100 p.s.f. dead load and equipment. Over slab two inches of concrete cover is formed in which the electrical outlets are embedded and also joined to laid wire mesh to prevent cracks and shrinkage.

The work and scaffolding will be greatly reduced in erection on site and the repetition of the use of casting forms will increase the output and operation of a 24 hour cycle.

MECHANICAL NOTES

Air Conditioning:

The building dimensions and flexibility requirements determine in office

(a) smaller exhibit area, (b) a use of two different types of an air conditioning.

The corners of the building where the office-exhibit area is will be air

conditioned with low velocity multi-zone controlled units and the higher

(27') exhibition areas will be air conditioned with single control low velocity

systems.

Interior load is calculated on the basis that lighting will yeild 3 watts/ x 3.415

BTU/Watt = 10 BTU / f. and the people 50 f/ person x 300 BTU/ person

$$= 6 \text{ BTU/ f.}$$

$$= 16 \text{ sq/f.}$$

$$\text{C.F.M.} = \frac{\text{BTU/hr}}{1.08 \times 20^{\circ}\text{AT}} = \frac{16}{21.4} = 0.75 \text{ CFM/ F.}$$

20° represents a temperature difference between outside and inside an air

conditioned area. To be on the safe side considering a balance of a sunny and

shady sides of a building for preliminary calculation the unit employed is 1 c.f.m./ f.

It means for a high exhibition area the total surface to be air conditioned is

130' x 170' which is total of 22,000 CFM of air to be handled.

The duct size required for this quantity of air is 54" x 36", which will be taken through the louvers on the facade and directed to the air conditioned unit. The difusers blow down the air from the height of 28 feet and the returned air is picked up by a row of louvered openings under the cantlevered slab of the intermediate floor. The returned air goes to the ventilation fan, and, depending on heating conditions, returned partly back to air conditioned unit. The ducts will pass through a limited opening in T and Viereudeel trusses. The ducts will always be placed after the whole construction is in place.

Electrical conduits being dimensionally insignificant for the depth of a floor construction can be easily incorporated in the voids. The electrical raceways however will have very often for every 10' x 10' of surface one junction box for flexible use of low voltage for lighting and high three phase voltage for motors and heavy lighting equipment. Junction boxes will have outlets both in floor and ceiling. Floor junction boxes will be embeded in 2" slabs with safety water-proof outlets.

The lighting equipment will be provided for all office areas and low height exhibitions by standard fluorescent tube fixtures to get a good working condition of 70 candles per square foot. All other areas will have only general spot lights, because all other lighting fixtures will be removable to allow greater possibilities of exhibit arrangements.

CONCLUSION

From the first exhibition in the nineteenth century until today there is a difference of more than 100 years. The idea for the necessity of an International Trade Center which would have a sample exhibit along with the offices for administration of business is gaining ground. The previous experience and actual or future needs however serve as basic elements for a design of such a building. Hence in this academic study for such a building where both offices and exhibition spaces have nearly equal values, and with the emphasis on exhibition space, the programming for such a building is in a sense guess work. This is especially true when the programming and design must be in this special case submitted to a predetermined kind of construction material which is, in this case, precast, prestressed concrete. By choosing the staggered floor as a basic design fixture which allows different floor heights, the possibilities for precast prestressed concrete became more limited. The minimum floor construction height of the biggest span is of main importance. The design emphasis the exhibition side of trade and the office spaces are to be converted into exhibition spaces any time the need occurs. The secondary purpose of the building is to serve for meetings and conventions, which is convenient because of a present central space and the possibility to install bleachers and make galleries on the first two floors.

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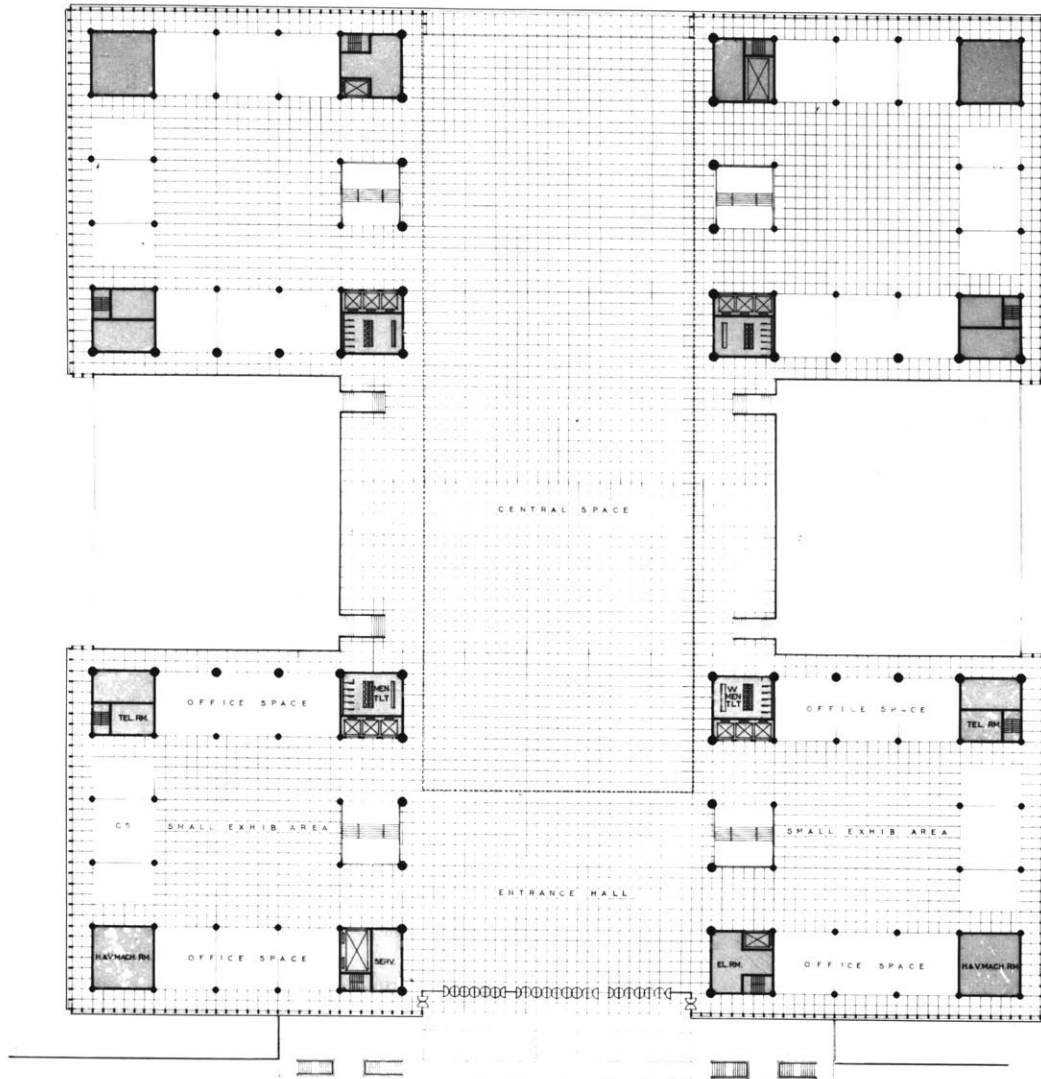
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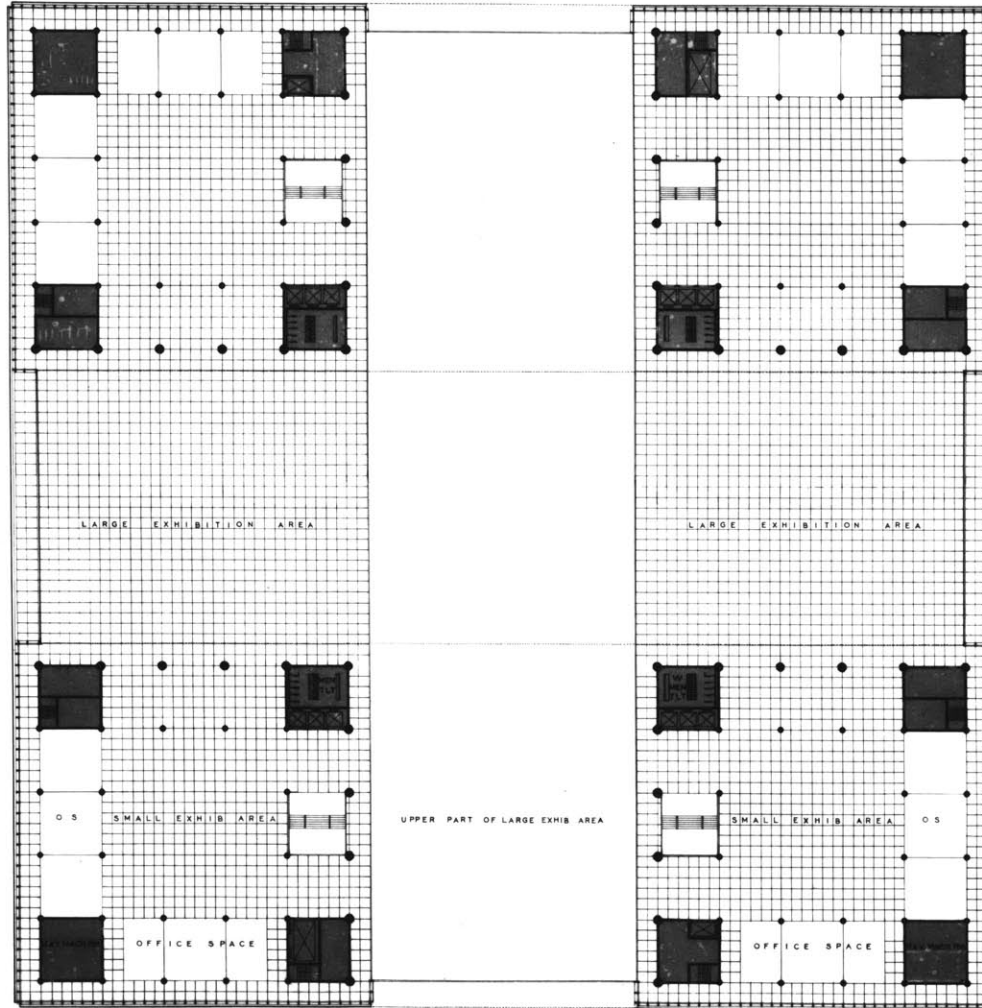
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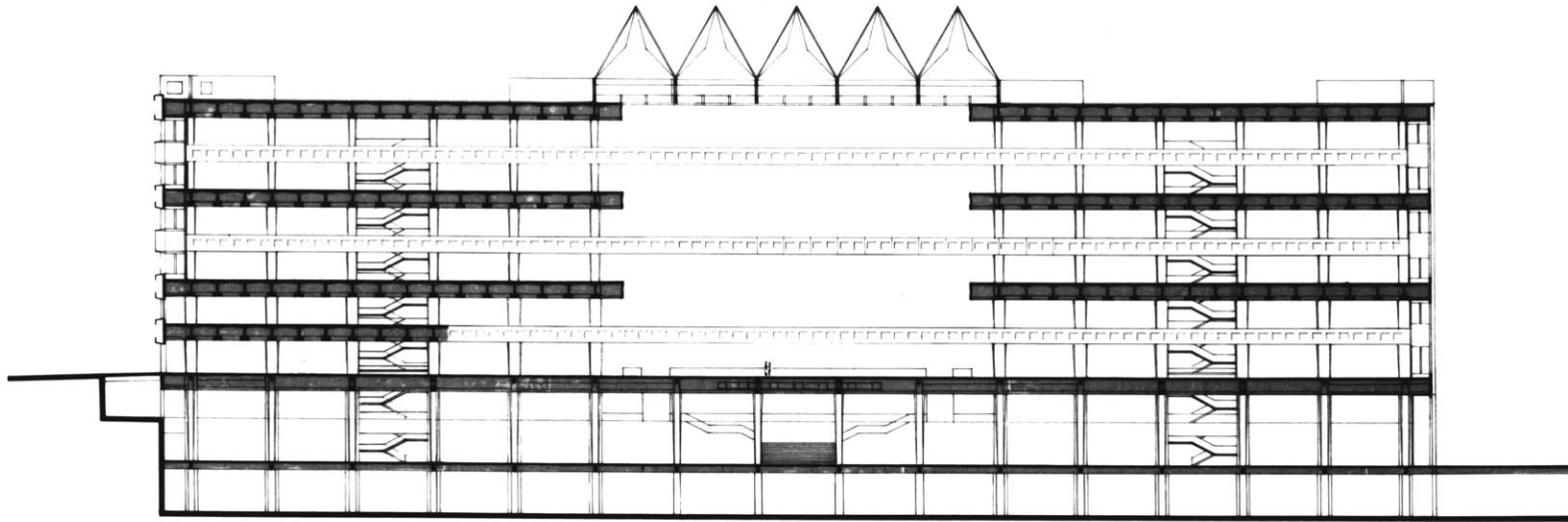
first floor plan 1

PERMANENT EXHIBITION HALL
Master of Architecture Thesis June 1963 O. G. VUKOVIĆ

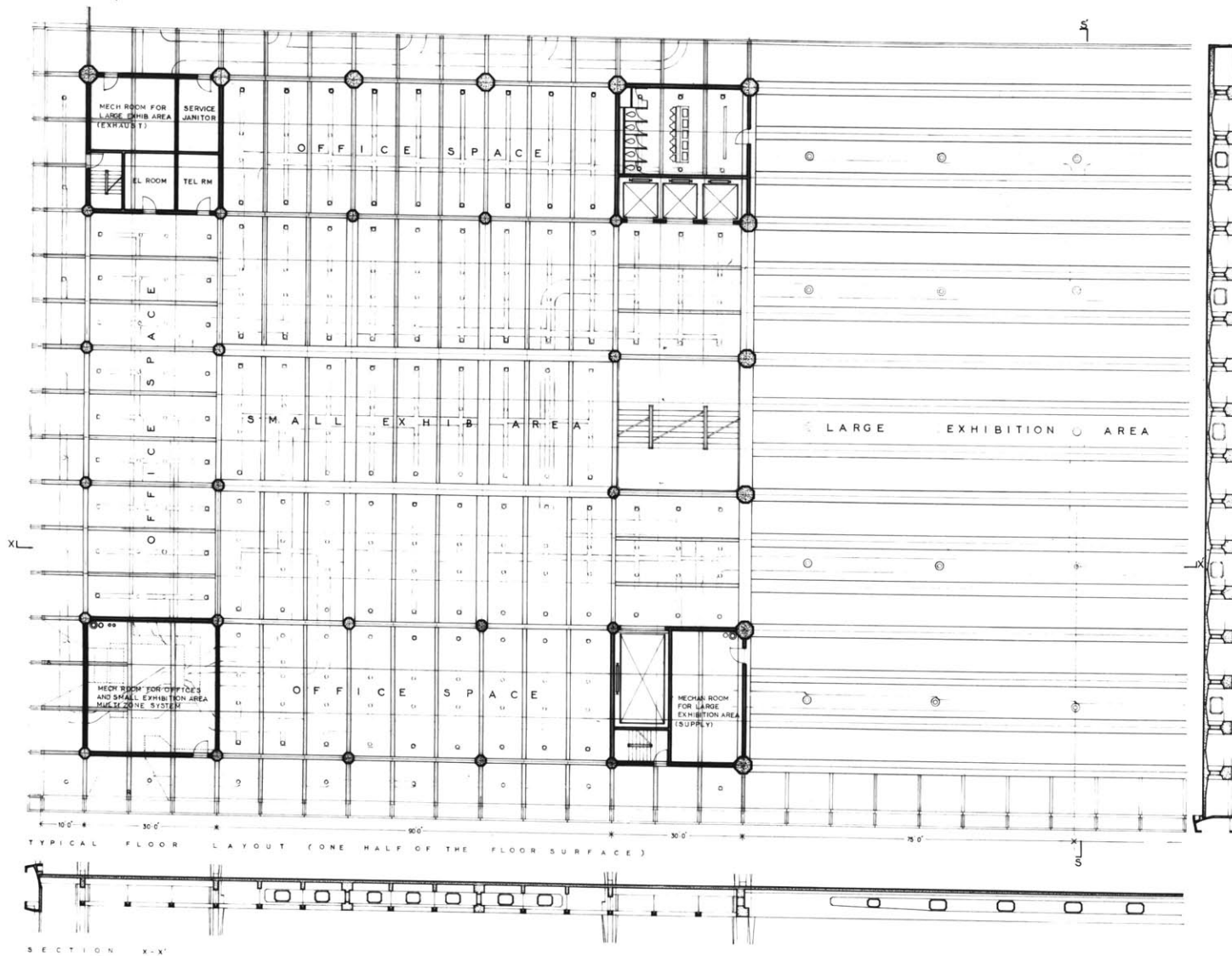


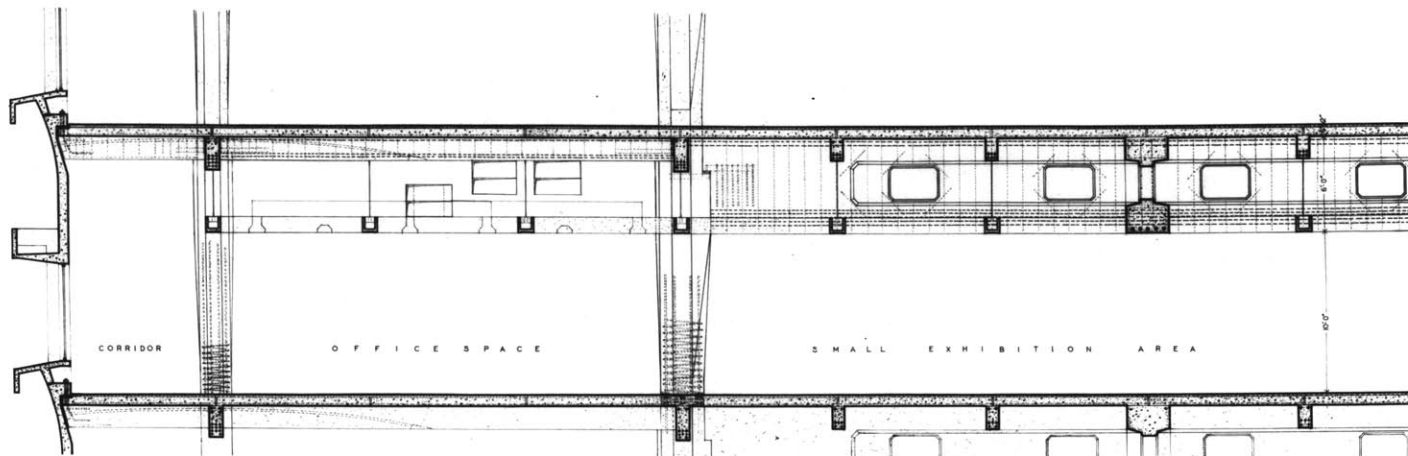
fourth floor plan 2

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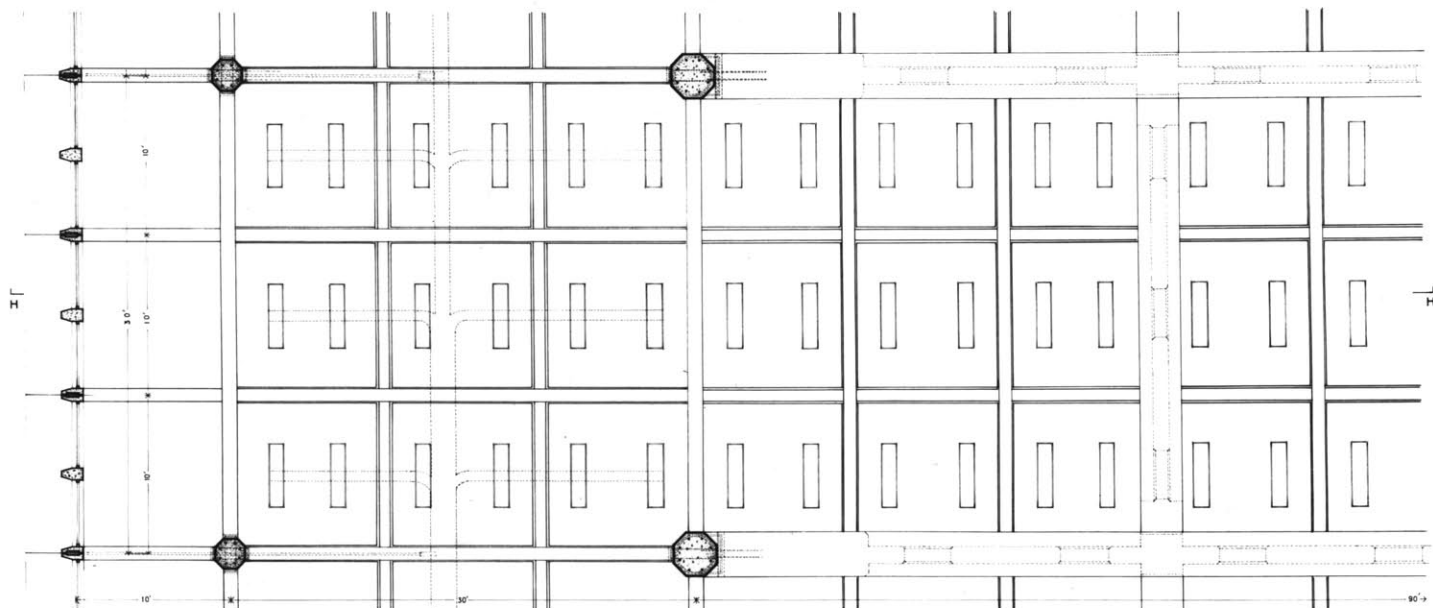


section 3
0 10 20 30 40 50 60 70 80 90
PERMANENT EXHIBITION HALL
master of architecture thesis june 1983 D. GJ. VUKOVIC





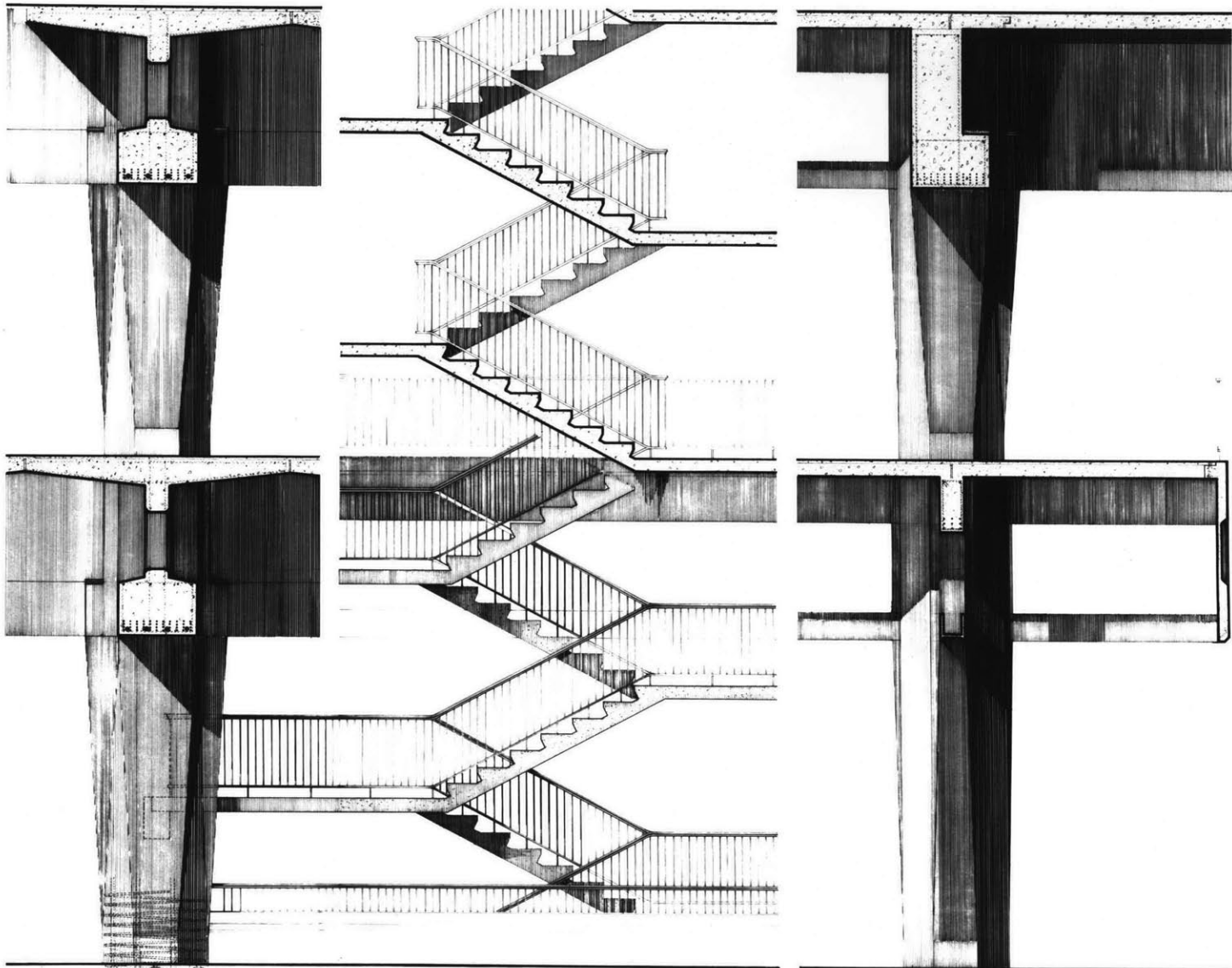
S E C T I O N N - N



P A R T I A L P L A N O F 3 0 F E E T M O D U L E

details 5

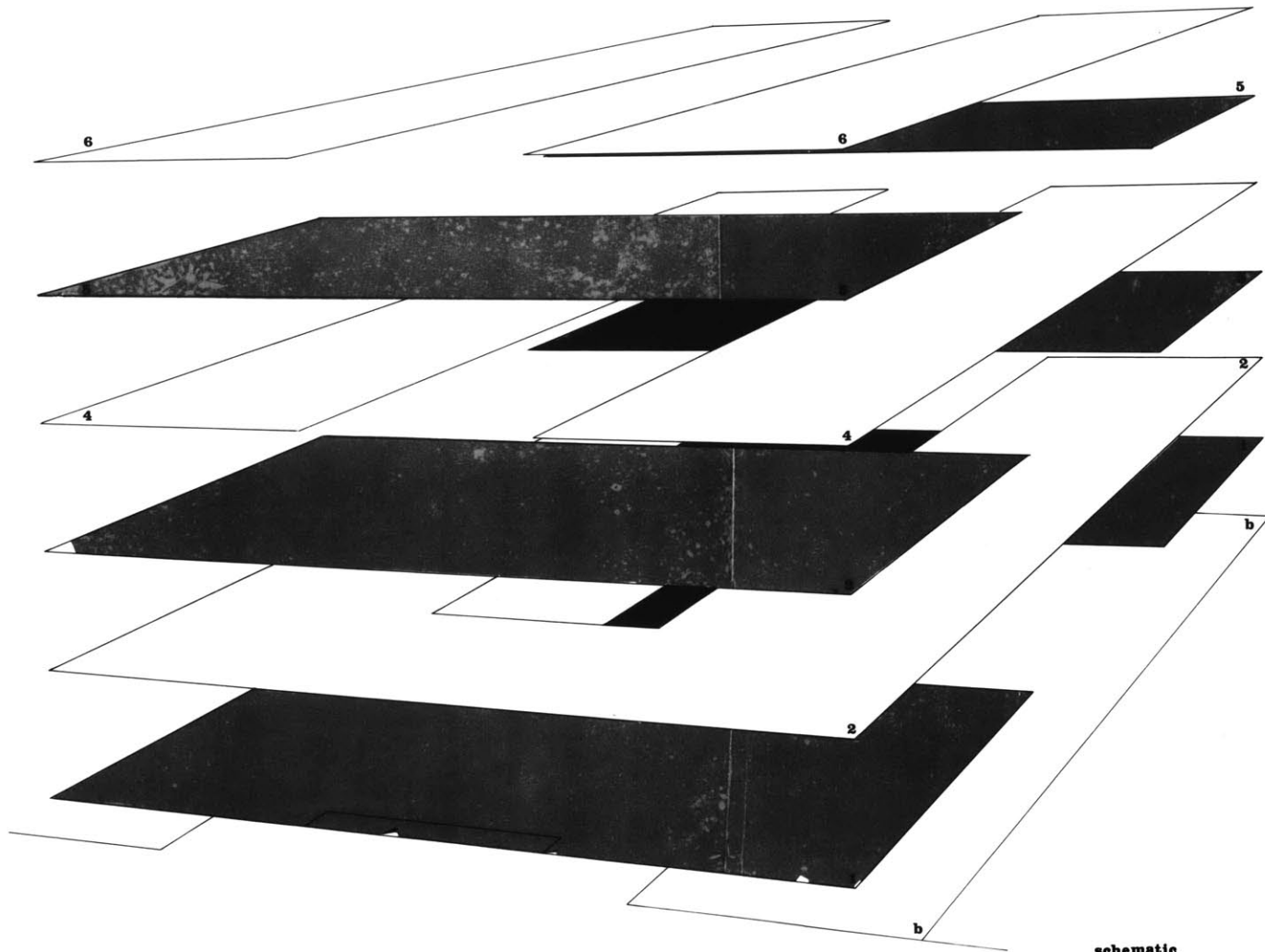
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details 6

PERMANENT EXHIBITION HALL

Scale: 1/4" = 1'-0" (1:12)



schematic **7**
PERMANENT EXHIBITION HALL
MUSEUM OF MODERN ART, NEW YORK

