ARCHITECTURAL DESIGN OF A CONCERT HALL IN BEIRUT

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ARCHITECTURAL DESIGN OF A CONCERT HALL IN BEIRUT

By

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A U B

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A C K N O W L E D G M E N T

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I MUST ACKNOWLEDGE MY SINCERE THANKS AND DEEP GRATITUDE FOR THE VALUABLE HELP AND ADVICE OF PROFESSOR K. YERAMIAN, WITHOUT WHICH THE PRODUCTION OF THIS WORK WOULD HAVE BEEN A MUCH MORE DIFFICULT TASK FOR ME.

INTRODUCTION

The desire of human beings to witness performances of others appears so inherently deep-rooted in their nature that it can be taken for being instinctive in its nature. When this desire is coupled to a certain standard of education, out of which we particularly distinguish musical culture, an urge for the availability of concert halls and musical theaters is felt. The candidate has himself felt the need and has, therefore, undertaken the task of trying to fill this gap.

The striking congestion of the city and the resulting diversity of the artistic tastes of the different groups of its population make it necessary to convey and direct these different groups with their respective tendencies each to the kind of environment that gives it most satisfaction.

Cinema lovers, for instance, have many good motion picture theaters to go to, while nothing that could satisfy more refined forms of recreation is available.

A superficial study of the economic capacities of Beirut shows us clearly that any building which is meant to be used exclusively as a concert hall is an unsound commercial enterprise. Thus it has been the endeavour of the candidate to combine in the same structure the essential characteristics of a theater as well as those of a concert hall.

Due to the fact that a quiet atmosphere is highly desirable for the enjoyment of a musical or theatrical performance, the candidate has chosen the site for his construction to be opposite the UNESCO buildings where little noise is made either by traffic or other factors.

The seating capacity was limited to a figure varying between 750 and 800 seats because that is considered to be the maximum economical capacity under the conditions offered by a city such as Beirut.

PART ONE

BASIC REQUIREMENTS

Functional and Departmental Analysis -·

The main functions of the theater are three:

to accomodate a performance,

to accomodate an audience

and to bring the two together.

It must be emphasized that theatrical functions must be the primary determinants of the size, shape and arrangement of the parts of the theater building and in no other kind of building is suitability of form to function more precisely demanded. Departmentally, the theater requires the following primary units:

a. Auditorium
b. Stage
c. Artists' accomodations
d. Workshops, scenery storage, paintshop
e. Office accomodations for executives
f. Public service and circulatory spaces.

Unit a - Auditorium

The scale, size and construction of the auditorium are dependent on the seating capacity. This capacity should be governed by the provision of good visual and acoustic conditions as well as comfort and intimacy of atmosphere for all

members of the audience.

Unit b - Stage Area

The stage area comprises the acting area, wings, backstage space and fly galleries. The scale and dimensions are dependent on the size and type of performance envisaged.

Unit c - Artists' Accomodations

Structurally, all necessary rooms in this unit are of domestic scale. The stage door is the backstage link with the outside world. Internally the primary considereation has been the planning of dressing rooms and green rooms with quick and easy access to the stage.

Unit d - Workshop and Paintshop

This unit is essentially planned at stage level, with particular consideration for proximity to stage. An efficient sound barrier between workshop and stage is very essential.

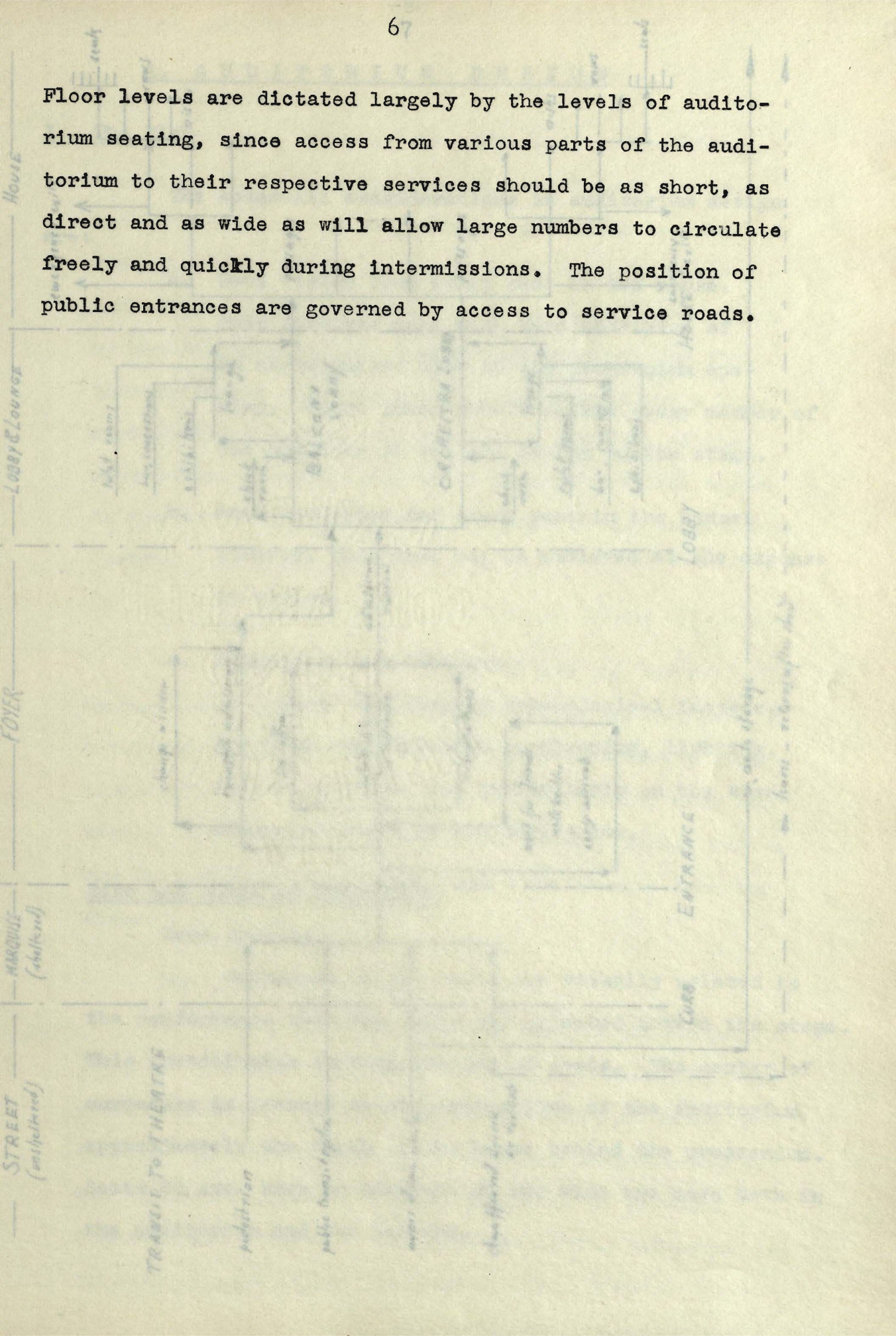
Unit e - Executive Offices

These too, are of domestic scale. For convenience's sake, they are planned as close to their related departments as possible.

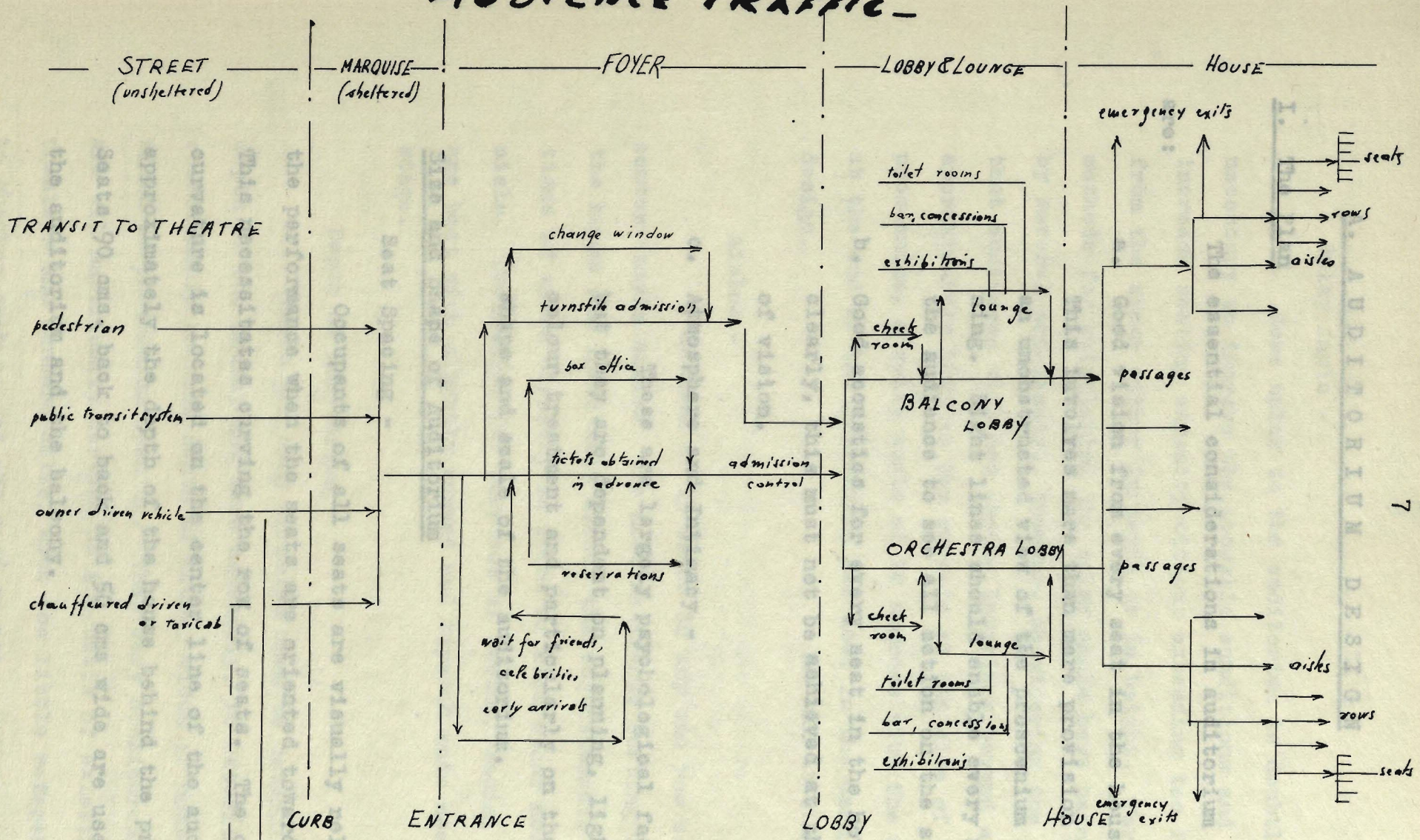
Unite f - Public Service and Circulation Spaces

The scale of foyers, bars, cloaks, etc., will be larger than domestic on account of the large number using them.

Floor levels are dictated largely by the levels of auditorium seating, since access from various parts of the auditorium to their respective services should be as short, as direct and as wide as will allow large numbers to circulate freely and quickly during intermissions. The position of public entrances are governed by access to service roads.



AUDIENCE TRAFFIC



A. AUDITORIUM DESIGN

I. The Plan

The essential considerations in auditorium design are:

a. Good vision from every seat in the house. This involves more than mere provision of an unobstructed view of the proscenium opening. Sight lines should enable every member of the audience to see all action on the stage.

b. Good acoustics for every seat in the house; clearly, this must not be achieved at the expense of vision.

c. Atmosphere and Intimacy -

These are largely psychological factors, but they are dependent on planning, lighting, colour treatment and particularly on the size, shape and scale of the auditorium.

Size and Shape of Auditorium

Seat Spacing -

Occupants of all seats are visually related to the performance when the seats are oriented toward the stage. This necessitates curving the row of seats. The center of curvature is located on the center line of the auditorium approximately the depth of the house behind the proscenium. Seats 90 cms. back to back and 50 cms wide are used both in the auditorium and the balcony.

Splay Angle -

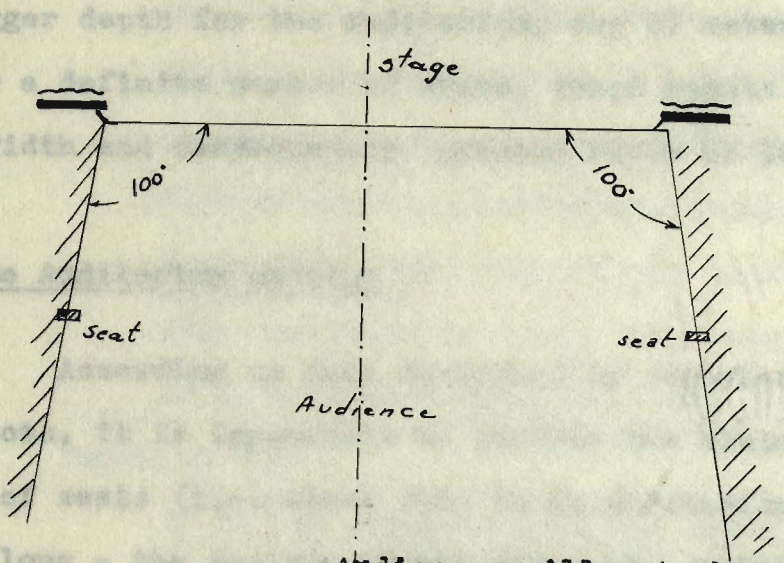
Some splay to the auditorium is doubtless necessary to improve the acoustic conditions and to increase seating capacity without extending too far from the stage either in depth or in height. Various methods for calculating the splay angle have been tried by several architects. However, considering the fact that audiences will not choose locations beyond a line approximately 100% to the curtain at the side of the proscenium, a splay angle of 10 degrees with the normal at the end of the proscenium was used in the candidate's design.

Aisles -

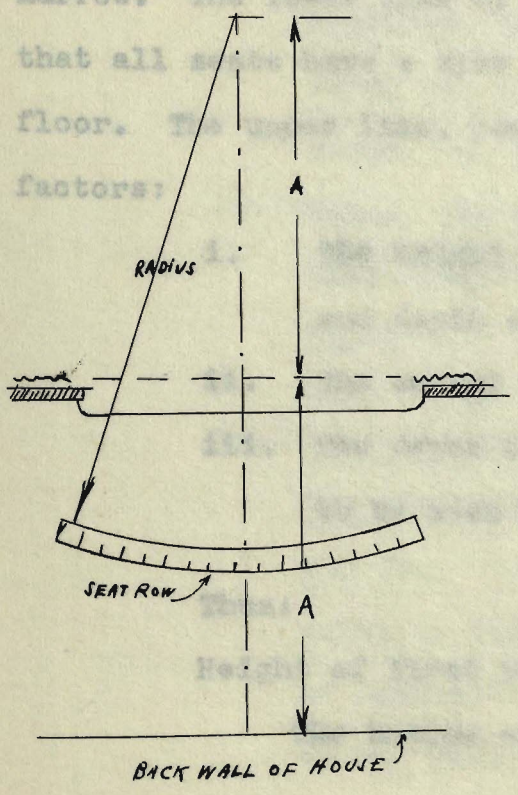
A maximum of 15 seats in any one row was used. The center aisle wastes the most desirable seating area in the house and inevitably causes the objectionable conditions of seats directly in front of each other near the aisle. Obviously, for purposes of seeing, radial aisles are best with slightly curved and tapered ends near the stage.

Depth of Auditorium

There are many formulas used to determine the depth of the house, and more accurately, to determine the relationship between depth of house, width of house, and width of proscenium opening. They vary considerably and are all empirically derived on the basis of existing theaters and concert halls, with too little reference as to whether such houses are good or not. However, consi-



Audiences will not choose locations beyond a line approximately 100 degrees to the curtain at the side of the proscenium



Location of center of curvature of seat rows

dering the fact that visibility from the remotest seat still allows the occupant to see well the facial expressions, the total depth of the auditorium was limited to 23 meters from the stage. It would have been possible to choose a bigger depth for the auditorium, say 27 meters, but this, for a definite number of seats, would result in too small a width and consequently, greater waste of land.

II. The Auditorium Section

According to data furnished by experienced theater architects, it is impossible to provide the minimum economical number of seats (i.e. about 750) in an auditorium of 23 - 27 meters long - the maximum length desirable - without resorting to double banking.

The angle of sight within which seats can be placed vertically to give good vision of the whole stage is relatively narrow. The lower line of this angle should ideally be such that all seats have a view - however slight - of the flat stage floor. The upper line, however, is determined by the following factors:

i. The height of the first border or lighting batten and depth of set.

ii. The amount of back wall height to be seen.

iii. The depth of stage at which artists will need to be seen when raised above stage level.

Thus:

Height of first Border or Lighting Batten

The bottom edge of the border must mask the light

sources on the batten from the front row of the stalls. The height of the batten itself depends on that of the ceiling of the box. In a box set, this height is dictated by the height of flats. There is no standard height for flats; for the purpose of seat and sightline planning, however, 5.50 meters is a satisfactory height to work with. The bottom edge of the lighting batten will therefore be lower than this and is taken as 5.10 meters above the stage floor.

Depth of Set -

It is the distance from the downstage setting line to the actual back wall of the set. For sightline purposes, this has been taken as 5.60 meters back from the setting line. However, in case a bigger depth of stage is required, this may be possible by either receeding the cyclorama nearer to the backwall stage, or, if needed, by removing it completely. Hence, the maximum depth of stage that can be used amounts nearly to 7 meters from the setting line.

Height of Backwall Required to be Seen -

The sightlines should enable actors' bodies and faces to be seen on eventual entrances or exits at the backwall. Therefore, the height of backwall that is necessary to be seen should be not less than 4 meters, allowing therefore,

for the case where the actor is raised above stage level.

Rake of Stalls Seating -

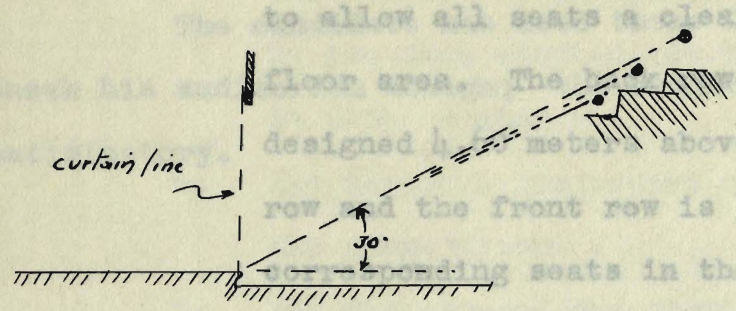
A rake of 1 to 12 gives very comfortable viewing conditions where the seat spacing back to back is 90 cms. (The maximum permitted rake is 1 to 10) The candidate has designed the auditorium floor to have one uniform rake, with slight flattenings at both ends.

Height of Balcony Front above Stalls -

The rake of the stalls seating must be determined before deciding on the balcony design as the underside of the balcony front must clear the upper sightlines from the rearmost stalls seat. Thus, having assured that the back row of stalls can see clearly all the stage floor and the required part of the back-wall, the balcony soffit can be placed.

Distance of Balcony Front from the Stage -

Not more, but even preferably less, than half the stalls area should be under the balcony. Apart from the acoustic reasons, there are psychological reasons against too many stall seats being covered by a low ceiling. A distance of 13.50 meters from the front curtain was deemed satisfactory. (Total depth being 23 meters)



Maximum tolerable sightline angle

Balcony Rake -

Obviously the balcony rake must be great enough to allow all seats a clear view of the stage floor area. The back row of the balcony was designed 4.60 meters above the auditorium back row and the front row is 3.85 meters above the corresponding seats in the auditorium. However, it might be of some interest to know how most of American architects treat the question of auditorium section. To this effect we quote Burris - Meyer and Cole in 'Theaters and Auditoriums':

"The vertical angle of 30 degrees at the spectator's position establishes the distance from the closest seat to the screen or to the highest significant object on the stage. The lowest seat in the orchestra must be located where the patron can just see the stage floor (except in the case of theaters built for motion pictures only). The highest seat in the balcony must be on a line which is not more than 30 degrees to the horizontal at the front curtain at the stage floor if it is not to be beyond the limit of reasonable distortion. The standing patron at the back of the orchestra must be able to see the top of the screen, which is usually as high as any significant portion of a stage setting. Each spectator must see the whole stage - or

screen - over the heads of those in front of him."

The candidate has used these last principles to check his auditorium design; the results were fairly satisfactory.

B. STAGE AREA

Size and Shape of Stage

The size of the stage area is a direct function of the number of performers who use it, their costumes and the nature of their performance. The shape and arrangement of this area are functions of the kind of action and amount of movement inherent in the production type, and of the audience-performance relationship which provides total uniform effect for the particular kind of action. As the action is primarily of the concert or recitational kind, face to face relationship between the performer and the audience is necessary. In his present work the candidate has planned a rectangular stage area of (7.50 x 15) meters gross dimensions. The three side walls - excluding the proscenium wall - are made sound proof.

Stage Height above Stalls -

The height of the stage floor above the datum floor level of the auditorium is goverened by by the rake adopted for the stalls seating and is also related to

a. The vertical projection of the footlights above the stage floor.

b. The distance of the front row of the stalls from the setting line.

There are some basic requirements and data relevant to the stage design:

i. The stage floor must be flat.

ii. The height of eye of a comfortably seated person can be taken at 110 cms. average.

iii. The projection of the footlights above the stage floor level is taken as about 10 cms.

For the sake of floor level balance, the designer has taken 107 cms. as being the difference in elevation between the stage floor level and the front row seats of the auditorium.

Accessibility -

The shape and layout of the stage area is goverened by factors other than those already mentioned, such as the position allocated to dressing rooms, the availability of workshops and the relationship of the stage area to the street or service road

from which scenery and furniture for all kinds of musical performances will be brought in. The following factors should be borne in mind:

Access from the dressing rooms should be as short, as easy and as direct as possible. The entrance for artists to the stage is placed within view of the stage manager's position, i.e. on the prompt side wall.

The candidate has put special emphasis on the fact that access from dressing rooms to stage be made without the use of steps; the stage floor is level with both side wings levels. The stage manager's position is traditionally - and with no special reason - on the right of the proscenium looking from the stage. Ideally, the stage manager should be in direct visual and vocal control of

1. the prompter,
2. artists coming on to the stage,
3. the lighting board,
4. the man operating the act drop,
5. and the by-side machinery and property shelves.

Fly Galleries -

A reinforced concrete gallery is cantilevered out from the wall on both sides of the stage for the operation of flying systems. It is 0.90 meter wide and 5.60 meters high. The factors affecting the height are:

1. Practical visibility into the flies for operation

of hung scenery.

2. Clearance under gallery for the highest generally used standing scenery.

Lighting Positions -

Details of lighting requirements are out of the scope of this work. It may be mentioned, however, that switch boards are best located at recessed corners in the wings.

C. DRESSING ROOMS

Successful planning of the dressing room unit depends largely on the following factors:

1. Careful sectional design enabling the dressing rooms to be placed at stage level, for easy access and egress to and from the latter.
2. Adequate ground space, preferably at one side of the stage block.
3. Selection of a unit scale for each dressing room which will allow flexibility in the number of actors to be accomodated. In addition, the theater has two single dressing rooms providing greater comfort and space for the leading man and woman.

D. S T O R A G E

Workshops: No matter what the size or type of theater, some space should be reserved for repairs to flats and general carpentry work. Space should allow for scenery building and cloth or property making to be carried on at the same time. A net area of (4.20 x 7.90) meters is devoted for this unit.

Storage Space:

Storage space is also quite an essential part. When finished, flats and cloths have to be stood clear of the working space until they are required for use. Few of the finished flats may be flown from the grid but seperate additional storage is necessary. Such areas are best distributed in the basement and first floor, being kept off the stage area.

Scene Dock

This should be at stage level and is conveniently planned between the workshop and the principal scenery entrance. In this position, it provide temporary storage not only for finished work coming from the workshop, but also for any hired stuff coming in from outside the theater until it can be taken into the stage area.

Paint Frame:

The paint frame must be seperate from the stage so as not to interfere with rehearsal space. It should be adjacent to the workshop and have its floor at stage level.

E. OFFICE ACCOMODATION FOR EXECUTIVES

This work includes the business management, ticket selling, sale of programmes, paying of salaries, holding of auditions, as well as some aspects of the rehersal programme.

Stage manager -

The stage manager is generally regarded as the pivot of all professional business problems within the theater, and as such, he should be given some sort of a prominent position. Proximity to stage area should be considered as a requisite for stage manager's office position.

Manager's Office -

Access should perhaps preferably be from the main entrance foyer. The office should be large enough to accomodate eventually some space for a secretary.

Tickets Box -

The ticket box should be as near to the main entrance doors as possible. It needs at least one window for current sale of auditorium tickets and another for the sale of those in the balcony. The connection of the ticket box to the manager's office is of prime importance.

F. PUBLIC SERVICE AND CIRCULATION SPACES

Foyers -

In addition to accomodating ticket queues, the foyer must provide space for members of audience waiting to meet friends. While fulfilling these functions the foyer must be so arranged that the patron who has his ticket can pass through without getting tangled in the queues.

The arrangement of the foyer is also an important question to deal with. Foyer doors are best placed on the long dimension of the foyer due to the fact that patrons waiting for friends habitually stand just inside the doors.

The foyer area per seat is generally about 0.1 square meter. (one square foot per seat)

Lounge, Promenade Hall and Bar -

The lounge, as its name implies is the place where the audience stretches, talks and refreshes itself during intermissions. An adjoining bar can advantageously be placed at the end of the promenade hall. The lounge area per seat is about 0.56 square meter (6 square feet per seat) so that, including the bar and the promenade area with that of the lounge proper, the total approximate area furnished is about 250 square meters while that required for the ground floor is $0.56 \times 450 \doteq 252$ square meters.

The last three units, namely, the lounge, promenade and bar have exit doors to a terrace of 90 square meters approximately in area. All three exit doors are covered by a

common marquise allowing thus, possible circulation when atmospheric conditions do not permit patrons to spend the intermission period on the terrace.

Cloakrooms -

Such areas are located in recessed bays with the idea of having them off the main circulation, and still near enough to the ticket box and entrance doors to the house.

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PART TWO

ACOUSTIC DESIGN

Main Requirements:

The architect must realize the importance in a concert hall of securing uniform acoustic conditions over the whole of the musical gamut or, at any rate, over the important range of frequency which lies between 100 and 5,000 vibrations per second. At the same time, the audience must be protected against distracting exterior sounds.

Insulation of Sound -

This chapter deals with the reduction and isolation of unnecessary sound. Dealing with undesirable sounds, it is usual to distinguish between

a. air borne noises, and

b. structure borne noises.

The former are either

i. external sounds penetrating through open windows, doors and ventilation system into the building,

ii. or sounds produced in the atmosphere of other rooms.

The latter (i.e. structure borne noises) may be

i. either impact noises on the floors, footsteps, etc. or,

ii. noises of machinery in contact with the structure.

Impact noises can to a certain extent be reduced at the source; the slamming of doors shall be quietened by rubber beading applied to the jambs or prevented by pneumatic pistons.

Coco-nut matting or carpets shall be used to deaden emanating sound from footsteps and corridors.

The principles underlying the reduction of noise in machinery consist in smooth interlocking of moving parts, avoidance of blows and sudden accelerations, etc.

As for airborne noises, they must be absorbed as much as is possible in the immediate neighbourhood of the source by having sheets of strongly absorbing material in its vicinity. All doors in the auditorium shall be made tight for maximum sound insulation.

Sound Distribution -

Getting the sound to all the audience is a problem of distribution. Ceilings are the principal distribution surfaces. When ceilings are laid out, they must be planned to reflect the sound back to the audience, either directly or by means of walls. This reflection should be in such a manner that sound will neither be concentrated in some spots, nor reflected back and forth between parallel surfaces and get to the audience out of phase with the direct wave.

Sound distribution requirements govern the shape of the side walls, ceiling under the balcony and rear wall. The fact that the angle of reflection of a sound wave is equal to the angle of incidence makes it possible to lay out tentative shapes on paper.

Reverberation Time -

The reverberation question involves getting the sound to the audience at almost equal intensity everywhere and have it die away at a predetermined interval after it has ceased to

emanate from the source so as not to interfere with the next sound as it comes along. The time between the cessation of the source of sound and the instant the loudness has fallen below the audible limit is known as the time of reverberation.

Absorption of Sound -

The absorption coefficient of a material is the fraction of incident sound that is absorbed, the rest being reflected. It should be evident that a compromise is necessary with regard to the amount of absorption that should be introduced into the hall in order to reconcile "sufficient loudness" and "short reverberation" requirements.

Calculation of Reverberation -

In houses accomodating both music and speach

$$A = 1{,}000 + 0.027\,V$$

where

A = total number of absorption units

V = volume of hall in cubic feet.

V = (23 x 19 x 10)35.32 = 154,200 cubic feet.

Hence, A = 1,000 + 0.027 x 154,200

= 5,170 absorption units.

Therefore, the time of reverberation "t" as given by Sabine's formula

$$t = 0.05\,\frac{V}{A}$$

$$= 0.05 \times \frac{154{,}200}{5{,}170}$$

$$= 1.49 \text{ seconds}.$$

Reverberation optima have been the subject of much investigation. However, the candidate has checked the above value of 1.49 seconds by using the chart given by Knudsen and Harris in "Acoustical Designing in Architecture". This chart gives the optimum reverberation time for a definite volume of hall and for a particular kind of performance, the frequency being equal to 512 cycles per second. According to this chart, t = 1.5 sec. , which checks very closely the above found value.

Absorbent Materials -

In the development of new absorbent materials, research has been directed to what are known as cavity absorbents, in which the damping of air-borne sound is facilitated by resonnance in an air vessel or in a vessel stuffed with wadding. This type of absorbent depends greatly for its efficiency on the sound entering the throats of the cavities at perpendicular incidence. Hence, these honey-comb absorbents are best mounted on walls facing the source so as to trap the wave arriving normally; and for that purpose, the nearer they are to the stage the more efficiant is their action.

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PART THREE

ARCHITECTURAL TREATMENT OF THE EXTERIOR

The Concert Hall is a building with a kind of civic dignity. Consequently, it should be treated architecturally in a way that confers to it this character.

The candidate saw to it that exterior fantasy in decoration be reduced to a minimum. The façades and particularly the main one, should please and impose.

The first effect that one has when entering the building from the front is that of general verticality inducing the idea of height and dominance. The entrance central block is the pivot of the whole facade, as it bulges out of the general building line. This unit, mainly composed of glass blocks walls arranged in vertical sequence is accentuated by a frame of greyish marble that confers to the whole a majestic and attractive ensemble. Four rectangular columns add to the general element of strength of the façade.

As for the openings, the dominant note that is the basis of the overall rythm is a vertical frame binding each two corresponding windows of the two reception storeys.

In the side façade - i.e. the southern - this same motive is used in the horizontal direction, thus furnishing a certain effect of quietness and balance. The color treatment of the walls is an ash grey shade.

The candidate will finally list some of the main reasons to justify his use of the above mentioned glass blocks which provide:

a. Thermal insulation, being a valuable help for the air conditionning of the building.

b. Light transmission: the daylight which streams through such glass panels is softly diffused and natural in color.

c. Sound insulation, which is an important factor for securing proper acoustical conditions by reflecting all intrusive sounds with a minimum of transmission.

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B I B L I O G R A P H Y

Primary Sources-

DESIGN OF THEATRES.- by CHARLES CRICHTON,A.R.I.B.A.

THEATRES AND AUDITOTIUMS.- by HAROLD BURRIS-MEYER & EDWARD C. COLE

Secondary Sources-

ACOUSTICS FOR ARCHITETCS.- by E.G. RICHARDSON

ACOUSTICAL DESIGNING IN ARCHITETCURE.- by V.O.KNUDSEN & C.M.HARRIS

SPECTACLES.-(L'Architecture d'aujourd'hui) No 23 - May 1949

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