

AN OPERA HOUSE FOR THE LINCOLN SQUARE PROJECT

Submitted in partial fulfillment of the requirements
for the degree, Master of Architecture

L. J. Williams
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Dean Pietro Belluschi
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Dear Dean Belluschi:

In partial fulfillment of the requirements for the degree,
Master of Architecture, I respectfully submit herewith a
thesis entitled "An Opera House for the Lincoln Square
Project".

Sincerely yours,


Lloyd J. Williams

47 Allen Street
Boston, Massachusetts

INTRODUCTION AND GENERAL REQUIREMENTS

FOR THE

LINCOLN SQUARE PROJECT

AN OPERA HOUSE FOR THE LINCOLN SQUARE PROJECT

An influential group of patrons has indicated the desirability of providing a central facility in New York City for the presentation of symphony concerts, opera, drama, chamber music, recitals, debuts, and like attractions; as well as an array of supporting activities such as a museum, a garage, a restaurant, a library, office facilities and the like. A site comprising approximately 11 acres has been made available by the Slum Clearance Committee of the City of New York. Based on these desires four auditoria are required, as well as supporting activities.

The grouping of these facilities requires some study to provide ready access to each without unnecessary mingling or confusion of the respective audiences. The educational buildings and the library should be disposed on the periphery of the site to permit ready access to that portion of the public which is not directly concerned with the auditoria. The garage on the other hand should be located so as to provide ready access to all parts of the Center.

The site is a roughly square block extending from West 62nd Street to West 65th Street, and from Amsterdam to Columbus Avenues. It is not far from Central Park, and is presently

occupied by old over-crowded tenement houses, a number of commercial buildings, and a few open lots. It is expected that the residents of the area will be relocated and all of the existing structures will be razed.

The Metropolitan Opera of New York has been consistently losing money in its operations in its present building. The management of the Opera feels that many of the inefficiencies and inadequacies of their present location have contributed to their excessively high operating costs. Much consideration has been given to various means of solving these problems as well as the problem of a large number of seats providing only a partial view of the stage within the structural limitations of the present Opera House. Some improvements have been made. However, it is evident that any major structural changes that might be made within the present building would be certain to fall far short of the optimum goal. Therefore, the management of the Metropolitan Opera Association has decided to obtain new quarters.

The Philharmonic Symphony Society of New York has been notified by the owners of Carnegie Hall that their lease would expire early in 1959. The necessity of providing a new home for the Symphony Orchestra has given, in large part, the impetus for the Lincoln Square Project. By joining with the

Metropolitan Opera Association in making an offer to the Slum Clearance Committee for the purchase of land in Lincoln Square, the Philharmonic Symphony Society has attempted to assure itself of an economical site in a favorable location for its future operations.

The construction of a single purpose concert hall for the use of the Philharmonic Symphony Society which could also be used for additional recitals and concerts is, therefore, required.

The concept of the Center for the Performing Arts would be incomplete indeed without including facilities for the dance and drama. A combination facility for these arts poses a set of conflicting requirements. Drama is best presented in intimate theatres of 1000 to 1500 maximum seating capacity. Economic requirements for self-sustaining operation of a ballet company require audience capacities in excess of 2000. Unfortunately, a ballet company's schedule could not be integrated with that of the Philharmonic Symphony Society which precludes the use of the concert hall for an extensive ballet program.

The desirability of providing a mutual facility for drama and ballet makes it apparent that there is a need for a flexible capacity theatre.

In the city of New York there are several hundred recitals, musicales, concerts, debuts, and other non-commercial performances. The demand for halls of approximately 1000 or less seating capacity exceeds the existing supply. Because of this and the fact that the Metropolitan Opera has expressed a desire to present small intimate operas such as those of Mozart, Rossini, and Gluck, it is desirable to include in the Center a Recital Hall having a capacity of 1000 seats. This hall could also be used by the educational facility for workshop drama and possibly for the Public Library for the presentation of recorded material.

An exploratory committee for the development of the Center, headed by John D. Rockefeller, III, has decided that the Center should include educational facilities for students of sufficient talent to indicate promising careers as performers, composers, and/or artist-teachers. Such a school is estimated to include facilities and accommodations for approximately 500 students, of which some 80% would be in the music school. The proposed facility should include housing for approximately 200 students. It is assumed that such service functions as administrative office space, library, health department, student lounges, etc., would be centralized and usable by all departments. It has also been decided by the committee that a facility for housing the collections of the New York Public Library

Reference Department pertaining to music, dance and theatre; and space for the Circulation Department of the Public Library Music Division should be included in the Center. Space for items of the Metropolitan Museum of Art Musical Instrument Collection should also be provided as well as office space for the administrative personnel, and locker space for the operating personnel of the Lincoln Center for the Performing Arts. It is assumed that the Library activities will be operated by the New York Public Library as a branch library.

Since the Center will have between 300 and 500 employees as well as some 500 students, some provision for their meals should be made. The operators of the Metropolitan Opera Restaurant, together with operators of other restaurants and cafeterias have agreed that a suitable restaurant for the Lincoln Square Project should have a total seating capacity in its dining room of approximately 800, of which the cafeteria should seat 300, including 60 people at a coffee counter. The cafeteria could well be located below grade with common food storage and adjacent kitchen facilities serving both restaurant and cafeteria. It is estimated that the restaurant will require 11,000 sq ft of floor area, and the cafeteria would occupy about 5000 sq ft, thus the kitchens would require about 14,000 sq ft.

A survey prepared by Brown and Blauvelt for the Slum Clearance Committee of New York indicates that when full capacity audiences use the four proposed auditoria, the estimated number of automobiles in each direction of travel will total approximately 2040, of which approximately 1250 will be private cars. Careful evaluation of the various factors related to providing parking facilities directly on the site indicates that the garage should be limited to between 50% and 60% of the potential full capacity demand. It is particularly important that attention be given to coordinating start and finish times of attractions at the two large auditoria. This attention will provide the only possible spread of peak traffic loads in the already congested area near Lincoln Square.

The New York Transit Authority has announced plans for a major improvement of the local service on the entire Seventh Avenue line subway by lengthening platforms, including the existing 66th Street Station. It has also announced its intention of using modern high-speed cars. This would greatly increase the carrying capacity of the line by permitting operation of ten-car trains. The major portion of subway riders to and from Lincoln Square would use the 66th Street Station. In fair weather, of course, an appreciable number would prefer walking to the Columbus Circle Station of the 6th and 8th Avenue IND Express Lines.

GENERAL REQUIREMENTS

OF THE

OPERA HOUSE

The determination of the general size of The Opera House is complicated by two opposing views. The purely artistic view is that a hall of approximately 2000 seats is optimum. The fund raisers' feeling is that double this capacity is more reasonable.

As presently produced, performed and judged, Grand Opera depends on natural vocal projection, balanced orchestral sound and visual perception of stage action. Due to physical limitations of humans, e.g., 1' resolution power of the human eye,¹ the argument is strong for a small hall with seats arranged as close to the stage as possible.

The traditional European opera house is a development partially due to state subsidization and has led to small seating capacities. The seating plans are generally horseshoe, and there are usually two or three balconies to reduce the distance between audience and stage.

A deviation from traditional opera house design may be noted in the Carlo Felice Opera House, Genoa, Italy. This hall seats 2000 and has a single balcony with a separate tier of boxes,

1. Theaters and Auditoriums, Burris-Meyer and Cole, 1949

similar in arrangement to the San Francisco Opera House. Carlo Felice depends on the reflective qualities of the ceiling for voice projection, and has begun to acquire the reputation of an excellent hall for opera, in spite of its somewhat longer than usual sight lines.

In the United States the financial life of Grand Opera is dependent upon our private subscriptions and box office receipts. Without government aid, this had led to fewer opera houses and opera companies than in Europe. In 1956 there were only two major companies (New York Metropolitan and San Francisco Co.) and no more than six real opera houses per se in the United States.

In 1956 a research organization¹ was of the opinion that Grand Opera could not be produced profitably in the traditional manner in any city if amortization costs of a new building must be covered. It was also their opinion that artistically successful opera could not be produced in a building sufficiently large to cover operating costs. Therefore, the size of any new opera house should strike a balance between operating deficits of companies and building costs.

1. Little, A. D., Report to County of Los Angeles re New Auditorium and Music Center, 1956

Usual stage requirements for Grand Opera are approximately 120' x 100' deep with a proscenium 50' square. Narrow stage aprons are the rule with orchestra pits to accommodate up to 100 musicians for Wagnerian productions. High loft space over the main stage (100'+) is also required to handle scenery. Usually ten sets of bridges, a full gridiron, and about 70 sets of flylines are required in a loft. At least one, and preferably two, cycloramas are required for scenic background projection. These should be movable as they are not used in all productions.

Grand Opera houses require many dressing rooms, including small private rooms for all principal performers and the orchestra conductor at the stage level; chorus dressing rooms for both sexes, and orchestra rooms need not be on the stage level but should have easy access. It should also be noted that dressing rooms should have toilets.

In the optimum plan extensive rehearsal rooms are required which must be simultaneously usable. This requires careful treatment of construction details to achieve the proper degree of sound isolation.

Many opera houses have the common weakness of a lack of adequate storage space for scenery and other materials which

adds greatly to operating expenses of companies. Adequate facilities for carpenters, electricians and the wardrobe department must be included in any workable design of an opera house.

Broadcasting and television facilities, as well as internal communication networks, are becoming requisites in modern opera houses.

The orchestra and cast should have a separate entrance and lounge areas. An ample lobby and ticket area are essential. There are usually several lounge areas and service rooms. Rest-rooms, bars, sandwich shops and smoking rooms should be included on each public level, if possible.

DESIGN ANALYSIS

In designing an opera house it is necessary to consider the basic nature of the art form as architectural and acoustical design must stem from a full knowledge of the general and special requirements of the performance. It is particularly important to note that musical tastes change as to the acoustical qualities of all music halls with the passage of time. Indeed, the reputation of some halls is based primarily on their antiquity and not on any careful critique of their acoustical qualities.

A hall for Grand Opera is unique acoustically as it requires not only musical blending but also must provide a high degree of articulation and intelligibility in all parts of the audience area. Even when these requirements are met, the Opera House will be judged subjectively on the basis of the quality of the production and not purely as a space for listening to live music. Therefore, the reputation of any hall is based in part on the quality of the Company. Unfortunately, rehearsal costs are so high that the acting and choral passages of most operas performed today are slipshod, and Opera has to depend on the soloists as drawing cards and audience satisfiers. An efficiently designed building should reduce some of these costs and thus permit better overall productions.

An aspect of recent "pure" design has been a lessening of the modulation of surfaces in music halls. This has had the result of producing less diffuse sound fields with resultant areas of interference in the audience -- these are known as "dead" spots and quickly become known to audiences to the detriment of the reputation of both the company and the hall. It would then seem a good approach in designing an Opera House, where high articulation is required, to retain as much modulation of surfaces as possible.

There is a direct relationship between the size of a music hall and the amount of acoustic energy available to the individual listener. As the sound intensity is inversely proportional to the square of the distance between source and listener, it is obvious that as many seats as possible should be placed close to the stage. In Opera House design, as well as in any music hall, there is an increasing difficulty in reducing unwanted reflections of sound from rear walls on increasing the capacity. The farther back the rear wall moves, the greater the possibility of discreet echoes, to say nothing of the interference patterns that may arise. Because people are extremely good sound absorbers, it would seem logical then to have a high percentage of the rear wall at least covered with people.

Due to the fact that sound is rapidly absorbed on passing over people, it would improve hearing conditions for the rear seats if balconies were kept to a minimum depth.

There is in Grand Opera a great amount of gross gesture and mass movement of actors on stage. These gestures and movements are readily seen and appreciated from above the stage. As a consequence, it seems advisable to include a large number of seats above the stage level.

In the Opera House the performance must be considered as a social occasion as well as music-drama entertainment; therefore, the lobbies and circulation spaces should be arranged to show off groups of people and their clothes to advantage. This showing off should be extended to the auditorium as well if possible.

It may be argued that it is shortsighted to build an opera house with only a slightly greater seating capacity than the present home of the Metropolitan Opera. There are sound answers to the argument in that it has been only in recent years that the Metropolitan has had reasonably consistent capacity houses, and it is not necessarily indicated that these will continue, particularly in case of an economic recession.

If in the course of time the audience demand should rise to such a point that too many people were being turned away (to have to turn some away is considered very healthy in the show business), the Metropolitan Opera could accommodate the demand by reducing the number of operas in the seasons repertoire, which would have the added effect of reducing or eliminating the operating deficit. If the demand reaches completely unexpected heights, the solution would be a second opera house and a competing company.

METROPOLITAN OPERA ASSOCIATION RECOMMENDATIONS

FOR

NEW QUARTERS

The following are excerpts from data prepared by representatives of the Metropolitan Opera Association at various dates, and made available to the author by the kindness of Harrison and Abramovitz, Architects, New York.

The backstage areas in this program are based in part on the recommendations of the Metropolitan Opera Association's Consultant on Stage Design, Walther Unruh of Germany.

The Metropolitan box office has indicated a desire for more seats in the \$4 - \$5 range, and the addition of a \$6 range which they presently do not have.

Front of House Facilities

The main entrance lobby should obviously contain the necessary box office windows and should have a secondary box office to accommodate tenant attractions which might require ticket sale while the Met is still using the main box office.

Box Office

(1800 sq ft)

The box office should have three windows, be located so as to provide security for money, and have room for the subscription department, mail order department and treasurer. A separate telephone line system for this area is contemplated.

Press Department

(1500 sq ft)

The Press Department should be located in the "front" of the house so that there can be close access to the audience, and so that common filing for press, library and opera news may be used.

The area should have a critics coatroom, as well as working space and telephone booths. Direct access to the auditorium would be advantageous. Storage space connecting to the joint filing is also required.

Metropolitan Opera Guild

(2500 sq ft)

The Guild should have a small foyer for its own ticket service connected with its own box office. There are seven offices in the Guild complex which should have common access to a small typing pool. These offices should also relate directly to the Opera News Spaces described below. A meeting room for 50 people is required.

Opera News

(1000 sq ft)

As an adjoining part of the Opera Guild spaces, there should be four spaces for the operations of Opera News. An office for the publisher, an office for the assistant publisher, the art department and the advertising department.

Reference Library

(2500 sq ft)

The Metropolitan Opera Reference Library has a collection of tapes and records, as well as a wealth of music and printed material. Four listening booths equipped for tape or record are required, as well as reading area. As this is a non-circulating library, an "open stack" arrangement will be acceptable.

National Council

(1250 sq ft)

The National Council office requirements include secretary, files, director's office, foyer and board room for 20 people. A separate but connecting office for the Central Opera Service should be provided in the same area.

Small Auditorium

(2000 sq ft)

This is a small speech hall (150 - 200 seats) used mainly for intermission broadcasts which traditionally use the Opera audience for their audience. Therefore, easy access is a prime consideration. The control room for these broadcasts need not be the same as the one used for broadcasting the Opera; in fact, there are some arguments against it.

The Guild and National Council would use the small auditorium for meetings of over 50 people. The Administration would

also occasionally use the small auditorium for employee meetings. Complete stage equipment for record, tape and television control is required.

House Manager's Offices (1200 sq ft)

These spaces are small but important. They require ready access to lobby and auditorium. Included are House Doctor, Manager, Assistant House Manager, Secretary, Lost and Found Department, First Aid Room and Nurse's Room.

Club Rooms (4200 sq ft)

Easily accessible from one of the promenade levels should be a club room for the Opera Guild with private washroom and restroom facilities. If possible, it should connect with the Guild offices. (1200 sq ft)

Assuming the Opera Club will maintain its present status, extensive facilities such as bar, service for catered food, locker and washrooms, Club Manager's Office, lounge, etc. should be provided. (3000 sq ft)

Main Auditorium

Seating for 3500 - 3800 people with excellent acoustics.

Stage

The width should be approximately 230', depth 150', clear height of at least 110' over the center stage which should be provided with seven to eight elevators, seven feet wide and 60 feet long, adjacent to each other to provide for entire sets to be raised or lowered.

To each side of the main stage there should be a sliding stage 60' deep and 60' wide, with a clear height of 40', to slide over the center stage when the center stage descends.

To the rear of the main stage there should be another stage 60' wide, 50' deep, with a turntable 46' in diameter and a clear height of 40'.

Above the stage there should be 150 pipes, three inches apart, for hanging drops and draperies, to be lowered to stage level and raised to a height of 110'. There should be electronic or hydraulic controls located with good visibility of the entire stage from the side of the stage.

There should be master controls for the elevator system, sliding doors and a turntable that is located with excellent view of the stage.

This plant requires easy freight access to the Scenic Studio, Storage Warehouse and street loading.

The actual scenery manufacturing plan includes one foot - 10,000 sq ft of clear space - of which 3,000 sq ft should have a clear height of not less than 30 ft and be completely free of holes or obstructions; the remaining 7,000 sq ft should have a height of 20 ft.

A. Carpenter Shop

Manufacturing Departments

gories:

The Backstage Departments are described under three cate-

dark scenes.

There should be two cycloramas - one for light and one for

one back stage.

which three should be at stage level, one in the balcony and

At least five camera positions should be provided for, of

located so as not to obstruct the view of the audience.

There should be built-in radio and television communication to points outside the house; television cameras should be

forum.

There should be a projection booth in the rear of the audi-

The drop and ground cloth manufacturing plan includes 4000 sq ft on the floor mentioned above, 50' x 60' of pole-free space, space for a few sewing machines. Access is not of great importance.

B. Property Shop

The Property Shop requires 7500 sq ft as clear of obstructions as possible. The space for molding and shaping should be in a section adequately insulated and protected from other parts of the shop. The required access opening is 15' x 15'.

C. Tailor Shop

The Tailor Shop requires 8000 sq ft on the highest floor for the best light. There should be a separate room, approximately 40' x 40' for dyeing fats.

D. Electric Shop

The Electric Shop requires 5000 sq ft, preferably in the Opera House proper.

E. Wig Shop

The Wig Shop requires 3000 sq ft adjacent to the Tailor Shop.

F. Scenic Studio

The Scenic Studio requires 8000 sq ft located above the Carpenter Shop. There should be very good light sources in the center area. There should also be two frames to hold drops 50' x 70', leaving a pole-free space of not less than 5000 sq ft on either side of the frames; if the frames are placed parallel, there should be 8' of space between. The access should be by drop cut to the Carpenter Shop below to take full height, and there should be an access to the studio to receive drops 70' long.

Each shop should be provided with at least two offices, locker space and sanitation facilities.

Storage and Shipping Facilities

A. Scenery Storage

We have carefully studied 45 existing operas in our warehouse and have tabulated the number of square feet each opera would require if only major sections of it were kept assembled. The 45 operas should have 61,000 sq ft for scenery, with a ceiling height of 35 ft.

It is hoped that this vast space requirement can be found by having one or more of the park areas flanking the Opera House raised in such a way that the scenic storage would be underneath the parks. This space should be completely unencumbered except for the necessary supporting members. In this way we might be enabled to store large sections of individual scenes that happen to require false floors, completely made up and on rollers. The movement of such large scenery units to and from the elevator to the stage would be accomplished by small electric tractors.

B. Property Storage

The nature of properties renders their storage close to the stage a matter of some importance. On the other hand, for the most part they do not require high ceilings. The ideal nature of a property storage area would be something like a giant tier of pigeonholes with a central elevator. The present Metropolitan Opera property storage space is not only absurdly inadequate but completely decentralized. What we need would be about 40,000 sq ft, which however, need have only a 6' or 7' ceiling height and does not require large individual unit floor spaces.

C. Wardrobe Storage

There should be 25,000 sq ft of wardrobe-storage space in the cellar above the stage or the auditorium, adjacent to, above or below the scenic or property storage areas. This storage space should be air-conditioned, and there should be access to a freight elevator 10' x 5' x 10'. The ceiling height need only be 6'.

D. Electric Storage

According to our estimates, we shall require 4000 sq ft of electric storage space, with a height of approximately 15' adjacent to the stage area for hanging 100 chandeliers - perhaps in the Electric Shop.

Operating Departments

A. Wardrobe

This department requires a room on each dressing-room floor to hold costumes and accessories for all artists on that floor for the entire season's repertoire, including space for sewing machines, ironing boards, etc. There should be locker and sanitation facilities for the wardrobe personnel. This space may be included in the figure for Wardrobe Storage.

B. Stage Carpenter Department

The Stage Carpenter Department requires 1000 sq ft adjacent to the stage to keep soft goods. There should be a drop cut on a hydraulic lift, on side or rear, to allow easy loading off the stage, and to provide storage above or below the stage for 4000 drops, 60' long and 9" in thickness. There should be a hardware room for the storage of cable, hardware, etc., a locker room for 40 men and sanitation facilities, and an office in the corner on stage for the master mechanic and his assistant.

C. Electric Department

This department requires 1000 sq ft very close to the stage, a door facing on stage, this space being for an emergency workshop and the storage of lamps not in use. There should be a room 15' x 30' on each side of the stage for lamps in current use, office space in one of these rooms for the master electrician and his assistant, and locker and sanitation facilities.

Recommendations for Offices

The following are recommendations for offices for Stage Departments:

Offices are required for a rehearsal manager and rehearsal manager's assistant, for a production stage manager, for administrator of stage departments, possibly two offices for stage directors, an office for stage managers and one for assistant conductors.

All these should be close together and with immediate access to the stage. The conductor's room mentioned before should also be nearby. It would also be very advantageous to have on stage level a Green Room where principal artists could wait during performances and rehearsals while not on stage, and indeed if there are sufficient locker facilities, they could leave their coats, etc. during rehearsals when not in costume.

Offices for actual stage staff, property, carpenter, electrician, etc., have been mentioned in the section dealing with backstage departments.

The stage manager's office should be not too far removed from the principal stage manager's desk on stage.

Recommendations for Dressing Rooms

Generally speaking, Solo Artists' Dressing Rooms are divided left and right of stage for male and female singers. There should be at least three principal artists' dressing rooms on each side of the stage. They should be large enough to have comfortable couches, upright pianos and, of course, adequate washing, shower and toilet facilities.

In addition to these six dressing rooms, possibly on stage level, there should be a small emergency dressing room practically on stage for very fast costume changes.

There should further be on each side a minimum of an additional six dressing rooms on either side; three of which should be able to accommodate a minimum of two or possibly three artists while three other rooms should be for one artist. These dressing rooms should also be able to accommodate an upright piano and a couch.

The Conductor's Dressing Room should be a good-sized room equipped with sufficient space for at least six to eight small wardrobes, a couch, at least an upright piano if not a baby grand and, of course, washing, shower and toilet facilities.

The Chorus Dressing Room too should be divided on both sides of the house and provide adequate dressing-room space and washing facilities, showers, etc. for at least 50 people on each side. Access from the chorus dressing rooms to chorus wardrobe storage is important, as is quick and easy access to the stage.

Recommendations for Rehearsal Rooms

The following are recommendations with regard to Solo and Ensemble Rehearsal Rooms:

There should be a minimum of six rehearsal rooms.

One should be rather large for ensembles of up to 20 solo artists with grand piano.

One should be fairly large for an ensemble of up to 12 and a piano.

Four smaller rooms for two or three people plus an upright piano, if necessary, should be provided.

The following are recommendations for Chorus Rehearsal Rooms:

One very large room for the entire chorus - up to 100-120 people should be provided. Most likely the seats should be arranged in amphitheatre-like tiers.

There should be a second chorus rehearsal room to accommodate perhaps up to 60 people.

Chorus rehearsal rooms should be as close together as possible and soundproofed, so that divided chorus rehearsals could take place simultaneously. The same soundproofing should, of course, apply to all other rehearsal rooms which will always be in use simultaneously.

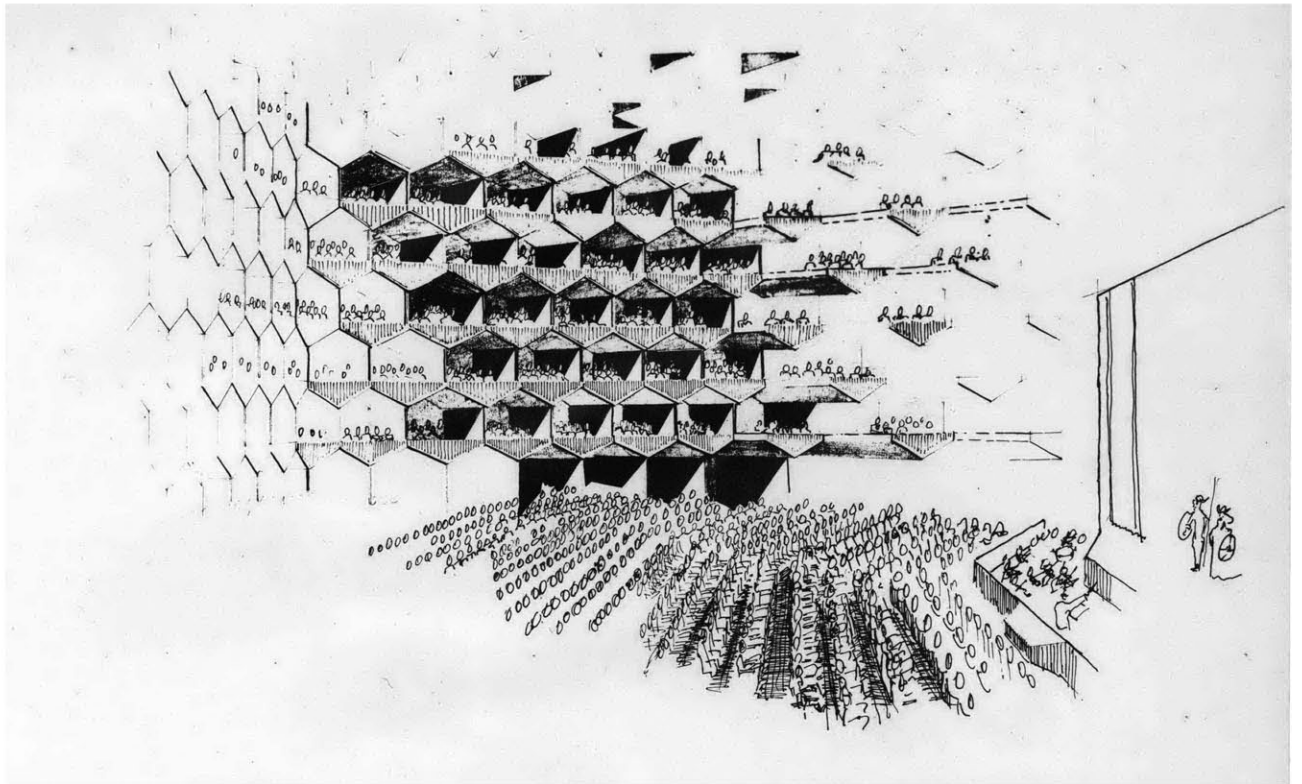
The following are recommendations for the Orchestra Rehearsal Room:

There should be a special large room for orchestra reading rehearsals. It should be possible to accommodate up to 100 musicians. This room should be suitably wired and equipped for recording and radio transmission.

Nearby should be the office of the orchestra manager and his secretary, a large music library and a room for the storage of special instruments owned by the Association.

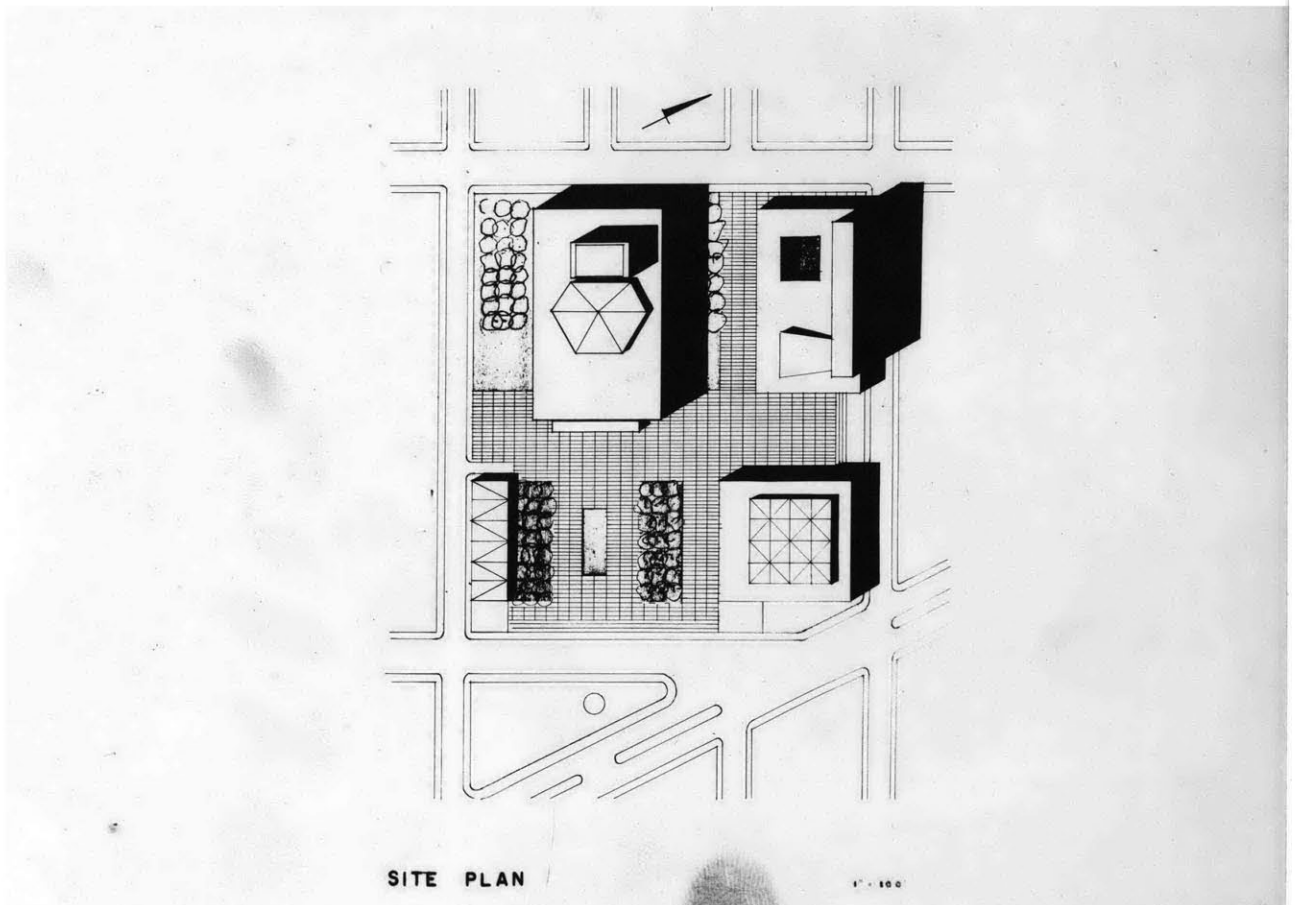
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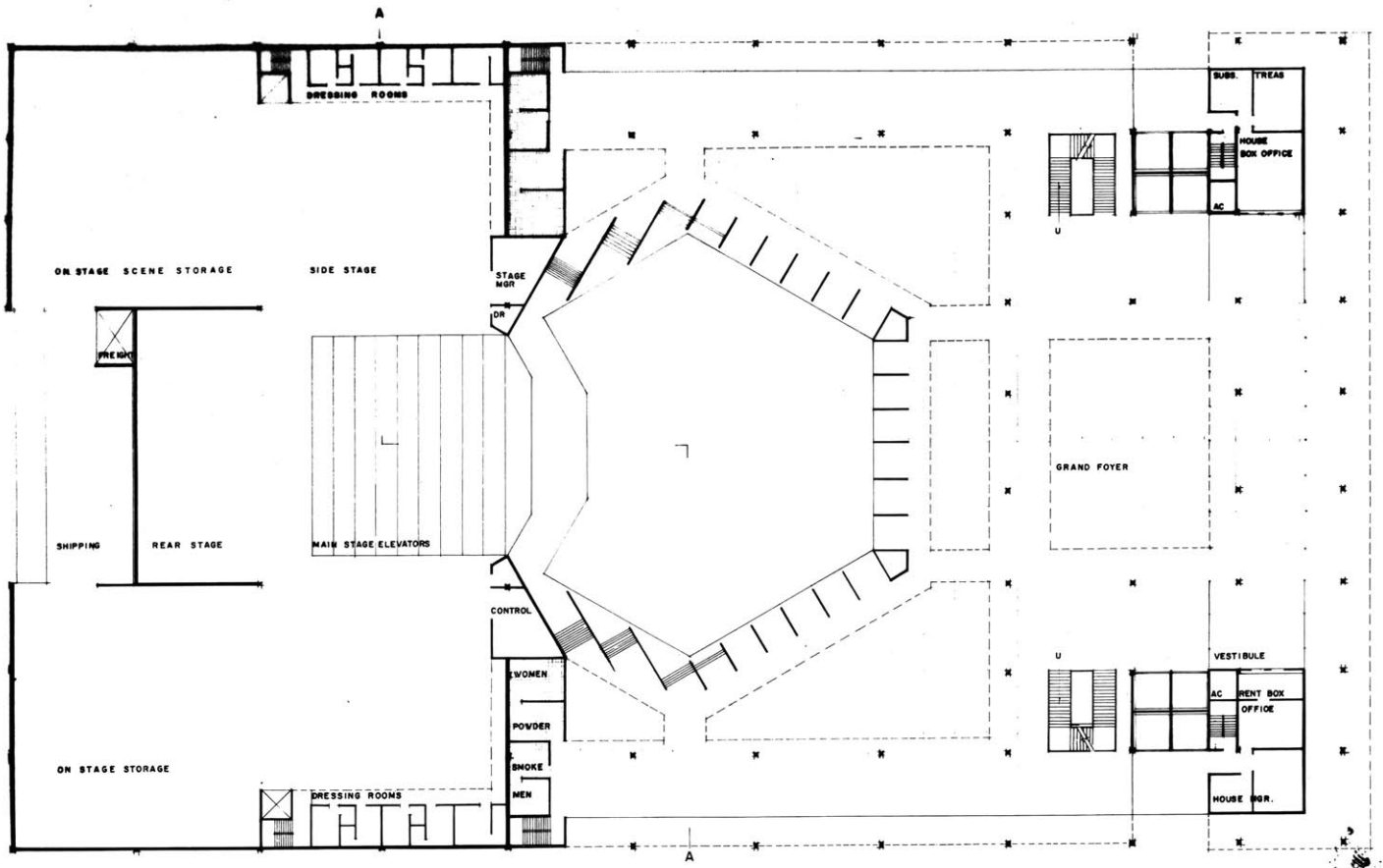


OPERA HOUSE IN LINCOLN SQUARE

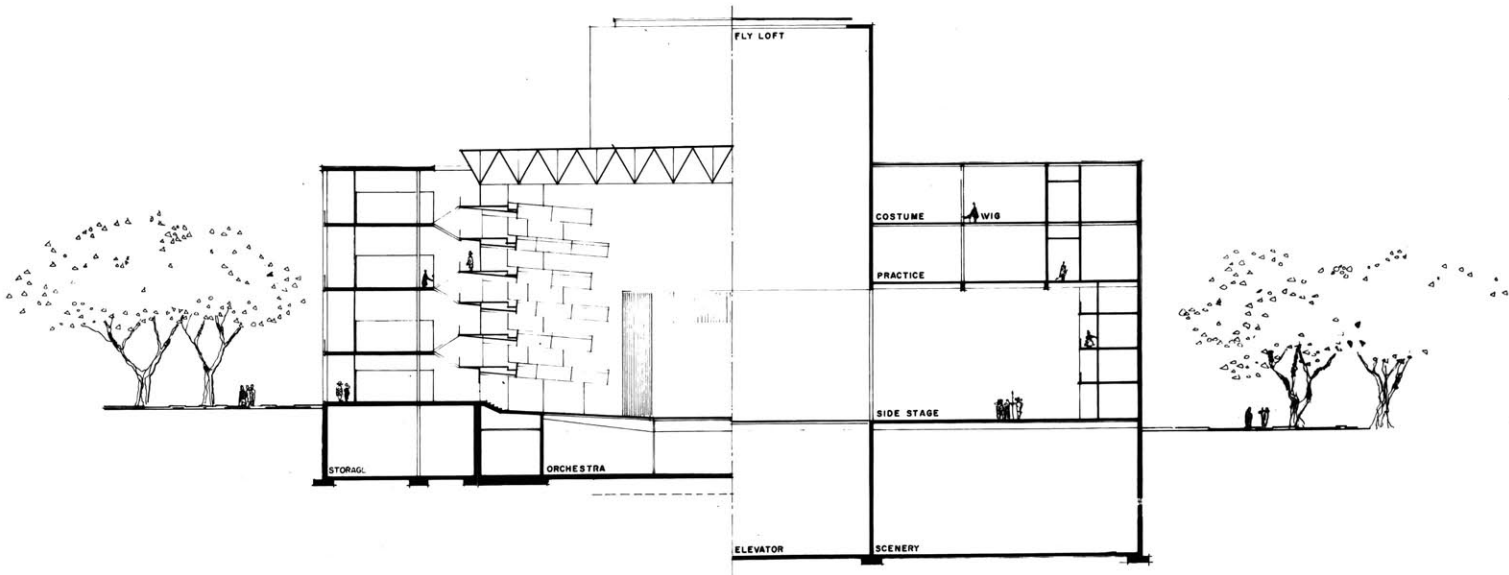
MASTER IN ARCHITECTURE THESIS SUBMITTED BY LLOYD JOHN WILLIAMS
MASSACHUSETTS INSTITUTE OF TECHNOLOGY AUGUST 1957



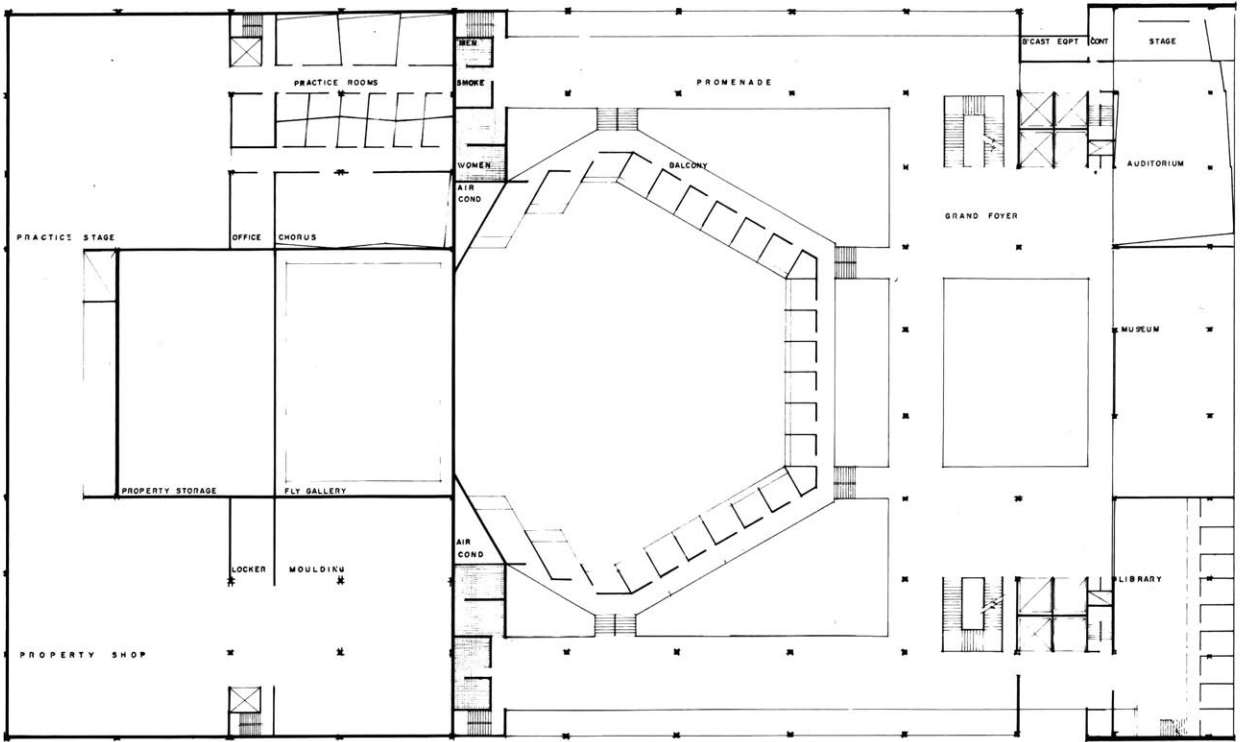
SITE PLAN



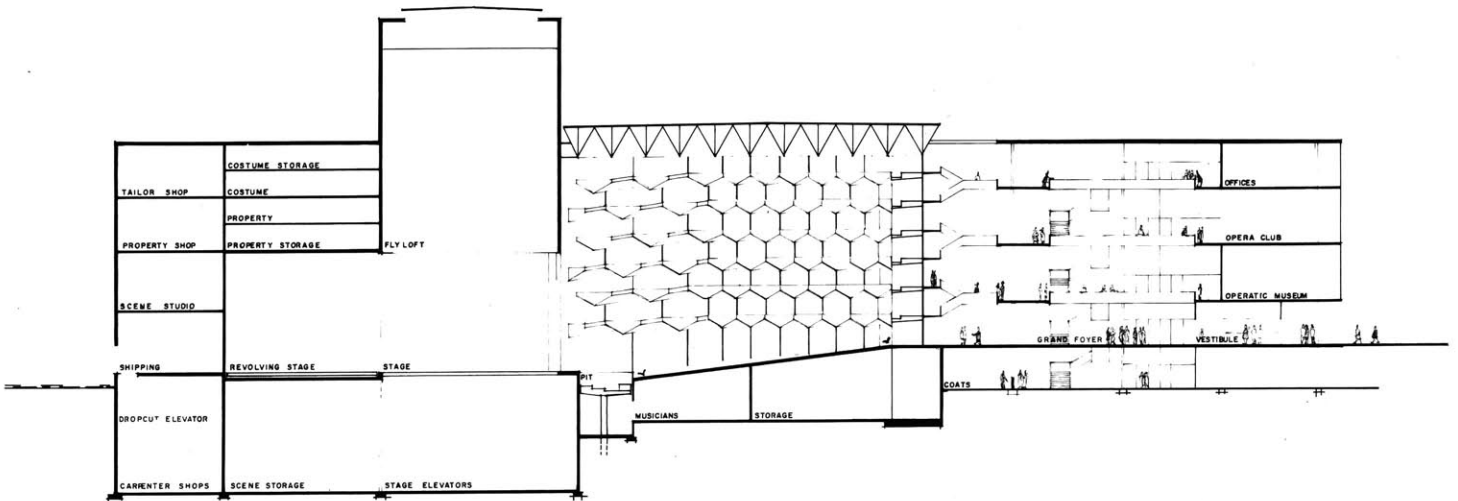
ENTRANCE LEVEL PLAN



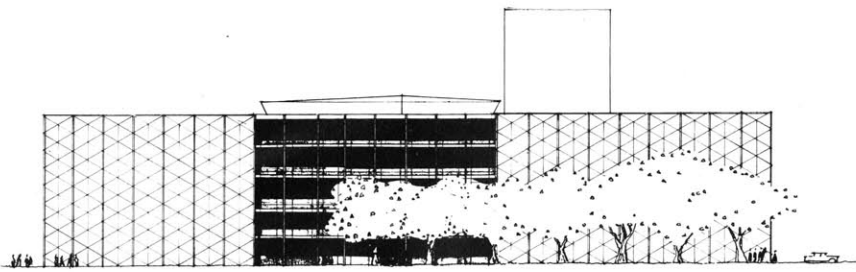
TRANSVERSE SECTION A-A



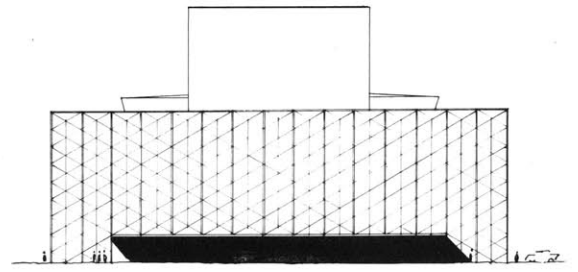
UPPER LEVEL PLAN



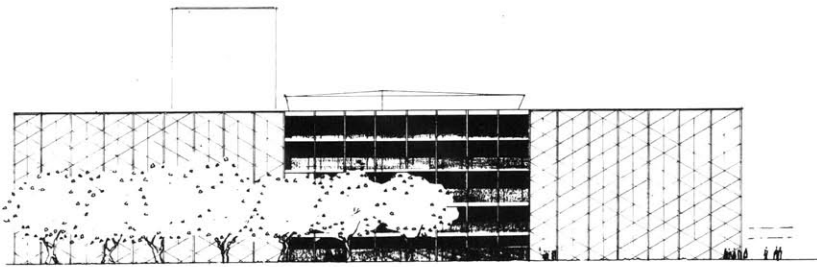
LONGITUDINAL SECTION



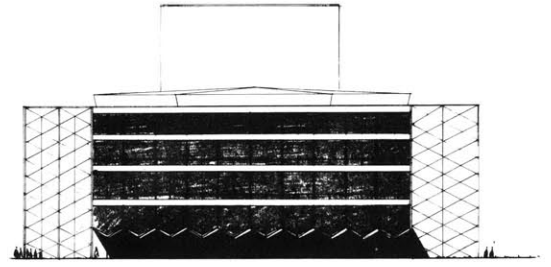
NORTH



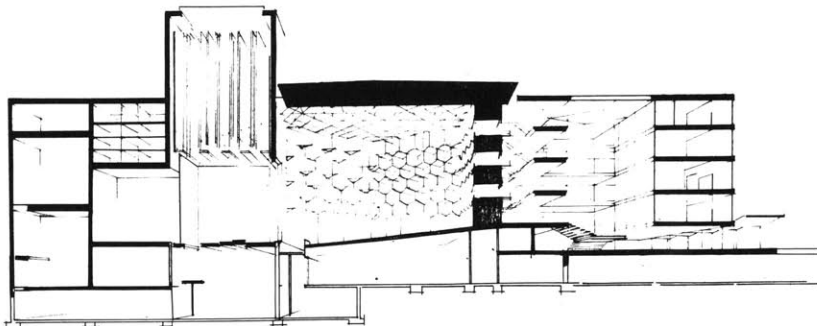
WEST



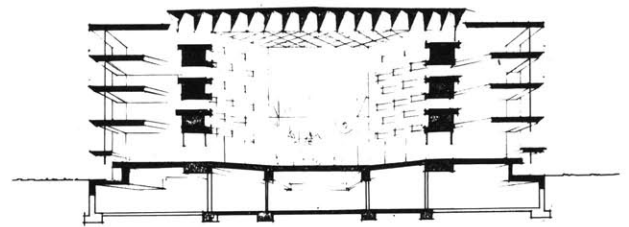
SOUTH



EAST



LONGITUDINAL SECTION



TRANSVERSE SECTION