

ALLAN GUY LUPONE

A THEATRE ARTS COMPLEX
FOR BOZEMAN, MONTANA

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A THEATRE
ARTS
COMPLEX

A THEATRE ARTS COMPLEX FOR BOZEMAN, MONTANA

Part I of a

Terminal Project in Architecture

By

Allan Guy LuPone

Submitted to the School of Architecture as partial
fulfillment of the requirements for the degree of
Bachelor of Architecture

at

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March, 1972

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local

conditions

Local Conditions
and
Site Location

- (1) Water Table is 10 - 20 feet - there you reach gravel.
- (2) You hit water whenever you hit gravel, and/or silty clay.

This site is surrounded by classroom buildings, dormitories and science labs, with parking lots to the South. Also a small pond is located due east across South 11th from this site.

The dormitories are of brick veneer, with pre-fabricated panels for window placement. These structures are 11 stories or 120 feet in height.

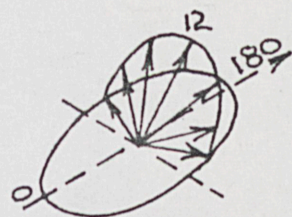
The classroom buildings are from one to four stories in height.

The married student housing is of wood construction and are eye sores. This housing for the married student is in the immediate vicinity. The parking lots are paved.

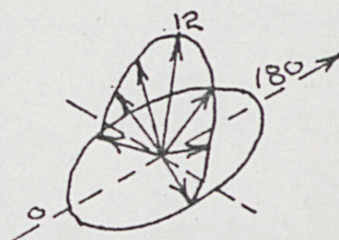
Accesses to this site now are South 11th, West Yellowstone and South 19th.

This site for all practical purposes will be considered to be flat. This does not say that it could not have forms of grading employed into the design.

WINTER



SUMMER



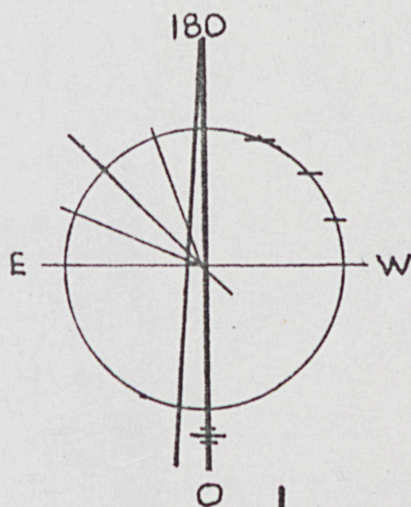
AM*	PM*	Az	ALT
NOON	—	180	21
10	2	151	7
9	3	148	6
8	4	132	5
7:40	4:20	129	4

AM*	PM*	AZ	ALT
NOON	—	180	45
10	2	141	38
8	4	112	20
6	6	90	0
—	—	—	—

AM*	PM*	AZ	ALT
NOON	—	180	68
11	1	145	65
10	2	121	57
8	4	83	37
4:20	7:40	55	0

* M. STANDARD TIME

SUN ANGLES



LATITUDE - $45^{\circ}36'$
 LONGITUDE - $111^{\circ}5'$
 MEAN TEMPERATURE - 43° RAIN 17"
 FROST - SEPT. 12 TO MAY 28
 WINDS FROM EAST AND WEST

MUSIC

FOOD
SERVICE

CREATIVE

ARTS

MED.
SCIENCE

EXT.
SERVICE

LINFIELD

AGR.

INSECTORY

Noon W.



GREENHOUSE

conditions
creating
a need

Conditions Creating A Need

Bozeman, Montana is a culturally robbed area, and for the most part, so is Montana. Probably the biggest reason for this is that there is not a suitable performing area in the town of Bozeman or Montana.

To attend a concert and/or production in Bozeman, one must either go to the Field House, which is an acoustical abortion; the Sub-Ballroom, which is better suited for banqueting; the Willson School, which is fair, but not adequate; the Sub-Theatre, which is too small, or the Ellen Theatre, which is adequate for some things, but is lacking in stage, width and depth.

The needs of this community are also the same needs of the campus at Montana State University. We need a large hall to hold approximately 1100 patrons, with an intimate theatre for experimental purposes, to hold from 150 - 200 patrons.

This facility should be so located that it is easily accessible to the students and to the community as a whole. The type of productions to be seen in this facility could range from Lawrence Welk to a Jesus Christ Superstar.

In order to accomplish this, the hall must be flexible. To be flexible, the hall must have either an open stage or a multi-purpose type of theatre.

function
of the
building

Function of the Building

"The Showman's first contact with any member of his audience occurs when that individual comes in sight of the theatre. From that moment until he is on the highway ... headed for home, his every movement is the Showman's concern. The easier and pleasanter the patron's progress from home to theatre seat and back again, the better the Showman's chances of making and holding a repeat customer."¹

¹pg. 16 - Burris - Meyer & Cole
Theatres & Auditoriums

The Audience Goes to the Theatre ²			
Type of Production	Theatre	Audience Transit Time	Audience Assembly Time
Pageant Spectacle	Consideration Latitude in type. Large seating capacity only requisite. Stadium or Sports Arena (M.S.U. Field House)	Weeks (Oberammergan) Days (Lost Colony) Hours (Aquacade)	1 hour is on time
Concert	Any Auditorium with a platform	Average 30 minutes	40 minutes from advertised curtain time until half hour after show begins
Opera	Opera House when available		
Dance	Demands vary from as simple as concert to as complex as opera		
Legitimate and Musical	Commercial, School College, University Professional School, Community. Lacking these: Barn, Opera House or Tent	Less than an hour except for summer Theatre. Average 30 minutes	20 minutes beginning Approx. 7 min. before advertised curtain time
Presentation Vaudeville	Presentation House Commercial	Slightly shorter than Legitimate	Continuous show. Now alternates with pictures
Motion Pictures	Motion Picture palace	15 minutes	Continuous "
	Neighborhood News	10 minutes maximum	
Burlesque	Old Commercial	15 minutes	same as legitimate
² pg. 16 Theatres & Auditoriums			

Public Areas

There are four main areas which make up the public areas of a theatre. They are as follows:

1. Transportation and parking
 - (a) Access to and from
2. Foyer
3. Lobby and Lounge
4. Auditorium

To develop these areas so that the patrons have the easiest access to the theatre, here is a Composite Audience Floor Chart.³

³pg. 23 - Theatres & Auditoriums

Transportation and Parking

"The average car carries three theatre patrons. To the theatre, patronized by owner-drivers, patrons come irrespective of weather if there is a convenient parking space."³

Parking for the proposed Theatre Arts Complex for Montana State University will not be a problem for the patrons. The site condition will show an ample parking facility. If more parking is needed, the use of near-by dormitory parking lots can and/or will be used by the patrons.

The major accesses to the complex now are South 11th, West Yellowstone, South 19th and West College. The minor accesses to the complex will be South Willson and West Grant.

By using the above roadways, it will help make car transportation much easier to get to and from the complex.

³Ibid., p. 23

For the most part, most of the patrons will be coming to the complex by means of walking.

Married Student Housing and dormitories are very close to the site and for this reason, we can readily see that most of the patrons will be walking to the complex.

For the patrons coming by car, there should be an easy access to and from the building. In cases of inclement weather, fast and easy access into the building is of most importance to the patron.

FOYER
Foyer Area Per Seat Chart

Opera House	1 ft. sq.
Commercial Theatre	1 ft. sq.
Non-Commercial Theatre	
1. School	1 ft. sq.
2. College and University	1 ft. sq.
3. Community	1 ft. sq.
Motion Picture	
1. Palace and Presenta- tion	$\frac{1}{2}$ ft. sq.
2. Intimate	Negligible
3. Neighborhood	$\frac{1}{2}$ ft. sq.
Summer Theatre	Outdoor patio or terrace serving Multiple functions Usually adequate

You enter into the Foyer from underneath the Marque or from the outside. This Foyer area is used for the patron picking up their reservations or for the patrons who have not purchased their tickets.

Patrons having purchased tickets in advance must flow through the Foyer area with great ease. In order to do so "...the direction of the "Queues" at ticket windows must be so arranged as not to interfere with the straight path from Foyer door to Lobby door."⁴

⁴Theatres & Auditoriums

"It is obvious that there should be direct access to the Foyer on all sides of the theatre where there is a Marquee."⁵

⁵Theatres & Auditoriums

LOBBY

Lobby Area Per Seat

Opera House	2 ft. sq.
Commercial Theatre	1.8 ft. sq.
Non-Commercial Theatre 1. School 2. College University 3. Community	1.2 ft. sq. 1.4 ft. sq. 1.4 ft. sq.
Motion Picture Palace and Presentation Intimate Neighborhood	1.8 ft. sq. 1 ft. sq. 1.5 ft. sq.
Summer Theatre	1 ft. sq.

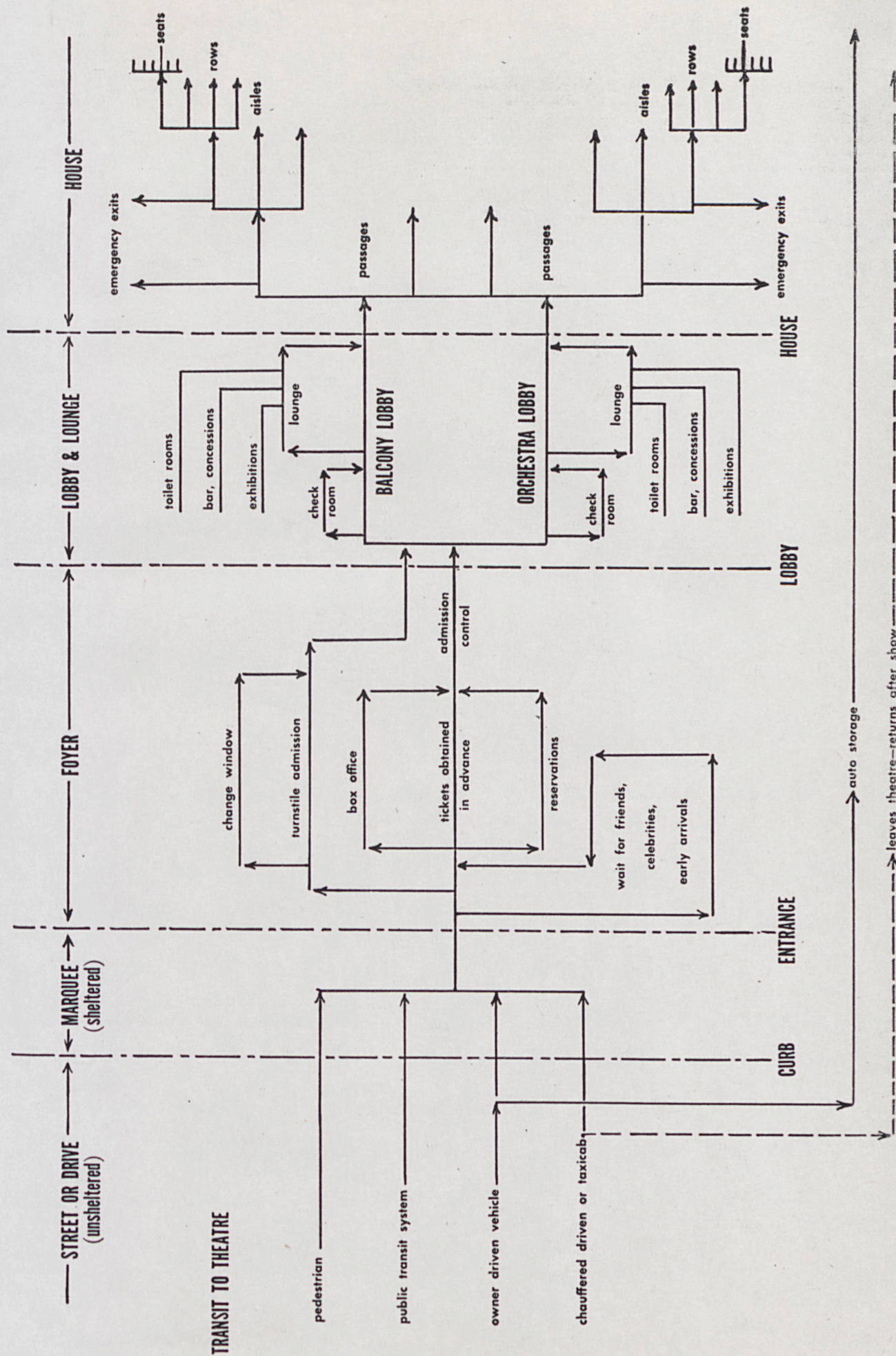
pg. 26 Theatres & Auditoriums

"The Lobby is principally a distribution area. Like the Foyer its efficiency is measured not only by its size but by its arrangement."⁶

To attain a greater efficiency, one must be able to direct each and every patron to his aisle and/or stairway (rampway) without having them crossing one another on their route to the aisle's and/or stairway (rampway).

The design of a Lobby must do the above in order to be considered adequate.

⁶Theatres & Auditoriums, pg. 25



Composite audience flow chart.

LOUNGE

Lounge Area Per Seat

Opera House	8 ft. sq.
Commercial Theatre	6 ft. sq.
Non-Commercial Theatre	
1. School	6 ft. sq.
2. College and University	6 ft. sq.
3. Community	8 ft. sq.
Motion Picture	
1. Palace and Presentation	1 ft. sq. 2 ft. sq.
2. Intimate	
3. Neighborhood	1 ft. sq.
Summer Theatre	10 ft. sq. out of door (veranda, lawn, garden, patio)

pg. 29 Theatres & Auditoriums

The traffic areas in the Lounge should be to refreshment stands, Lounge area, and to lavatories. The lavatories should be the left and right of the Lounge Entrance. By doing this it enables you to split the traffic flow. This is an area used mostly during intermission.

Some theatres contain a bar with the lounging area. I feel for the campus of Montana State University this would^{not} be acceptable.

"Foyer, Lobby and Lounge have separate functions... there must be structural separation between Foyer and Lobby, but doors can be opened at intermission. Lobby and Lounge can be structurally combined where paths of movement are so routed that both functions can be fulfilled simultaneously without crossing.⁷

⁷pg. 28, Theatres & Auditoriums

Auditorium

The most important aspect in determining the design of the Auditorium is the Acoustical considerations. If, in any theatre, you can accomplish excellent acoustics, the visibility and comfort factor will, for the most part, be accomplished. So from this, here is a breakdown of general Auditorium needs.

1. Acoustics
2. Visibility
3. Comfort

1. Acoustics

All acoustical considerations will be found in the Appendix, under Acoustics for Auditoriums.

2. Visibility

The demands of the audience and actor must be satisfied by the Architect. Each and every member of the audience comes to the theatre to see the entire performance. Likewise, the actor wants the patron to see the entire performance. In order to accomplish this, the Architect must follow rigid guide lines. They are as follows:

- (a) Sight Lines
- (b) Plan
- (c) Seating
- (d) Stagger of Seating
- (e) Aisles
- (f) Depth of House

(A) Sight Lines

- (a) The Horizontal angle of poly chromatic vision (no eye movement) is approximately 40 degrees.
- (b) The Horizontal angle to the center line at which objects on-stage, upstage...and to background is approximately 60 degrees.
- (c) The Horizontal angle to the projection screen - less than 60 degrees to the far side of the projected image.
- (d) Judged by the audience"s ability to recognize shapes...
- (e) Audience will not choose locations beyond a line approximately 100 degrees to a curtain at the side of the proscenium.
- (f) Vertical angle less than or equal to 30 degrees.⁸

(B) Plan

Your plan is directly controlled by sight lines.

(C) Seating

Your seating is controlled by sight lines which will create a floor slope and row separation.

⁸pg. 31, Theatres & Auditoriums

(a) Floor Slope

To determine floor slope, the position of a spectator in the first row on the center line is approximately 30 degrees angle vertically.

"A point 3'-8" below, and 18" in front of the eye position will be the floor level for the front row. Draw a sight line from eye position to downstage edge of stage, and extend it back of the eye position for the front row. Step off horizontal seat spacing (back to back), and draw vertical lines at the points thus established. Establish a point 5" above the intersection of the extended sight line and the next vertical line. This is the eye position of the second row and the floor level at the front edge of the second row seat is 3'-8" below and 18" in front of the eye position. Repeat this process and draw floor slope!"⁹

For floor slope exceeding $1\frac{1}{2}$ " per foot, platforms and steps in the aisles are required.

(b) Row Separation Back to Back¹⁰

Maginal - 34"
Allows easy passage - 45" } somewhere between

(D) Stagger of Seating

Sight lines determine this aspect.

(E) Aisles

Seating requirement, floor slope, and sight lines determine this aspect.

(F) Depth of House

50 ft. - 75 ft. maximum

⁹pg. 35-36, Theatres & Auditoriums

¹⁰pg. 62, Theatres & Auditoriums

3. Comfort¹¹

1. Shape and upholstery of seat
2. Distance between rows, position and width of aisles
3. Airconditioning, and heating
4. Decoration and lighting of the Auditorium
5. Floor slope
6. Absence of distraction

¹¹pg. 17, An Opera House by Skram

Non Public Areas

Non public areas consist of the areas not pertaining to the public.

1. Stage
2. Orchestra pit
3. Backstage working area
 - a. Stage entrance and vestibule
 - b. Dressing rooms
 - c. (1) Green Room
(2) Ante-room
 - d. Musicians room
 - e. Off stage
 - f. Stagehands' rooms
 - g. Stage manager, designer and Director
4. Stage machinery
Lighting

1. Stage

Should be the most important non public area. To determine the size, shape, and arrangement of stage will be the type of performance being presented.

Another aspect we can and will consider is if the stage should be sloped or not. A sloped stage will give the patron a better view of actors in the back lines of a performance. For all practical purposes, I feel that a sloped stage should be incorporated into my theatre design. The slope on stage should be such that it would not interfere with the actor's performance.

The depth of the stage should be adequate. Adequate means not too shallow and not too deep, so that the last

person in the house will be able to see without distortion of faces. He should see with great clarity at all times.

2. Orchestra Pit

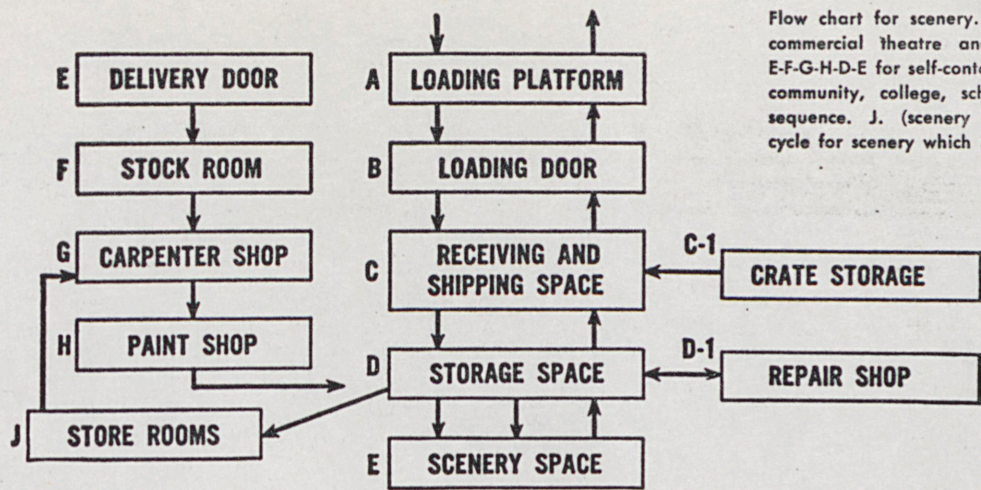
There are three basic types of orchestra pits. I would like to talk about one type in particular. The sunken, open pit is the one I would like to employ in my theatre.

Part of the pit is buried under the stage. This only acts as a facade to try to keep the patrons from seeing the orchestra and letting the actors see the conductor for their musical cues.

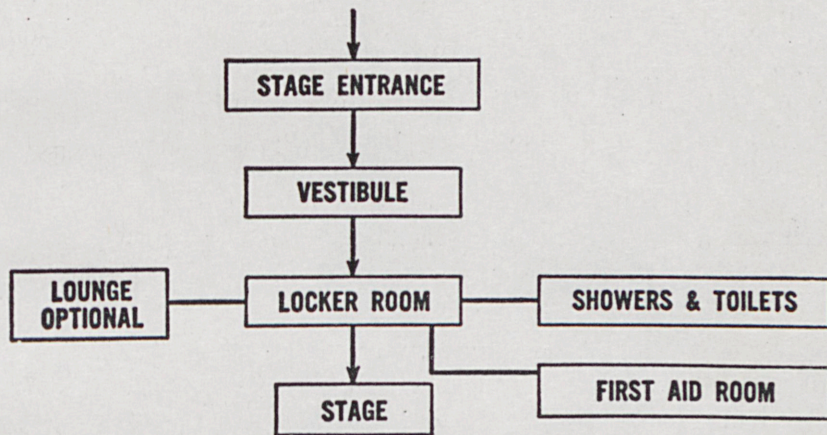
3. Back Stage Work Areas

To best describe this function of the building, here is a Flow Chart which should help to explain what the interaction backstage entails.

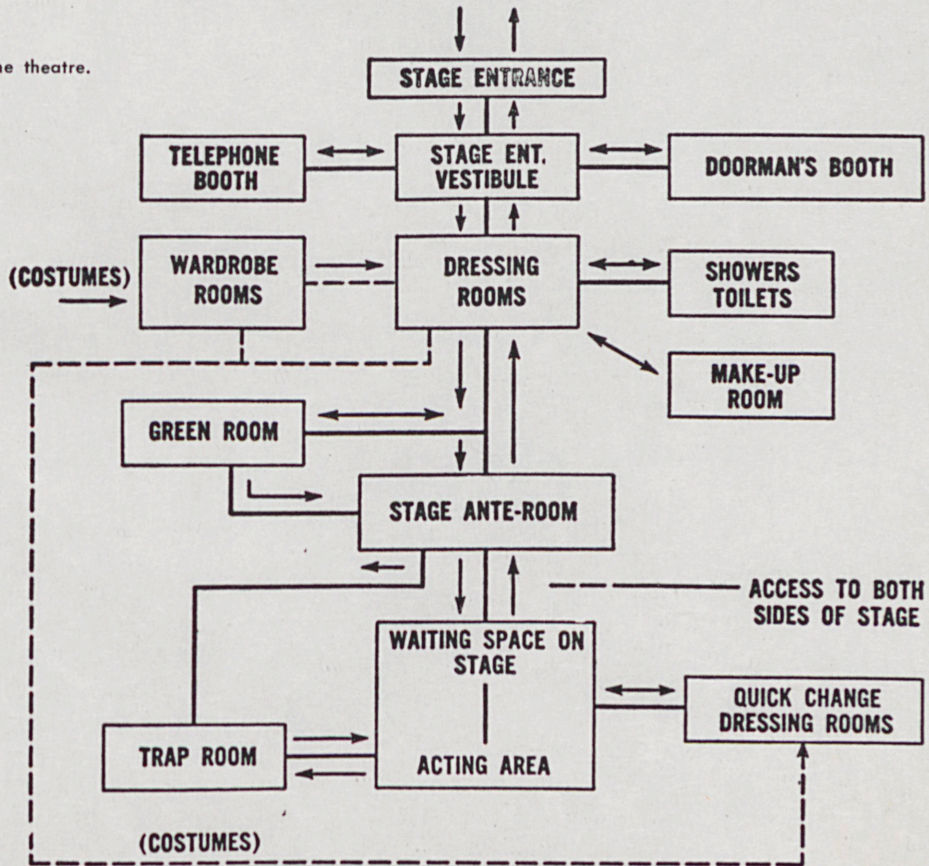
Flow Chart, pg. 90, Theatres & Auditoriums



Flow chart for stage hands.



Flow chart for actors in the theatre.



SOLID LINES — PERSONNEL
BROKEN LINES — MATERIALS

(a) Vestibule and Stage Entrance

This part of the backstage area is used by everyone who is working in the theatre. Therefore, this area should be centrally located in the backstage area.

(b) Dressing Rooms

A minimum of 70 sq. ft. of floor space is required for each principal performer with a minimum of 2 linear feet of closet space per person.

Continuous mirrors, make-up tables, plus one full length mirror should be in each dressing room.

There should be a women's and men's lavatory close to the dressing rooms. Minimum requirements for lavatories are one toilet per 6 people.

Principal performers should have a shower in their rooms.

(c) (1) Green Room

This is a social gathering room for performers. It should be set up as a Lounge area. Direct passage from the dressing rooms to the Green Room should be in conjunction with the stage.

(2) The Ante-Room

This is the room where the stage manager checks the cost and assembles the chorus before the show starts.

Both the Green and Ante-rooms should be large enough to accommodate the entire case.

(d) Musicians Room

This area must include lockers, music cabinets, and some little rehearsal room areas. This space is somewhat like the Green Room in so much that this area is a lounging area for the Musicians. This area should be furnished as a lounging area.

Showers should also be supplied with lavatories for both women and men. Dressing rooms are also located in this area.

(e) Off Stage Space

An area or areas where actors enter and leave the stage. We must remember that an actor is always responsible for his own entry onto the stage.

(f) Stagehands Room

In the Theatre Arts complex, I am proposing that the stagehands will be students from M.S.U., and the Drama Department. Therefore, this room could just be a place for storing coats with just some space for sitting and lounging.

(g) Designer, Director, Stage Manager

These offices will be offices located near a common conference room. This space should be accessible to the Theatre Lobby.

Typical office materials are needed and used in these areas.

4. Stage Machinery

Such stage machinery as moving platforms may be employed into my stage area. These platforms can transport people as well as scenery. For the most part, most of the set arrangements will be handled by student help. Other sets will be controlled by the flies in the fly area. In the fly area is also the Gridiron.

"The Gridiron is an open work floor of steel located under the roof of the stage on which sheaves may be fastened either permanently or temporarily..."¹²

Stage crew workers must be able to move freely and safely in this area.

Another aspect of stage machinery is lighting. Lighting could become one of the most important aspects of the mood of a performance.

¹²pg. 136, Theatres & Auditoriums

The Projection and/or Control rooms should be located in such a manner in which it makes the men working in them able to hear the performance so they won't miss a cue. (control panels in these areas).

One part of my stage scenery will be the application of translucent screens on back and side walls of the stage. These translucent screens will be adjustable for stage, auditorium lighting, and movie projection.

aethetics

Aesthetic Considerations

The Aesthetical considerations for this complex, are very important to the entire building concept.

This Theatre Arts complex must be of the very best in all facets of construction and design. It must fit into the surrounding area very homogeneously while still having a very definite character of its own.

Theatres are meant to be places of beauty and enrichment; and the mood created by your design could either enhance or destroy what mood you were trying to create. You must treat every element of this complex with great integrity in order to accomplish the aesthetical feel you have originally planned.

There are so many other aesthetical considerations that it would be very unrealistic to list them in this paper. They will be used with great care and consideration while doing the complex.

ACOUSTICS

Acoustical Consideration

All acoustical consideration will be shown in the Appendix of this report.

One must state that the acoustics of a theatre is one of the most important aspects of the entire Theatre complex.

PROGRAM

Program

The program I am presenting is a very flexible one; it must be for all practical purposes. The most flexible area of all is the Non-public areas, where the type of performance controls the use of spaces in these areas.

Additions and changes will be made before the final design is completed.

Floor Loads

The safe live loads for all theatre floors in $\#/ft^2$

	<u>$\#/ft^2$</u>
Lobby and Corridors _____	100
Stairways _____	100
Auditorium _____	80
Balcony _____	80
Stage _____	250
Scene Docks _____	100
Property Rooms _____	150
Gridiron _____	70
Roofs _____	40

Public Areas Main Hall

Area per seat

Foyer

1 ft. sq.

Lobby

1.8 ft. sq.

Lounge

6 ft. sq.

Description	Proposed Area sq. ft. Approx.	No.
<u>Foyer</u> Function: Receiving area, ticket sales, and waiting area <u>Equipment:</u> Box Office Finish: Best quality	1100	1
<u>Lobby</u> Function: This area is a distribution area to check- rooms, House and Lounge. <u>Equipment:</u> Ticket handlers facilities <u>Finish:</u> Best quality	1980	1
<u>Coat-Check rooms</u> Function: patrons store coats and hats. <u>Equipment:</u> Coat racks and hat racks Finish: Simple, but of the best quality	150	2
<u>Lounge</u> Function: Area in which patrons go to during inter- mission <u>Equipment:</u> Refreshment areas Lounging area (seating) <u>Finish:</u> Best quality	6600	1

Description	Proposed areas sq. ft.	No.
<u>Men's Restroom public</u> Equipment: 10 W.C., 8 urinals, 4 lavatories <u>Finish:</u> Best quality	400	1
<u>Women's Restroom Public</u> <u>Equipment:</u> 8 W.C. 4 Lavatories <u>Finish:</u> Best quality	400	1
<u>Auditorium</u> <u>Function:</u> House for patrons <u>Equipment:</u> Seating <u>Finish:</u> Best quality (Acoustical)	7 sq-ft/seat min.	1

<u>Non Public Areas Main Halls</u>		
Description	Proposed Area sq. ft.	No.
<u>Stage</u> Function: The performing area for the actors, and all scenery needed. Equipment: Gridiron above acting area, flies. Translucent screen. Off stage space for actors. Finish: Acoustical, simple and very durable.	8000	1
<u>Stage Entrance</u> Function: A space used by everyone who belongs to the theatrical field entering the Theatre. Finish: Simple	90	1
<u>Dressing Rooms</u> <u>Principals (individual)</u> Function: Make-up, Costume changes, sometimes a warm-up area. Equipment: Make-up table, closet space, mirrors, Lavatories, shower	70	8

Description	Proposed Area sq. ft.	No.
<u>Dressing Rooms</u> <u>Cast</u> Function: Same as individual dressing room. Equipment: 2 linear ft. of hanging space per person. Lavatories, shower Finish: Simple	800	1
<u>Green Room</u> Function: Room for the cast to gather before and after performance. Equipment: Lounge furniture Finish: Best quality	400	1
<u>Rehearsal Room</u> <u>Ante Room</u> Function: Gathering room for performers to rehearse before shows. Finish: Simple	400	1
<u>Musician's Room-Men</u> Function: Warm-up and relaxing area. Equipment: Lounge furniture, lavatories, shower, lockers. Finish: Simple	300	1

Description	Proposed Area sq. ft.	No.
<u>Women's Musicians' Room</u> Same as men's	250	1
<u>Conductor's Dressing Room</u> Function: Office, dressing area Equipment: Lavatory, shower, closets Finish: Best quality	150	1
<u>Stagehands' Room</u> Function: Use for storing coat etc., lounging area Equipment: Seats and closet spaces Finish: Simple	200	1
<u>Costume Room</u> Function: Costume design, repair, fitting and pressing Equipment: Sewing equipment and costume repair equipment Finish: Simple	150	1

Description	Proposed Area sq. ft.	No.
<u>Workshop</u> Function: Used for set design, making and repair Equipment: Complete carpenters workshop plus tool; artist equipment. Electrical work area Finish: Simple	200	1
<u>Offices</u> Function: Conference room, Designers, Directors and offices. Equipment: Office equipment, all types Finish: Best quality	150	4

Intimate Theatre; Experimental

For 150 - 200 people

This experimental will be a flexible theatre, where you could have all types of informal theatrical performances. From Theatre in the round, to three sided arrangement, to one sided arrangement. This is a multi-use theatre. Location near Non public areas.

Description	Proposed Area sq. ft.	No.
<u>Foyer:</u> From Main entrance and/ or private	200 if private	1
<u>Coat-Check Room</u> Same as Main Hall	100	1
<u>Men's Rest Room</u> Equipment: 3 W.C., 3 urinals, 2 lavatories	200	1
<u>Women's Rest Room</u> Equipment: 3 W.C., 2 lavatories	200	1
<u>Auditorium</u> Function: House for patrons Equipment: Seats made to be of a flexible material Finish: Best quality	1000	1

Description	Proposed Area sq. ft.	No.
<u>Stage</u> Function: Flexible Equipment: Handled by stage hands and actors		
<u>Stage Entrance</u> From non-public areas		

All dressing rooms will be handled from Main Hall Dressing Rooms. Small areas can be developed for dress and costume change if desired. All lighting and sound will be controlled by one area designated by the best possible location. This will be decided by the design of the space.

An oral arts classroom may also be added to this complex if so desired.

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A P P E N D I X

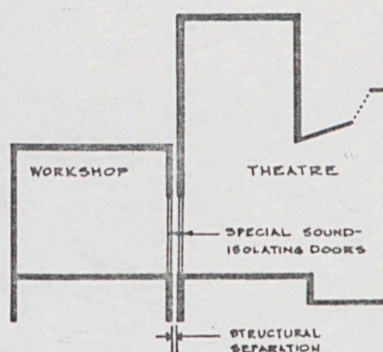


Fig. 31. Stage-scenery workshop isolation

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DESIGN FOR GOOD HEARING

Good hearing conditions in almost any kind of indoor or outdoor auditorium can be assured in advance if the four basic requirements discussed in the Introduction are satisfied: (1) quiet; (2) sufficient loudness; (3) proper distribution; and (4) adequate blending and separation of sounds.

QUIET

Really excellent hearing conditions, either indoors or outdoors, can only be achieved when the listening area is quiet. If we have too much noise, there is no point in worrying about the other factors which make for good hearing conditions. Outdoors, the noise may come from aircraft, from automotive traffic, or even from wind in the trees. Inside buildings, we not only have some of these outdoor noises transmitted through the shell of the building, but we have many noise generators such as air-conditioning systems and adjoining spaces (lobbies, stage work-

shops, other auditoriums) that must be kept under control. The techniques of noise control are discussed in the section on "Sound isolation" but unless these are all observed with great care, it is unlikely that an excellent auditorium will result, no matter how carefully the other aspects of room acoustics are considered.

Outdoors, the best noise control technique is to place the audience far away from noise sources. High quality concert music simply cannot be presented outdoors on a noisy site in modern city traffic. Walls and dense woods can help reduce traffic noise; a single row of trees or a low wall is only a visual help.

The indoor auditorium can be made quiet even in a noisy city location. The audience chamber must be treated as an isolated area separated from all other areas by walls, closed doors, lined ducts, and other positive noise control measures. Noises in surrounding areas should be reduced as much as possible at the source. Lobbies, for example, should have heavy sound-absorbing treatment and should always be shut off from the auditorium with closed doors, preferably weather-stripped. If there is a scenery workshop adjoining the stage, it should be separated with a complete structural break (Fig. 31) with double sound-isolating doors to eliminate the noise from hammering and sawing. If one auditorium is located above or next to another, the two must be separated with double construction to permit simultaneous use (see Fig. 27).

The ventilating system for an auditorium should be inaudible. This means that the associated ductwork must be lined with sound-absorbing materials or that special sound traps must be installed. The fans and compressors must either be remotely located or carefully isolated with resilient mountings and heavy housings. Normal "commercial practice" is never good enough for an auditorium.

LOUDNESS AND DISTRIBUTION

It is obvious that the sounds we want to hear should be loud enough, and that all sounds should be uniformly distributed. People in the front of the seating area should not receive great quantities of sound while those in the back barely hear at all. A dead spot or an area of focused high-intensity sound can be just as unsatisfactory as a seat in which a person hears everything twice due to long-delayed echoes. Adequate loudness and good distribution of sound are determined almost entirely by the size, shape, and surface finishes of the room and, in some cases,

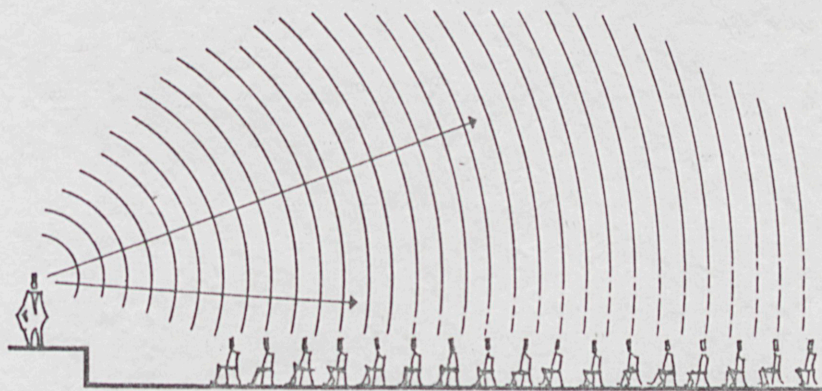


Fig. 32. Sound distribution outdoors over audience

By ROBERT B. NEWMAN and WILLIAM J. CAVANAUGH, *Bolt Beranek and Newman Inc., Consultants in Acoustics*

by the use of carefully designed sound-reinforcing equipment. In most moderate-sized auditoriums, however, it is not necessary to resort to electronic aid. If the space is designed carefully with well-chosen materials, the enclosure itself provides the needed sound reinforcement and good distribution.

In the small conference room or office there is seldom a problem of adequate loudness, but there can be problems of distribution caused either by concave walls or ceilings, or by flutter echoes between parallel, uninterrupted surfaces. At the other end of the scale, the large sports arena must depend almost entirely on amplified sound for hearing speech or music, and the enclosure is treated so that it will be as absorptive as possible to reduce troublesome echoes and unwanted confusion.

Figure 32 shows the typical distribution of sound to an audience seated on level ground outdoors (or in a large sound-absorbing room). The spherical sound waves radiate outward from the speaker, and the intensity of sound in these waves decreases inversely as the square of the distance. However, as it grazes over the clothing and hair of the sound-absorptive audience, additional losses occur which can amount to as much as 2 db per row. This means that people seated near the back of an audience not only receive less sound energy because they are far away from the sound source, but they are also deprived of sound energy by the people in front of them. Thus, in outdoor, flat audience areas the loudness and distribution requirements are poorly met.

In the ancient Greek and Roman theaters this problem was solved by placing the audience on steep hillside (in quiet locations: no airplanes, trucks, trains or cars). When the audience is placed on a very steep angle (Fig. 33), there is very little energy loss in the freely advancing sound wave, and until the audience is quite far away from the source, there is no great difficulty in hearing. It is always true in any listening situation that the better the sight line for vision, the better will be the hearing.

However, placing the audience on a steep hillside is not the only solution; we can get the same result by raising the sound source position with respect to the audience, or even more simply by using "mirrors." If the sound from the original source is reflected from a hard ceiling surface over the audience, it appears to come to the audience from the virtual image

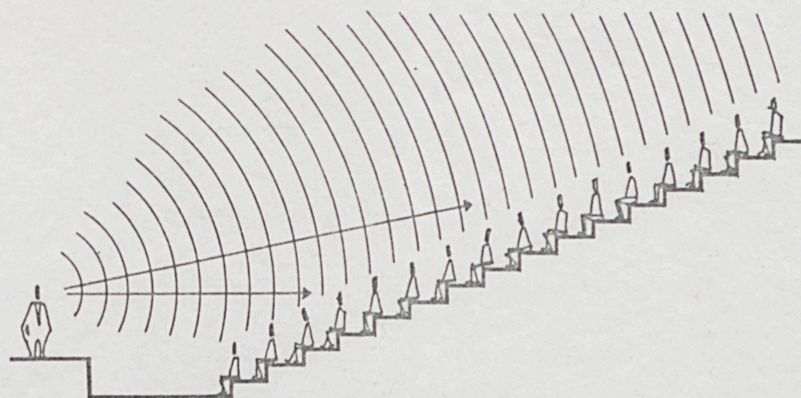


Fig. 33. Steep seating minimizes audience attenuation

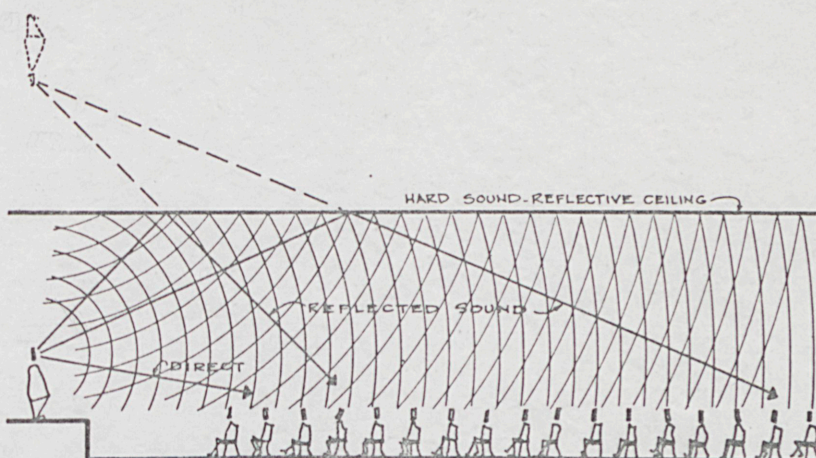


Fig. 34. A sound-reflecting ceiling reinforces the direct sound to the audience

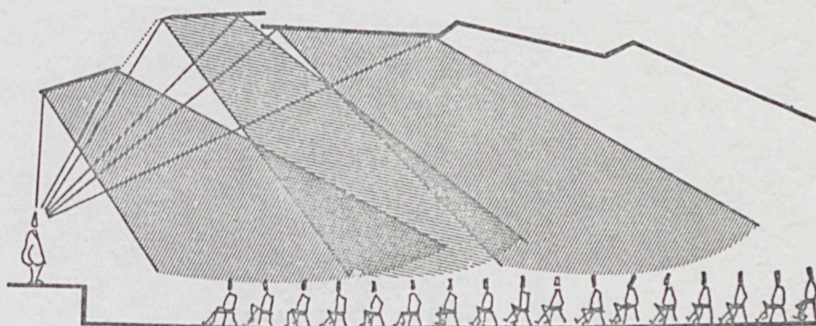


Fig. 35. Uniform distribution of reflected sound can be assured by proper ceiling design

position overhead, and thus, does not experience the grazing incidence losses of the original sound from the source (see Fig. 34). The action of the ceiling as a reflector, bringing sounds down on top of the audience, is extremely important in all auditorium situations. This sound mirror (the ceiling) is probably the most important surface in the room for determining

good distribution and adequate loudness. The walls are important too, especially where long reverberation time is wanted.

The shape of an auditorium can be varied and refined in many ways but, basically, the ceiling of any room where hearing is important should be hard and sound reflective and should never be treated with sound-absorbing materials ex-

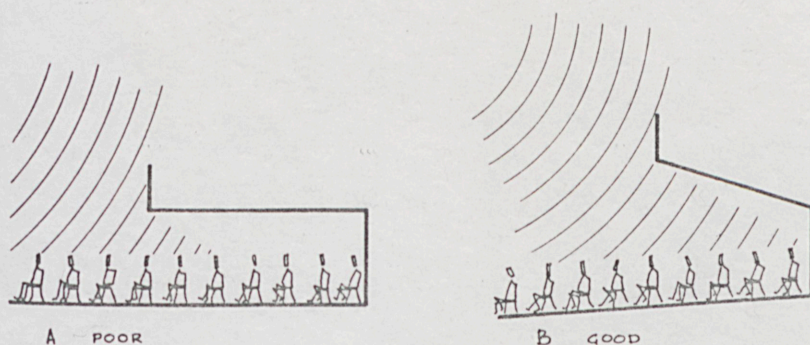


Fig. 36. Deep underbalconies deprive some seats of useful reflected sound

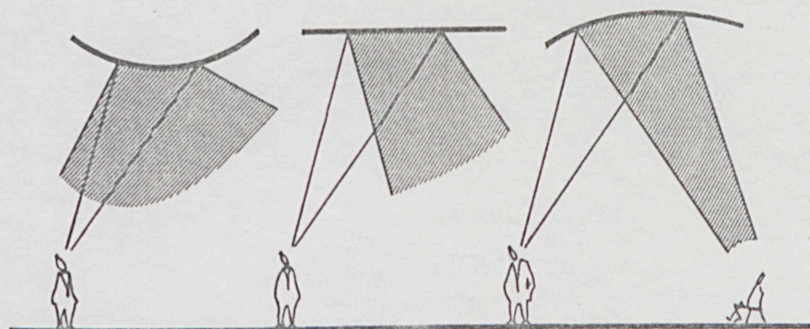


Fig. 37. Effect of surface shape on reflected sound

cept in very special situations (e.g., large sports arena).

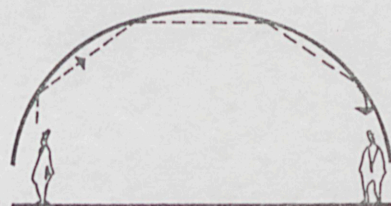
Figure 35 illustrates some possible refinements in ceiling design which provide more uniform distribution to an audience. The problems that come from using deep balconies are shown in Fig. 36. For good distribution and adequate loudness a listener must be seated properly in the auditorium so that he receives not only direct sound from the source but also reflected sound from the ceiling and walls. He must be able to "see" the ceiling and if he is seated deep under a balcony (or side aisle in a church) and cannot receive this reflected sound from the ceiling, he will hear poorly. If the balcony is handled as shown in the right-hand side of Fig. 36, people under the balcony will hear well. If the ceiling is made with

concave sections, either barrel- or dome-shaped (see Figs. 37 and 38), there will inevitably be concentrations of sound in certain areas of the seating. The only solution for shapes of this sort is to make them highly diffusing (discussed further on in this section) or to make them highly absorptive (in which case, we no longer have an auditorium but a noise control environment or an anti-auditorium).

Plan influence on loudness and distribution

The plan of an auditorium should be determined by many factors including the gross seating capacity; the possible need for short viewing distances; whether the hall is primarily to be a concert hall or primarily an assembly or lecture hall; conditions of the site; and dozens of other factors (see Fig. 39).

Although traditionally the seating is laid out on radial lines, there is no reason why very handsome and adequate arrangements cannot be made with straight sections of seating. Curved plan elements should be avoided whenever possible because they always give rise to troublesome echo problems. The rear wall of an auditorium should never be curved unless it is absolutely necessary and if it is a smooth, concave curve in plan, it must be treated very heavily with sound-absorbing material to reduce the possibility of echo.



CREEP, OR THE WHISPERING GALLERY
Fig. 38. Sound reflection along curved surfaces often results in strange effects

A straight or segmented rear wall is always a less troublesome surface. If sound-absorbing treatment must be used to control echo, it usually must be rather deep and the facings must be very open (see section on "Sound absorption"). Balcony fronts generally should be either open railings or tilted so that they do not reflect sound to the front of the room.

There is no "best" plan or section for an auditorium. Every scheme must be considered on its own merits. Certain types of plans are more troublesome than others, especially when the hall becomes quite wide and the time delay between arrival of initial sound and reflected sound becomes great. In general, side wall surfaces near the proscenium should be tilted to direct sounds toward the rear of the hall rather than across the room where long time delays would result (see Fig. 40). A wide fan plan is not as likely to be an excellent auditorium as a somewhat longer, more rectangular scheme.

REFLECTION AND DIFFUSION OF SOUND

We have discussed at some length the reflection of sound from the enclosing surfaces of a room, but it is important to keep in mind that, unless the surfaces or the elements of the surface are large compared with the wavelengths of sound involved, they will not reflect sound in a geometric fashion. The reflecting surfaces should have minimum dimensions of 3 to 6 ft. if they are to act as true sound mirrors. Small objects of a few inches or less will merely allow sound to pass by and will have little effect on the sound field (see Fig. 41). Thus, a pulpit canopy or suspended sound-reflecting panels over an orchestra or in the ceiling of an auditorium, or the elements of a faceted ceiling or side wall, must be sizable to handle sound reflection in a predictable fashion.

On the other hand, it is usually desirable to have a certain amount of random scattering or diffusion in the sound-reflecting property of the enclosure, and we try to introduce a great deal of irregularity in the enclosing surfaces of rooms. Coffers, splayed panels, or offset surfaces of scale ranging from 3 to 10 ft or more with depth of perhaps 1 or 2 ft give good diffusion of sound while at the same time they give good reflection of sound from source to listener. This means that for any of the possible source positions in the room, sound is quite likely to be reflected to all of the listening positions. The analogy can be drawn with a glossy paint surface as compared with a matte surface.

There is a general reflection of light from the latter but without the "hot spots" which are seen in a glossy surface. It is especially important for good balance in a concert hall to have a high degree of diffusion of sound surrounding the performers so that they can all hear each other very clearly. This achievement of good mixing and blending of the sound at the start almost always gives better results than very smooth enclosing surfaces.

REVERBERATION

The reverberation time of an auditorium is probably its most talked-about characteristic. Reverberation time can be measured, and in many cases it can be calculated and predicted in advance. The details for calculating reverberation time are discussed in the section on "Sound absorption."

Reverberation is something quite different from echo, and there is often confusion on this point. Echo is the distinct repetition of a sound reflected from a distant surface (see Fig. 42); it is almost always undesirable. Reverberation, on the other hand, is the smooth decay of sound as it reflects from surface to surface around the room, gradually losing energy on each contact with the absorbing elements in the space. Some reverberation is always desirable in a room to give it life and character. The absence of reverberation indicates an overabundance of sound-absorbing material and energy waste. The designer's problem is to adjust reverberation to an optimum value and to conserve all the sound energy he possibly can for the benefit of listeners.

In general, the reverberation time of an auditorium is largely controlled by the area occupied by the sound-absorbing audience and by the actual cubic volume of the space. These two factors set a limit on how much reverberation one can have, while the sound-absorbing materials added for the control of echo and unwanted reflections have only a minor effect. The shape of the auditorium is very important in determining the reverberation time and smoothness of decay of sound. The sound must have an opportunity to travel around the room and should not all be quickly grounded in the sound-absorbing audience. The more rectangular shapes seem to give the finest reverberation characteristics, especially for musical performances.

In many older concert halls the audiences were more tightly packed than in modern halls with their more luxurious seating. Consequently, for the same vol-

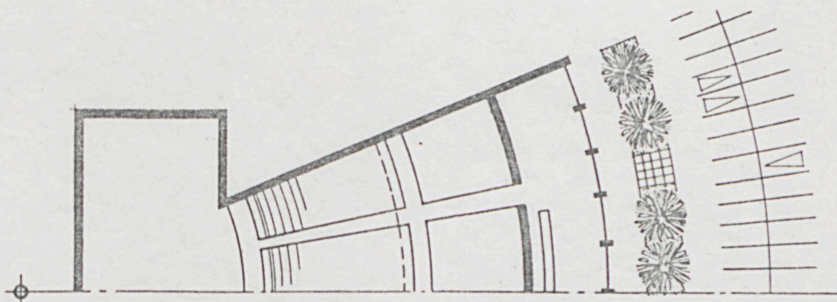


Fig. 39. The beam compass approach to auditorium design does not mean good sound distribution

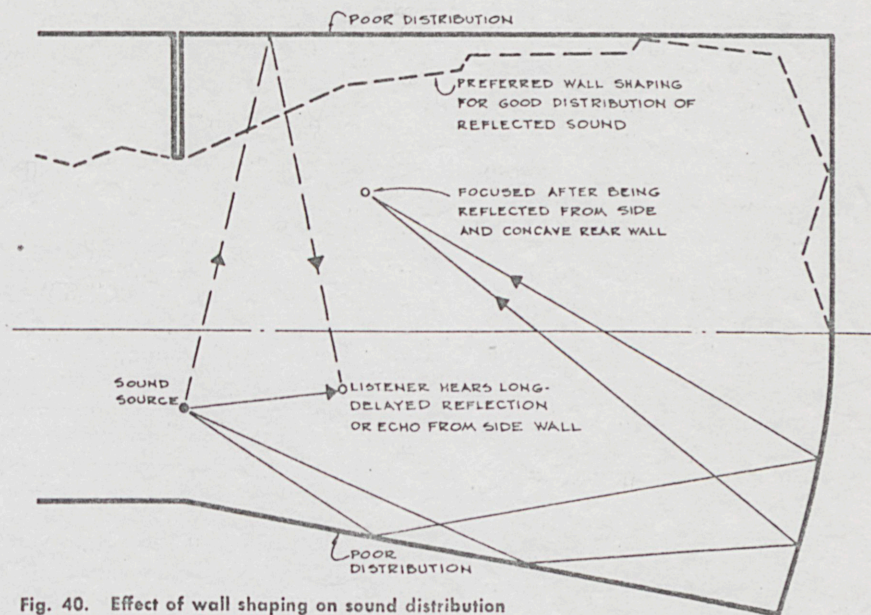


Fig. 40. Effect of wall shaping on sound distribution

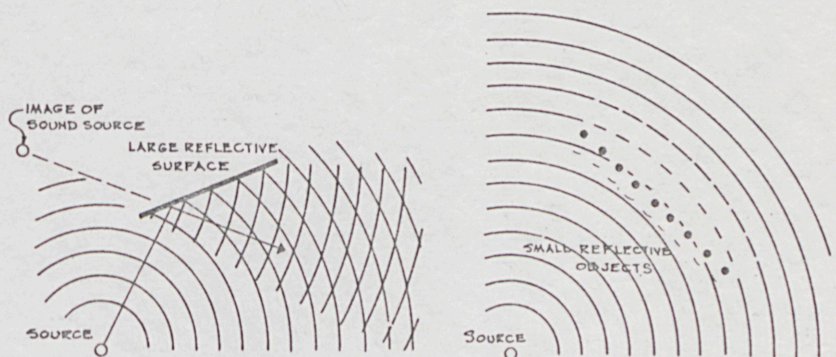


Fig. 41. Effect of size of surface on sound reflection

ume a larger number of people could be accommodated, and therefore, the reverberation time could be higher than in a modern hall with the same seating capacity unless the volume is also increased. But, increasing the volume also reduces the total energy density and if the hall gets too big, the sound tends to lose its "punch."

As we saw in an earlier section, the cri-

teria for reverberation time in auditoriums for various uses show a wide range of acceptable values. These go from less than a second for certain types of speech activity to two or more seconds for liturgical music.

If an auditorium must accommodate a very wide variety of functions, it may be necessary to introduce mechanisms for varying the reverberation characteristics.

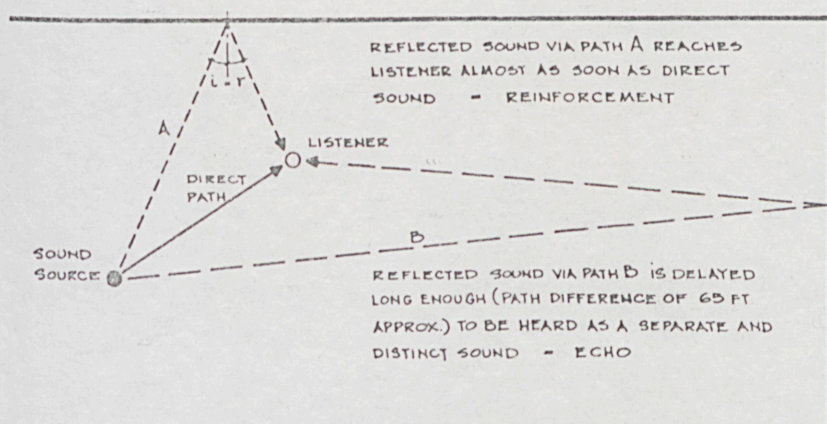


Fig. 42. Long-delayed reflection of sufficient intensity may be heard as echoes

However, if sound-absorbing panels or curtains or other elements are to be introduced to reduce the reverberation time from a high value for music performances to low values for speech, it is necessary to change large areas of the wall surfaces from hard to soft. A significant change cannot be accomplished merely by turning a few panels around or making other minor modifications. Remember that the seating area is a large "flywheel" of absorption, and that, unless one introduces an area of sound absorption almost equal to the seating area, he does not change things very much (see Fig. 43). It should also be evident that the seating area should have a fairly constant sound-absorbing characteristic regardless of audience size. Thus, fabric-upholstered seats are an acoustical necessity in any well-designed auditorium.

BUILDINGS WHERE HEARING CONDITIONS ARE IMPORTANT

Schools

Often overlooked in today's quest for flexibility and new structural forms in school design is the basic need for good hearing conditions in all of the spaces, either with or without folding partitions.

In the lower elementary classroom the problem is usually one of noise suppression; thus, an over-all treatment of the

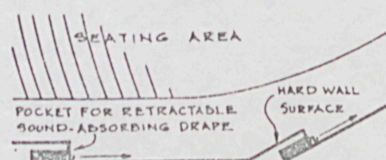


Fig. 43. Example of a method for introducing "variable" sound absorption in room design

ceiling area with a sound-absorbing material is advised. However, in the secondary school classroom where lecture teaching is normal, it is generally better to use the central part of the classroom ceiling as a sound reflector to make the communication between teacher and pupil easier: it is really a small auditorium. A very rough rule-of-thumb says that only about half the ceiling area should be covered with sound-absorbing material in an ordinary thirty-pupil classroom.

Music rehearsal rooms should, in general, have higher ceilings than ordinary classrooms, usually at least 15 ft and preferably 20 ft, and some effort should be made to introduce sound-diffusing elements in the enclosing surfaces. It is almost hopeless to ask a large school band to rehearse comfortably in a room with a 9 ft ceiling covered with acoustical tile. These rooms should be isolated as much as possible from the rest of the building, but if they must be placed close to other classrooms, special double constructions must be used to separate them.

The music department often contains, in addition to the large rehearsal rooms, small practice rooms which must have special attention to isolation details (discussed in section on "Sound isolation"). It is usually a good idea not to open the practice rooms directly into the rehearsal room but rather to have an intervening corridor or sound lock so that the rooms can be used simultaneously.

If the school has an auditorium, its design should follow the basic principles outlined earlier. There should always be a sound-reflecting ceiling in the stage area for the use of musicians when they perform. This can be permanent or removable depending on the program. Also, hopefully, the auditorium will have fabric-upholstered seats so that it will be as satisfactory for rehearsals when empty or for

small groups as it will be for full occupancy. When an auditorium can be used for a variety of functions and audience size it is an achievement of true flexibility.

Often the gymnasium must serve the function of an auditorium, and if it does, a good compromise can be achieved by treating only part of the ceiling with sound-absorbing material for noise and reverberation control leaving the central portion hard for sound-reinforcing reflection. If the stage is at one end of the room, the opposite end can be treated with a sound-absorbing material to reduce echo (see Fig. 44), and sometimes a sound-reflecting panel can be arranged at the platform end of the room to give additional sound-reinforcing reflections. The gymnasium is probably the only space in a school besides the auditorium where a speech reinforcing system may be required and only the highest quality components should be used. These systems should not be merely an extension of the basic paging and announcement system for the school.

Multipurpose auditoriums

Large auditoriums intended for conventions, concerts, plays, ballet, and every other conceivable type of performance are being built in many cities throughout the world. To be really successful, these buildings should not be designed to seat more than 2,500 to 3,000 people, and if concert music is an important part of the program of use, the design should certainly be governed to some extent by good concert hall criteria: i.e., shape, volume, and basic reverberation time. When the auditorium is used for concert purposes, there should always be a music enclosure installed on the stage to make the performance area a part of the auditorium and to give the musicians an opportunity to hear each other and achieve good balance. One cannot expect an orchestra or a chorus to perform in the usual stagehouse full of sound-absorbing scenery and draperies. An enclosure for the stage must be made of heavy, sound-reflecting material (plywood, steel, etc.)—it cannot be light painted canvas—and it must be so arranged that it can be put in place and taken down with a minimum of effort (see Fig. 45).

The plan and section for the multipurpose auditorium must of necessity be governed largely by occupancy requirements, but all of the basic rules still hold: no deep underbalconies, no domed ceilings, no curved walls, no over-all sound-absorbing treatment, good doors to the lobbies, well-isolated mechanical equipment and stage scenery shops, and fabric-uphol-

stered seats for stable reverberation characteristics. It may be desirable to provide a folding section ceiling to make the auditorium not only visually but acoustically smaller for certain types of use (e.g., theater for 1,200 people in a 2,500-seat hall) (see Fig. 46).

Churches

All of the basic requirements for good hearing must be met in the church, but there are a number of specific matters peculiar to this building type that the designer must take into account. Usually, the form of the church itself will not be governed quite so much by acoustical considerations as would a school auditorium, but basically difficult shapes, such as domes, barrel vaults, etc., should be avoided at all cost. The reverberation time in the church should be designed to be fairly high (upwards of 1.6 sec), and this means special attention must be directed to problems of speech intelligibility. In the larger church (300 seats or more), it will often be necessary to provide either a speech-reinforcing system or a carefully designed pulpit canopy. The latter is often an excellent device to bring direct speech sound to the listeners without the use of electronic reinforcement. The pulpit, of course, does nothing for speech at the altar and in the lectern, but many churches up to 1,000 seats have been designed with good pulpit canopies and no sound amplification with excellent results (see Fig. 47).

An important function of the enclosing surfaces in a church is to give strong, mutually reinforcing reflections to the congregation. This gives every member of the congregation the sense of being part of a group of people singing and praying, and encourages participation in common worship. A church with a sound-absorptive ceiling that does not reflect sound from one part of the room to another leaves each member of the congregation feeling alone and conspicuous, and thus nonparticipating.

Another important acoustics problem in the church is the placement of the choir and the organ and their relation to the congregation. The choir should be out in the open, it should be grouped in as nearly a square array as possible, and it should be immediately in front of the organ (the pipes, not the console) where the singers can hear the organ as the congregation will hear it (see Fig. 48). The choir should not be tucked in a low-ceilinged alcove, nor divided across a wide chancel, nor strung out in a long line, nor should the organ pipes be widely distributed. If the organ and choir are

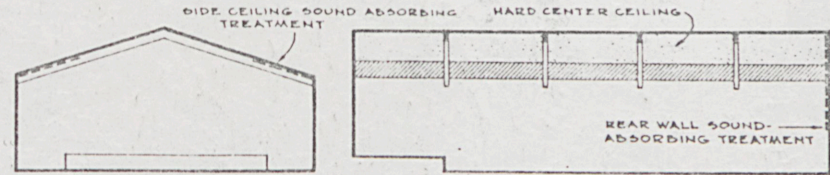


Fig. 44. Example of a simple acoustical treatment for a multipurpose room

well placed in the church, at either front or rear, if the ceiling and wall surfaces are so arranged that the congregation is in the same space as the musicians, and if all the people in the church receive reinforcing reflections from the enclosing surfaces, almost inevitably good results will be obtained.

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SOUND REINFORCING SYSTEMS

In many situations, to obtain adequate loudness and good distribution of sound it is necessary to augment the natural transmission of sound from source to listener by means of a sound-reinforcing system. In large sports arenas, in airport terminal buildings, and in other noisy locations, it is almost always necessary to provide sound reinforcement. Even in rooms where most strong-voiced speakers can be heard clearly, the weaker voices must be amplified, and there is often the need to amplify recorded material or movie sound. In all cases, however, the design of the sound-reinforcing system must be carefully integrated with the design of the room and with its acoustical characteristics.

There are two principal types of sound-amplification systems: central and distributed. The preferred type in most situations is the central system in which a loudspeaker (or cluster of loudspeakers) is located directly above the actual source of sound. Only one loudspeaker position

is used in a system of this sort, and it is capable of giving maximum realism. The listener with his two ears is readily able to localize the direction of the source of sound, and if the amplified signal comes from the same direction as the original sound, he gets an impression merely of increased loudness or clarity but not of artificial "amplified" sound (Fig. 49).

The other principal type of sound-reinforcing system is the distributed type. In this system one uses a large number of loud-speakers located overhead. This type of system operates much like down-lighting. We cover the room with small "pools" of sound, each listener receiving sound from only one loud-speaker. This type of system is used in any situation where the ceiling height is inadequate to use a central system or where all listeners cannot have "line-of-sight" on a central loud-

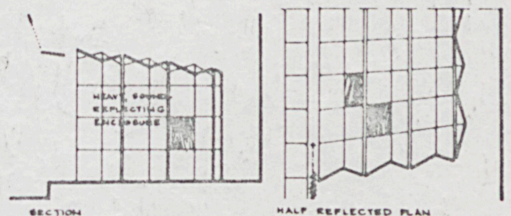


Fig. 45. Example of an orchestral enclosure for a large multipurpose stage

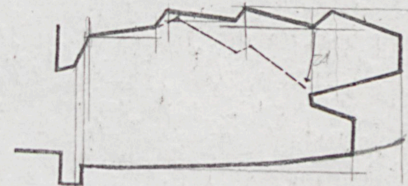


Fig. 46. A large hall can sometimes be converted to a smaller one by using properly designed adjustable elements

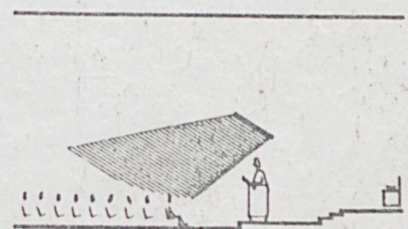


Fig. 47. A pulpit canopy may provide effective natural reinforcement of speech in churches

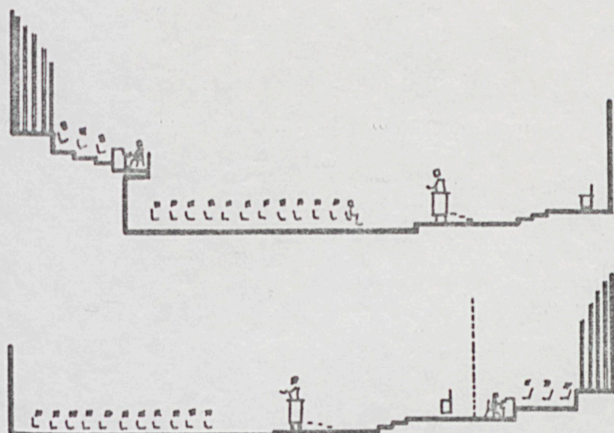


Fig. 48. The organ, choir, and console must be considered a unit of inseparable parts with unobstructed acoustical "line-of-sight" to the congregation. Front or rear gallery locations can be equally effective

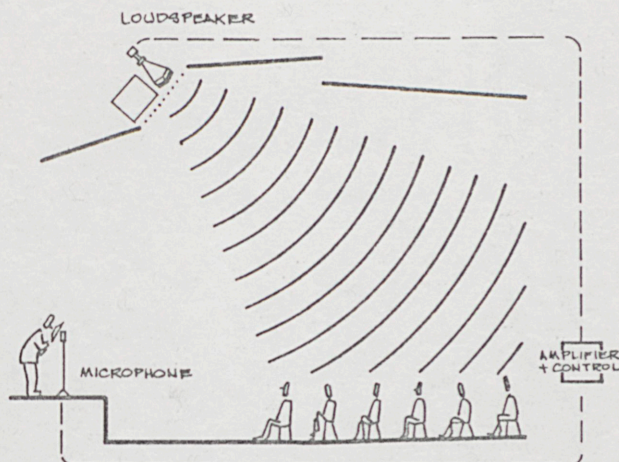


Fig. 49. Central loud-speaker system

speaker. It is also used in such spaces as large convention halls, hotel ballrooms, or large conference rooms where there must be a very flexible arrangement of the space for amplifying sources of sound in any position in the hall. It is the logical system for most airport terminal buildings where the amplified signal usually must be somewhat higher in level in order to override the high background noise levels due to aircraft operations. The distributed system is a flexible system, and while it does not give maximum realism, in reinforcing live activities, it can be made to provide high intelligibility in many difficult situations (Fig. 50).

Loud-speakers should not be located at the two sides of the proscenium opening, nor should they be distributed along the

two sides of the room, nor in the four corners of a large reverberant space. These systems never work well, and the hearing conditions in a space can usually be improved by shutting them off! (See Fig. 51.)

CENTRAL SYSTEMS

The loud-speaker for a central system usually consists of a cluster of directional horns, some of which handle the high-frequency end of the audible spectrum, and larger loud-speakers which handle the low-frequency end of the spectrum. The high-frequency horns are usually exponential, multicell, or radial horns and are arranged in clusters to give coverage of specific areas of the seating. It is important that the horns have excellent direc-

tional characteristics, and that the level of operation of the several units be individually adjustable. One cannot achieve high-quality sound amplification without loud-speakers with carefully controlled directional characteristics. If a loud-speaker system is to be used only for speech purposes, the system need not have any low-frequency loud-speakers and can be housed in a smaller space than a full frequency range system (used for music). Usually, a speech system is cut off at approximately 300 cps (i.e., these loud-speakers do not amplify sounds below that frequency). This results in no loss in realism and actually improves intelligibility in rooms with "boomy" characteristics.

The designer of an auditorium incorporating a loud-speaker system must realize that the system will take a great deal of space and that it cannot be tucked conveniently into a 1-ft slot. The grille in front of the loud-speaker must be completely transparent to sound and must contain no large-scale elements (see Fig. 52). Every listener in the room must have line-of-sight on the loudspeaker; we do not count on reflection of sound from room surfaces to fill in any areas not covered by direct "line-of-sight."

The operator of the sound system should be located toward the rear of the seating area where he can hear the system as it is heard by the audience. He should not be behind a glass window in a booth receiving sound only on a monitor loud-speaker. The power amplifiers can be in any convenient location but the actual controls must be "in the room."

Microphones must be placed near the sources of sound and if there are to be many sources, as in a play, there must be

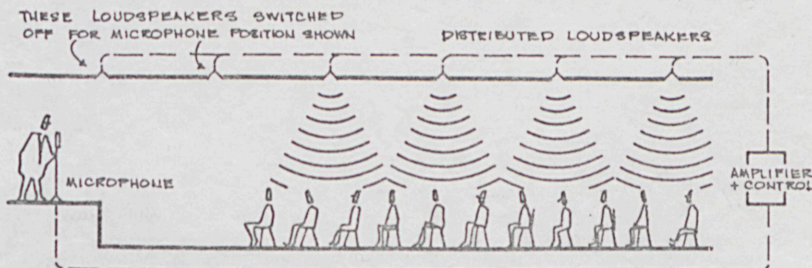


Fig. 50. Distributed loud-speaker system

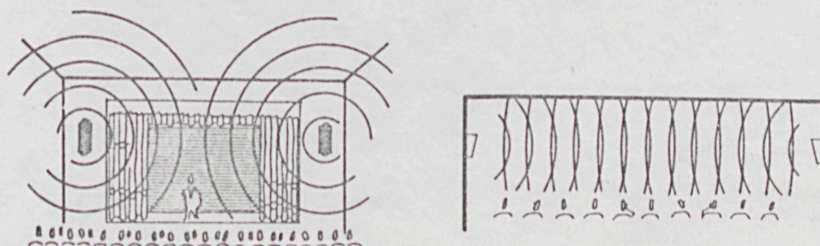


Fig. 51. Poor loud-speaker placement can mean ineffective sound reinforcement

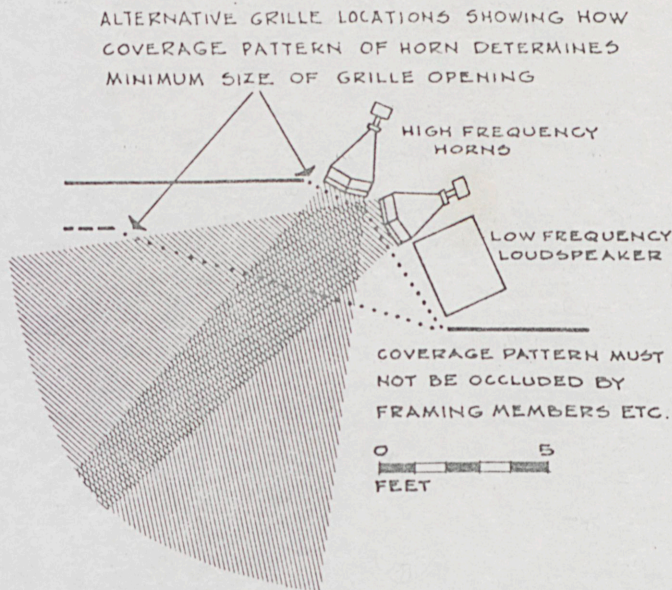


Fig. 52. Loud-speaker grille sizes are determined by the coverage patterns of the loud-speakers behind them.

many microphones suspended overhead or concealed in the scenery so that the actors are always relatively close to these pickup devices.

There is also the important problem of feedback of sound energy from loud-speaker to microphone, and the relative locations of microphones to the loud-speakers must be carefully considered to avoid the familiar squealing or howling of a poorly designed and operated system. This is a matter for detailed consideration by the designer of the system, and is not primarily an architectural question except in so far as relative location of loud-speaker to microphone is concerned. In the large arena or sports building, the central cluster of loud-speakers is usually suspended without any attempt at concealment, and some central position can usually be found giving everyone clear "line-of-sight" on the unit.

In some situations, line-source loud-speakers are preferable to radial or multicellular horns (see Fig. 53). These units, made up of a series of cone-type loud-speakers, also take space, and this must be carefully considered in the design of the building.

DISTRIBUTED SYSTEMS

In this type of sound-amplifying system it is extremely important to have an adequate number of loudspeaker units. They are generally placed in the ceiling facing down and sounding through appropriate grillage. Each loud-speaker unit is consid-

ered to cover between 60 and 90 deg, depending on the type selected. Even the highest quality units with the most suitable grille do not cover more than 90 deg adequately; when concealed behind fake diffusers, they are far less satisfactory (Fig. 54). Unfortunately, many loud-speakers employed in such systems beam high-frequency energy rather sharply. Uniform, high speech intelligibility is not possible with such systems; also, they must be operated at an uncomfortably high level to permit listeners between loud-speakers to hear properly.

In order to prevent feedback, a flexible system is usually provided with switching arrangements so that certain loudspeakers can be shut off when a source of sound is to be placed immediately under one of the units in a space for flexible use.

As mentioned earlier, loud-speakers should never be placed along the side walls of a room, cross firing. This cross firing always causes the listener to hear from many loud-speakers at the same time, with multiple time delays reducing speech intelligibility. In a church, the loud-speakers might be located in the bottoms of chandeliers over the heads of the worshippers; there are many ways in which loudspeakers can be located properly for such assistance. Sometimes, when a central loud-speaker system is used for an auditorium where people are seated on the platform with the speaker, participating perhaps in a panel or merely serving as background, a few loud-speakers operated at low level can be placed for the



Fig. 53. A line-source or column loud-speaker and its coverage characteristics

convenience of these listeners so that they hear more than merely the reverberant sound from the hall itself.

TIME DELAY

Artificial echo is often a problem, particularly in distributed systems. Consider a listener at the rear of a long auditorium which may use a distributed loud-speaker system for any of the reasons discussed above. This listener will hear amplified sound almost instantaneously from the

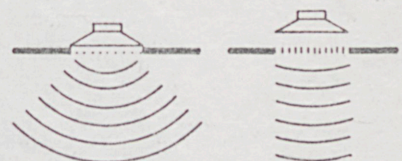
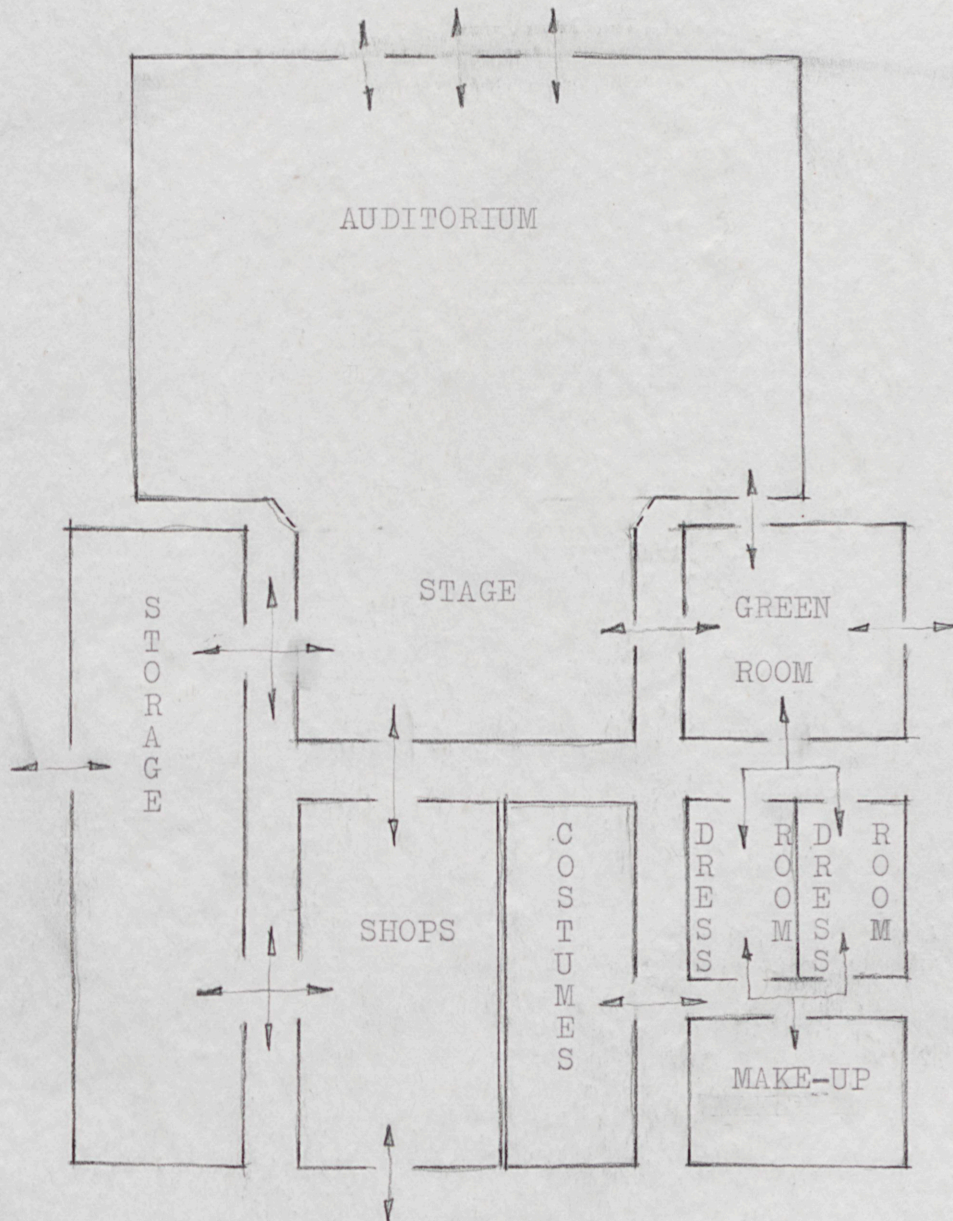
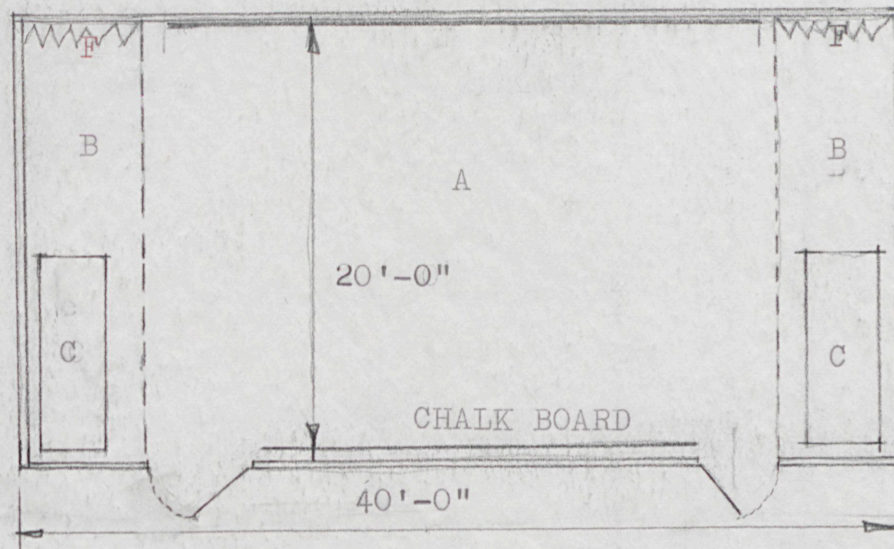


Fig. 54. Poorly chosen loud-speaker grille materials can markedly affect the sound distribution from any loud-speaker

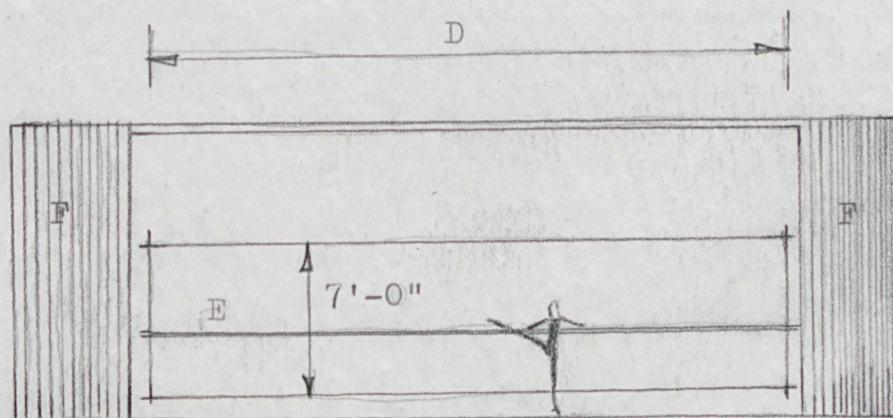
NON-PUBLIC AREAS



REHEARSAL ROOM SPACE



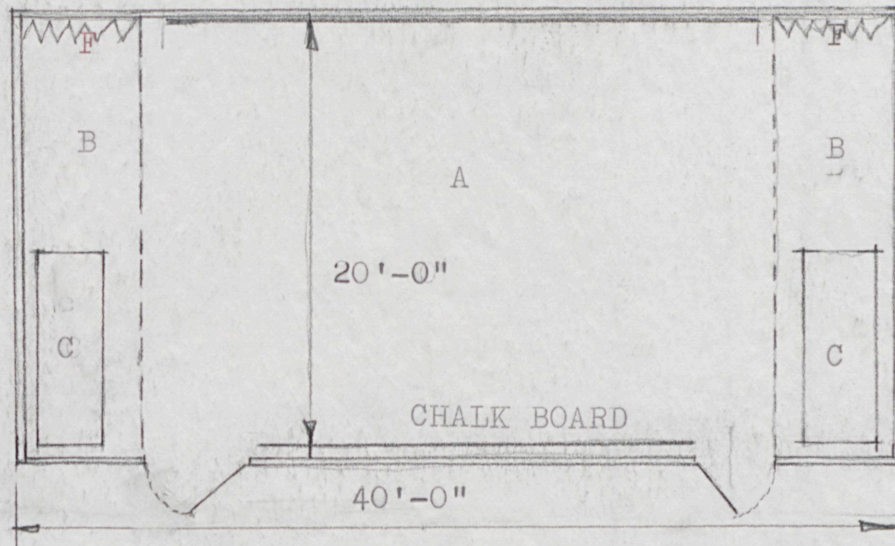
FLOOR PLAN



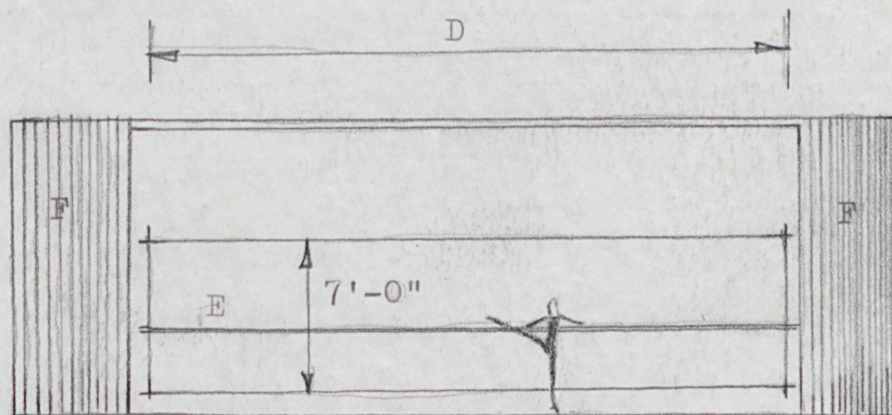
WALL ELEVATION

- A.) General rehearsal space in a room approximately 20'x40'.
- B.) Storage area on open floor for classroom type chairs, rehearsal furniture, and properties.
- C.) Cabinets for rehearsal properties.
- D.) Mirror wall extending from floor to height of 7'.
- E.) Dance or practice barre - 4' above floor. (also serves as rail guard/mirror)
- F.) Traveller curtains to cover the mirror when desired.

REHEARSAL ROOM SPACE



FLOOR PLAN

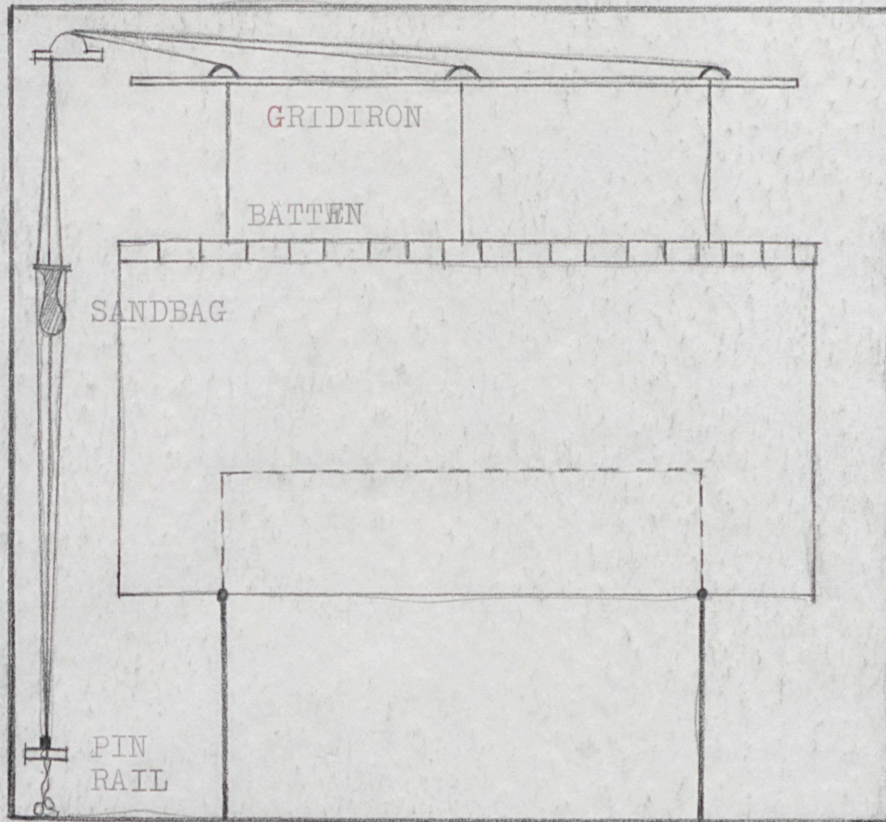


WALL ELEVATION

- A.) General rehearsal space in a room approximately 20'x40'.
- B.) Storage area on open floor for classroom type chairs, rehearsal furniture, and properties.
- C.) Cabinets for rehearsal properties.
- D.) Mirror wall extending from floor to height of 7'.
- E.) Dance or practice barre - 4' above floor. (also serves as rail guard/mirror)
- F.) Traveller curtains to cover the mirror when desired.

RIGGING SYSTEMS

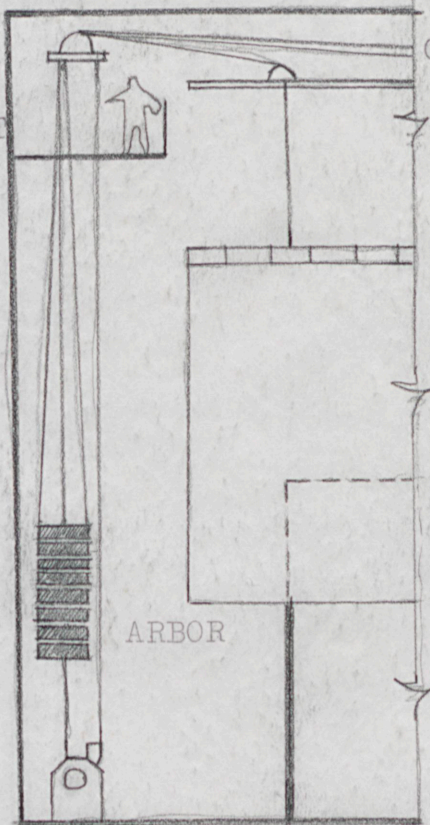
A)



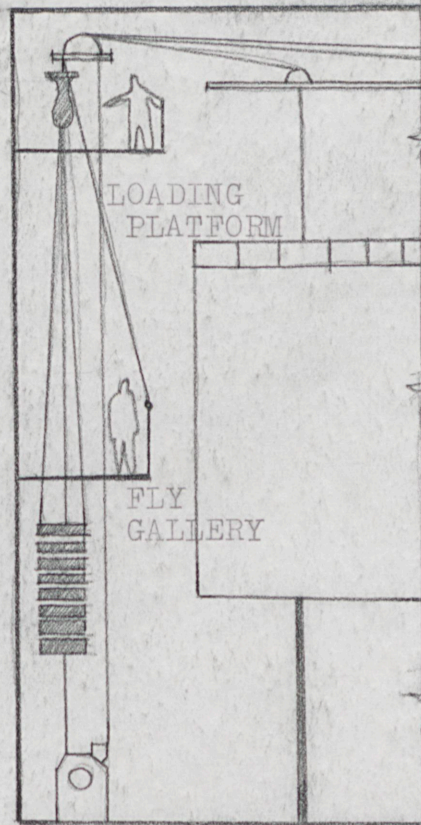
HEMP ROPE & SANDBAG SYSTEM

B)

A COUNTERWEIGHT
SYSTEM (STEEL
CABLES)

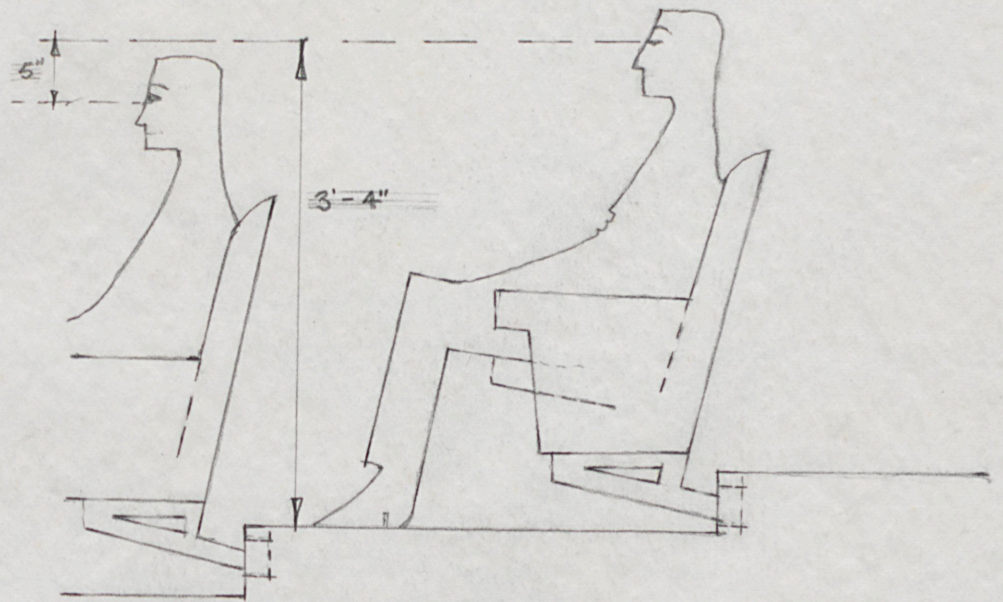


C)



A COMBINATION
ROPE AND COUN-
TERWEIGHT SYSTEMS.

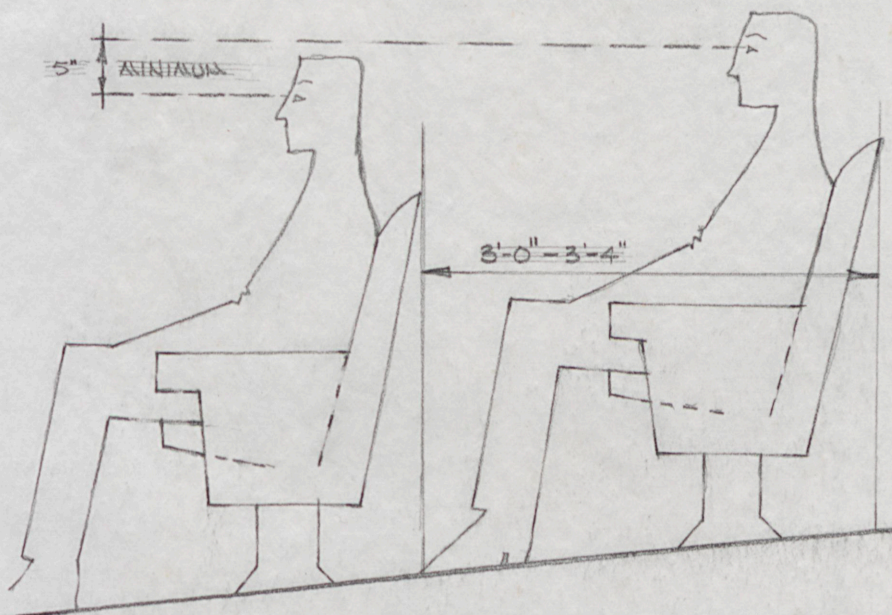
SEATING



RISER MOUNT, TERRACED FLOOR

MINIMUMS

SEATING

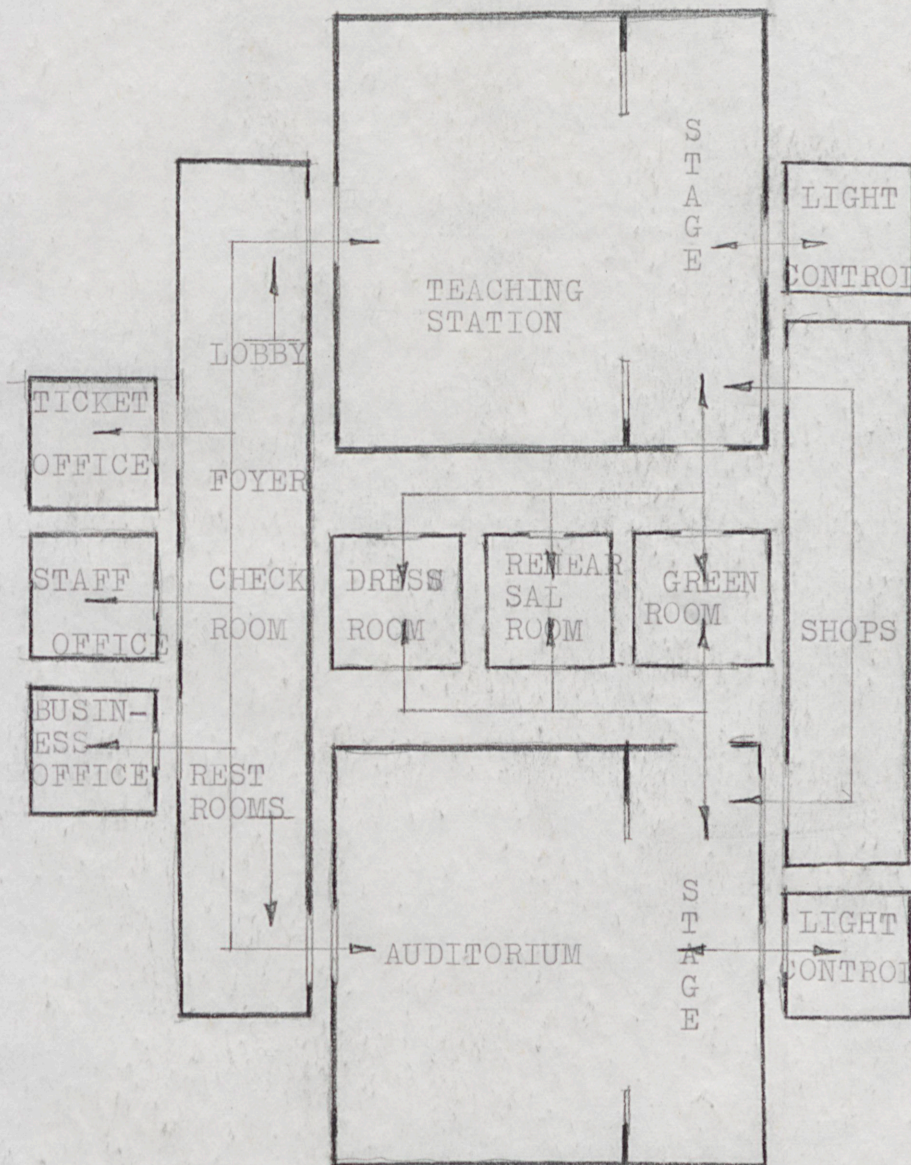


FLOOR MOUNT, INCLINED FLOOR

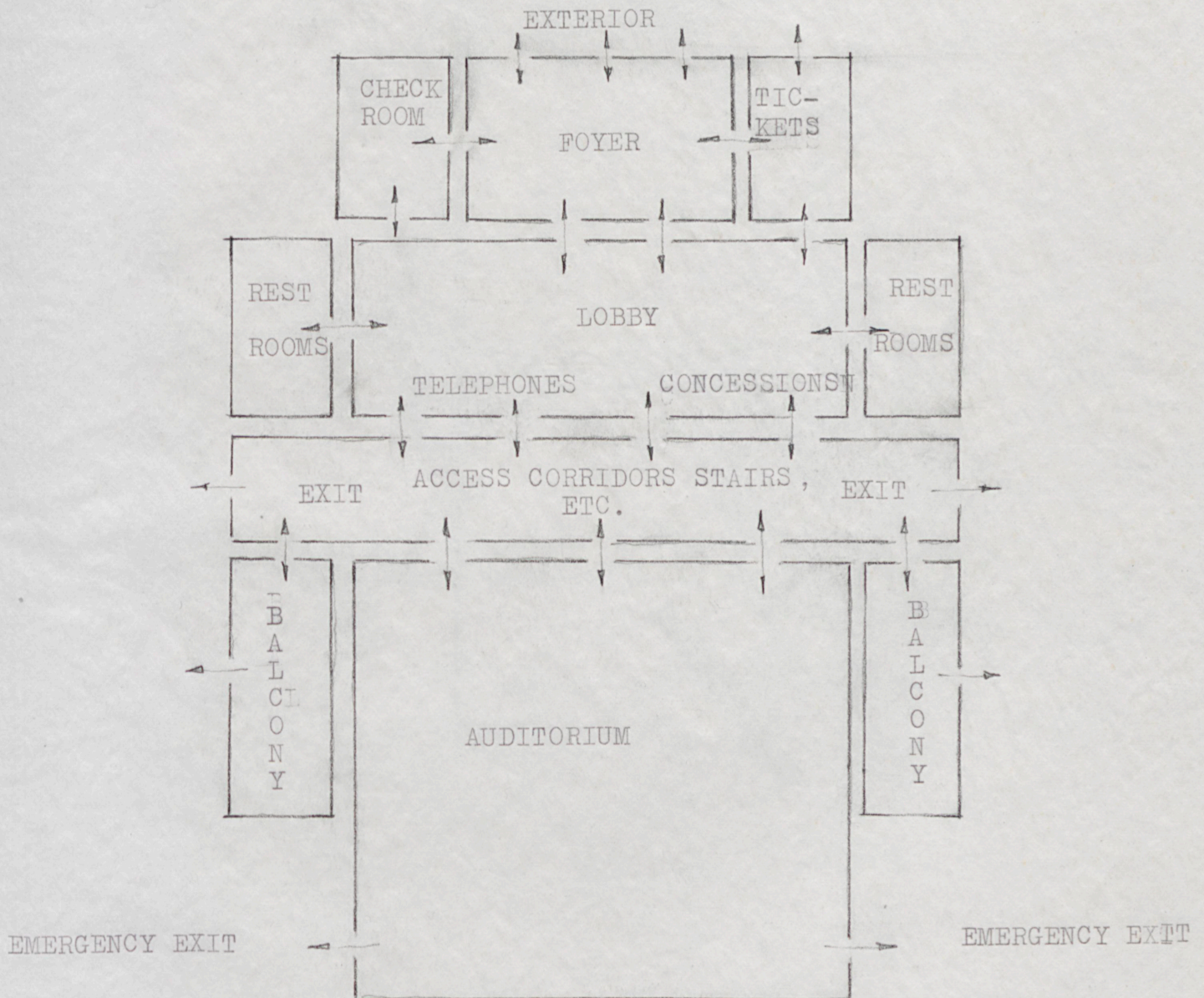
MINIMUMS

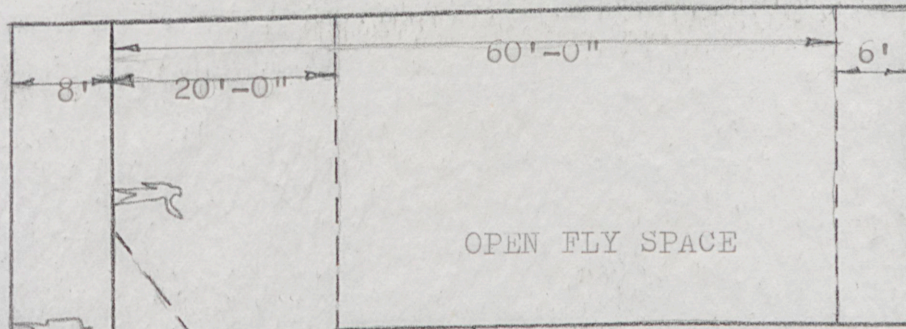
THEATRE-ARTS LABORATORY

Functional and space relationships of Auditorium to the teaching station.



PUBLIC AREAS





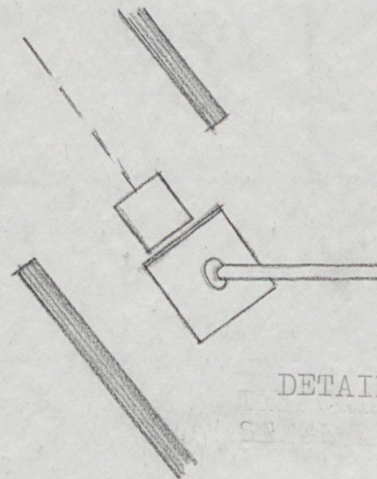
Gridiron

38°

ORCHESTRA
PIT

LIGHTING PORTS

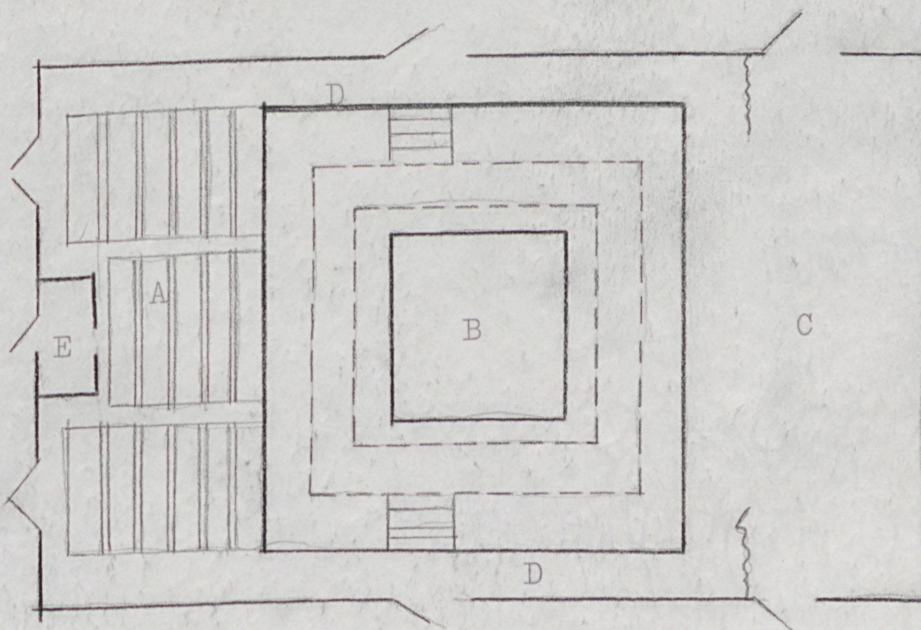
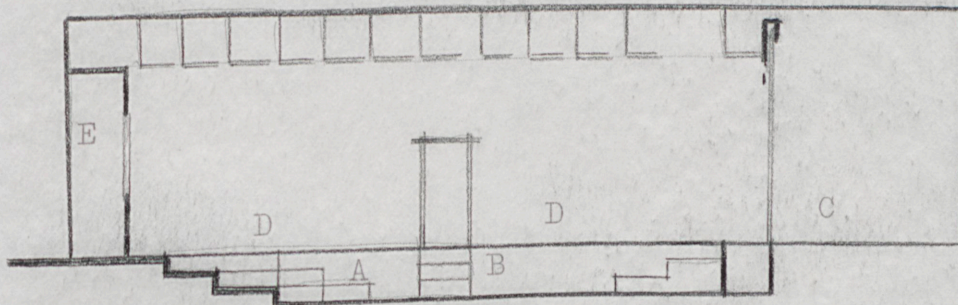
TYPICAL SECTION OF A STAGE AND
AUDITORIUM:



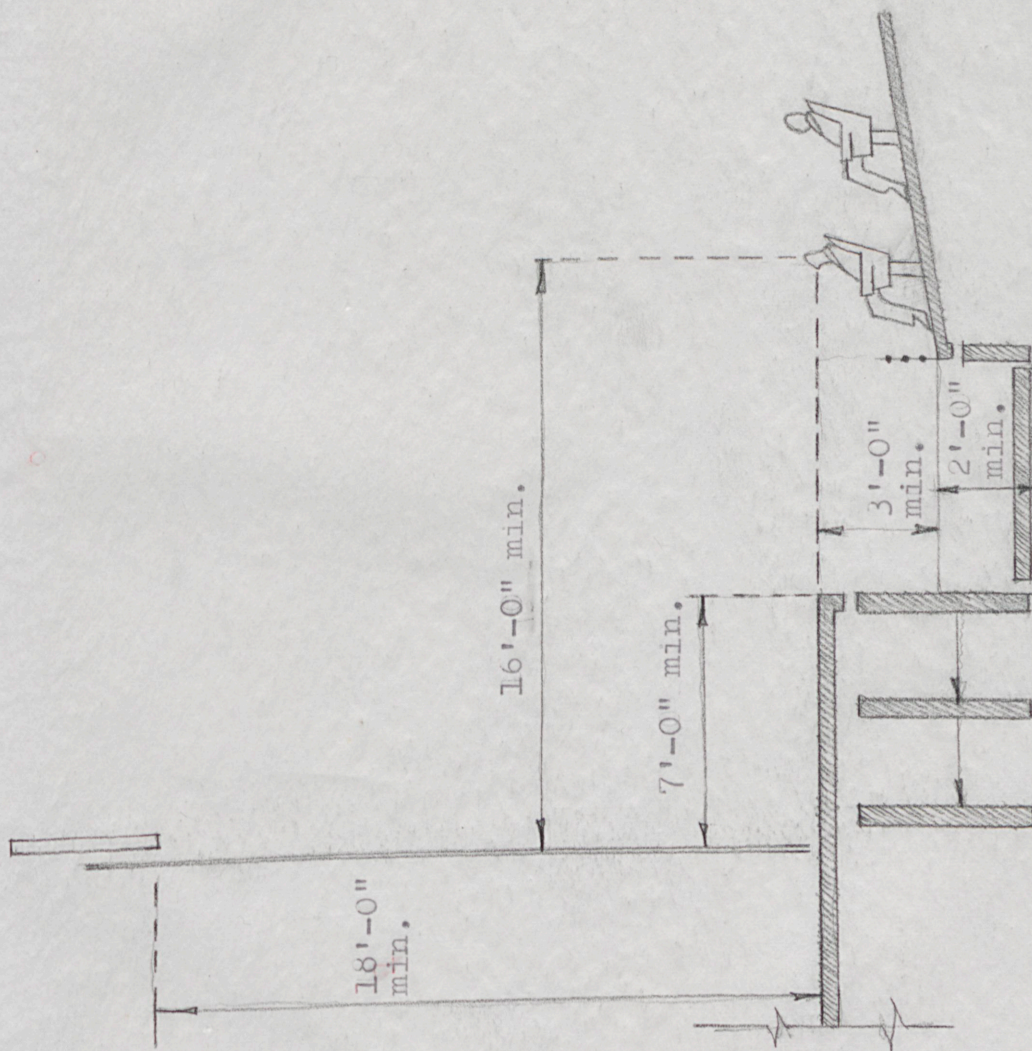
DETAIL: LIGHTING
POST.

THEATRE-ARTS-LABORATORY TEACHING STATION

- A.) Fixed Seating.
- B.) Potential arena staging.
- C.) Elevated stage, no fixed proscenium.
- D.) Elevated walkways on each side of the room serve as work tables, arena seating, and provide chair and platform storage underneath.
- E.) Projection room.



ORCHESTRA PIT



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