An Introduction to Architectural Design:
Theaters & Concert Halls, Part 2

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An Introduction to Architectural Design: Theatres and Concert Halls, Volume 2

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(This is the second in a series of volumes under editorial development dealing with planning and design of theatres and concert halls.)

1. ACCESSORY EQUIPMENT. Accessory equipment includes fixed and moveable devices, fittings, scenic properties, draperies, rigging and control systems that are desirable and often necessary to each performance type. Equipment design cannot be separated from or sequential to the Room design; it should not be thought of as “added to” the building. Acoustical design and theater stage technology are subjects for specialized technical consultants. The architectural engineer’s role is to coordinate the consultants’ efforts with the concerns of using service and construction service. Room configurations must account for location and functional operation of accessory equipment in harmony with other criteria. While detailed recommendations and technical discussion will be found elsewhere, the purpose of this section is to identify the equipment’s place in overall facility design by noting its general function, position and circumstances of use. Support and attachment, power supply, service access, enclosure, etc., are provisions that will be made for it in the architectural design.

1.1 GENERAL CONSIDERATIONS

1.1.1 NON-FRONTAL. It is assumed that the vast majority of Rooms will be Frontal in concept, and subsequent discussion reflects this. Departure from the Frontal form gives rise to a host of differences in the concepts of equipment use and placement. Certain principles hold true while their physical implications change greatly. Nevertheless, non-Frontal configurations do have application as potential facilities, especially where conversions of existing buildings or found space, independent rehearsal rooms, outdoor staging and exploratory programs are involved. A few general statements should be kept in mind regarding non-Frontal and Open Stage equipment. The Open Stage relies less on a framed view, elaborate scenery and hidden devices than on lighting and suggestion for visual impact. Similarly, electronic and acoustic supplements as well as tuneability acquire greater value relative to enclosure design. As concealment becomes impossible, equipment assumes an important role visually. Careful detailing and good housekeeping can turn this into a gratifying, even exciting experience for all. Perhaps the most significant benefit of non-frontal and Open Stage theater craft is derived by users who have limited technical manpower, production funds or preparation time.

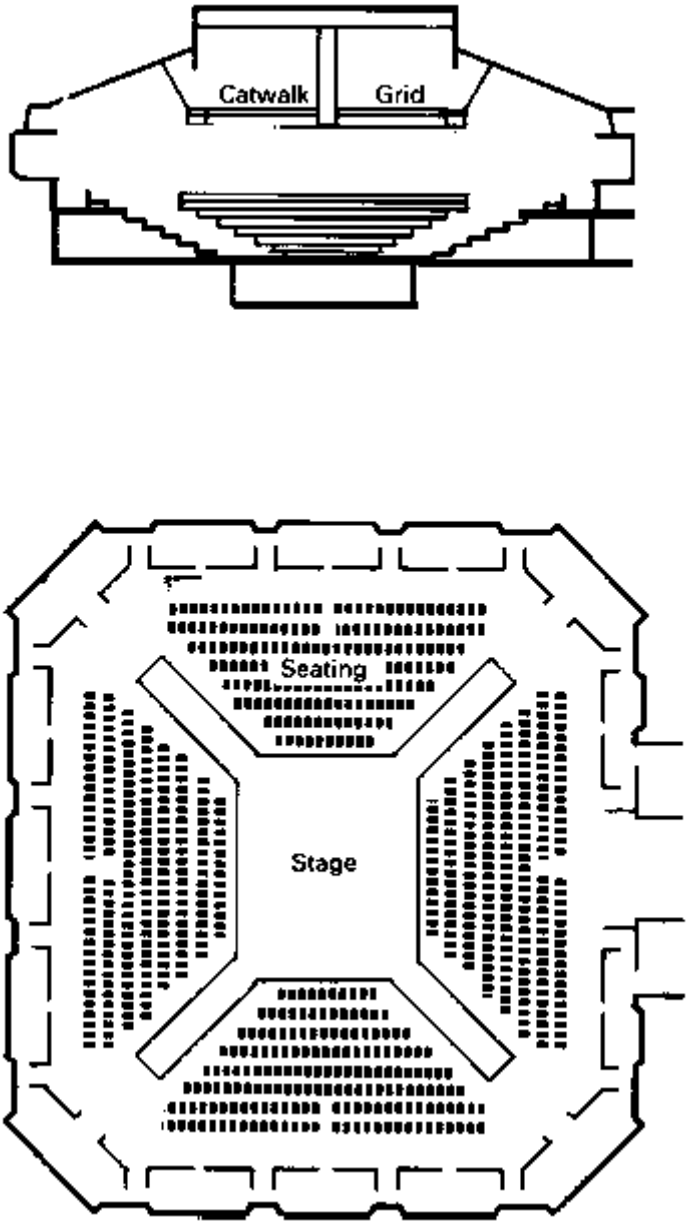

Figure 1

Non-frontal room

The absence of traditional stagehouse facilities frees them from production inertia and the obligation to fulfill ingrained audience expectations. In general, non-Frontal and Open Stage forms are appropriate for small scale, intimate Rooms for legitimate drama, modern dance and small ensemble music. Equipment is lightweight, low-power, short-throw,

portable and flexible in application. The stagehouse function is accomplished by a catwalk grid suspended 22 to 26 feet above the stage with supplemental low-angle lighting from positions in the house, installed in balcony fronts, and clamped to railings, wall or ceiling bars. Very little scenery is hung or flown; there are no house curtains, etc. Without wingspace, entry points from the house itself are necessary via runways, vomitories and a trapped stage. The stage is sometimes the lowest point in a steeply raked intimate Room. Portions of seating may be demounted and rearranged to alter the acting area configuration. In the typical small Room of this kind, acoustical precision is less practicable than for fixed Frontal arrangements, and less important.

1.1.2 FRONTAL. Most Rooms under this discussion are Frontal, one of three capacities or sizes, and for presentations of four varieties: drama, dance, musical drama, and music. The following discussion is concerned with the basic purpose of accessory equipment and its functional impact within such Room environment.

1.2 CLASSIFICATION OF ACCESSORY FACILITIES. Accessory functions may be grouped according to the communicative media they enhance. They are listed below in two groups associated with Vision and Hearing.

1.2.1 VISION:

- Lighting of performance and sets, and special effects.
- Masks, screens, closures.
- Backgrounds.
- Sets, properties.
- Visual monitoring for control of lighting and action.
- Television for broadcast.
- Film projection.

1.2.2 HEARING:

- Source positioning, risers, pits.
- Enclosures, shells.

- Reflectors, diffusers, absorbers.
- Additive/subtractive volumes.
- Electronic audio systems.
- Aural monitoring for control of electronic
- systems.
- Communication systems

The existence and operation of these accessories in the Room has impact on the total environment in both physical and perceptual terms. The type and quantity of accessories are related to the nature of performance in much the same way desired Drama and Music Room qualities are associated with vision and hearing parameters.

1.3 VISION-RELATED ACCESSORIES. Beyond the needs of operational utility, the purpose of vision-related accessories is to enhance visual perception emphasized in performances of legitimate drama, musical drama, and opera. Dance and operatic recital should be provided with a modest facility for scenic effects and dramatic lighting. Music presentations, including choral and recital forms, require the smallest amount of visual enhancement in the form of concert lighting, and in some cases profit from backdrops and masking to set scale and conceal distracting equipment.

1.3.1 LIGHTING. This is the most important drama accessory. It furnishes color, mood, atmospheric effects on stage; indicates change of context, passage of time, symbolic change of scene; and it centers attention on specific actors or regions of the stage. Theatrical lighting is not like architectural or exhibition lighting; it is constantly changing during performance and no two productions are likely to repeat a given array. Every sequence of dramatic events has a corresponding series of lighting events. At any point, there may be half a dozen ways to light an actor, a group of actors, a set piece, a single property, a backdrop, the stage floor and enframement. Each may involve several angles, colors, intensities and beam widths. When the actor moves, the light moves with him, or it may move without him. In short, the lighting scenario is as much an element of theater arts as the reading of a script. Lighting systems must be able to facilitate change with the

greatest range of options. A combination of portable fixtures, on-stage adjustable attachment points, and house wall and ceiling positions allows the selection of several basic types of lighting:

ON THE ACTOR

- Downlighting, creating pools of light on the floor from above.
- Sidelighting, giving form and color to the actor'sbody.
- Backlighting, making the actor stand out from the background.
- Frontlighting, coloring his body from the front.
- Area lighting, providing basic reference visibility from the front.
- Deck lighting, washing the floor with color from striplights overhead.
- Cyclorama lighting, coloring the backcloth with striplights over it or along side.
- Droplighting, coloring legs, borders and other drops with striplights.
- Specials, lighting specific pieces of scenery, such as sunlight through a window.

ON SCENERY

- Deck lighting, washing the floor with color from striplights overhead.
- Cyclorama lighting, coloring the backcloth with striplights over it or along side.
- Droplighting, coloring legs, borders and otherdrops with striplights.
- Specials, lighting specific pieces of scenery, such as sunlight through a window.

Each instrument employed during the performance must be fed power from dimmer circuits that allow one person to control relative brightness from a central location. Each mounting position includes one or more circuits routed to a patch panel where they are selected or combined for separate or simultaneous control. The majority of theatrical lighting instruments are located in the stagehouse. About 25% are located on the audience side of the proscenium.

1.3.1.1 STAGEHOUSE LIGHTING. Positions must be provided over the stage at various elevations interspersed with rigging lines and battens. Lighting is also mounted on vertical booms at either side of the acting space. While instruments may be assembled to pipes

at stage level and hoisted as a unit, final adjustment is accomplished from portable ladders. Stages without flylofts provide a network of catwalks for attachment of overhead lighting. In general, stagehouse lighting helps create the context of action; the parameters of its disposition are non-interference with movement on stage and invisibility from the audience. It is especially important for performance with minimal set material, such as dance.

1.3.1.2 PROSCENIUM LIGHTING. Positions above and alongside enable the curtains to be washed with color. Troughs with deck plate covers can also be installed at the leading edge of the stage, or pop-up footlights. Proscenium lighting functions to establish foreground attention at the curtain line, which can be useful between scenes and as a transition between concentration on the play and the general illumination of the house.

1.3.1.3 FORESTAGE LIGHTING. An elaboration of proscenium lighting occurs when apron or pit elevator extends into the house. The effective use of this projected area requires overhead lighting from a position equivalent to stagehouse lighting. It will also require adjustment of lighting from the house which is normally directed at the downstage curtainline zone. The usefulness of an apron in straight drama is therefore questionable since it also alters sightline considerations and defeats the purpose of a stagehouse; it is neither a Proscenium Stage nor a Thrust Stage. The forestage concept arises from multi-use considerations where a music shell installation requires a canopy for acoustics anyway (it can be motorized and retracted), or where occasional enlargement of the stage by covering the pit is deemed valuable for specific uses. The canopy position may also be occupied by loudspeakers and other electronic equipment. The pit itself can usually be lighted from house ceiling positions.

1.3.1.4 LIGHTING FROM THE HOUSE. The principal illumination of actors must occur at an angle from behind the audience to avoid the distorting effect of long vertical and diverging shadows. Most of this lighting is directed to the forward portion of the stage from vertical pipes concealed in the sidewalls of the Room and from catwalks near or above the ceiling. This lighting imparts the modeling component of shadow important to

perception of features, shapes and textures. The catwalks, ladders and/or booms are permanent construction on which the portable fixtures are mounted and adjusted. Their location should allow incident angles of 60 and 45 degrees from horizontal. Balcony fronts near the stage often serve as mounting points also. Give special attention to the distance relationship involved in obtaining these necessary lighting angles. Beam control decreases while fixture size, cost, power consumption and heat generated increase with distance. It is generally more economical and flexible to make the most of the positions within 40 feet of the subject.

1.3.1.5 FOLLOW SPOTS. The lowest line of lighting (30 degrees) is mainly devoted to manned followspots, although a few ellipsoidal projectors are often useful at this angle too. Small portable followspots on stands with a maximum throw of 60' are very useful for drama, and may be used from platforms in the house. Carbon arc followspots with a maximum throw of 200' generate poisonous fumes that must be mechanically vented; they are operated from an enclosed booth. This booth is at the rear of the house, often near or just below the ceiling. It contains at least two permanently mounted carbon arc lights with interchangeable color filters.

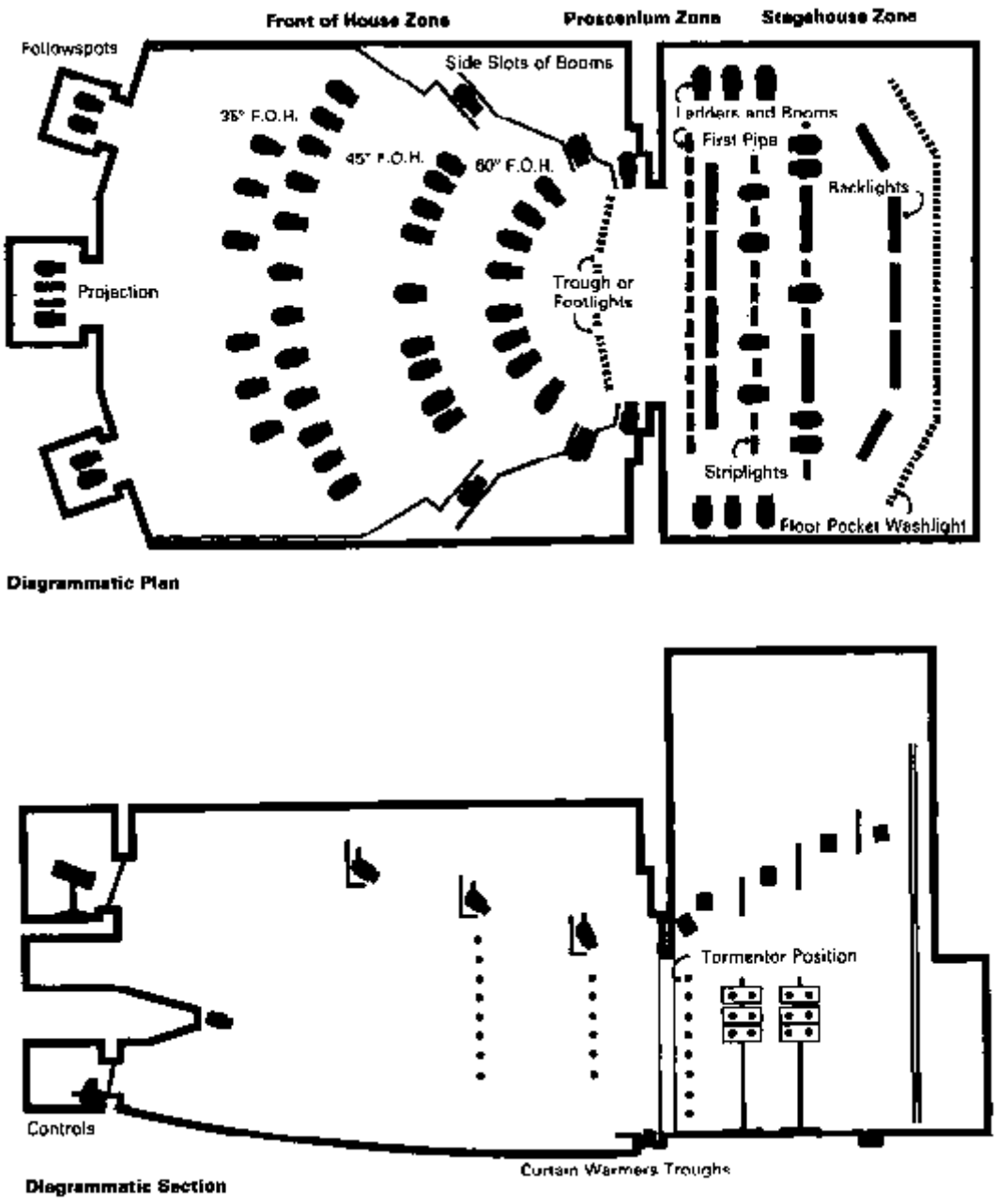

Figure 2

Lighting positions

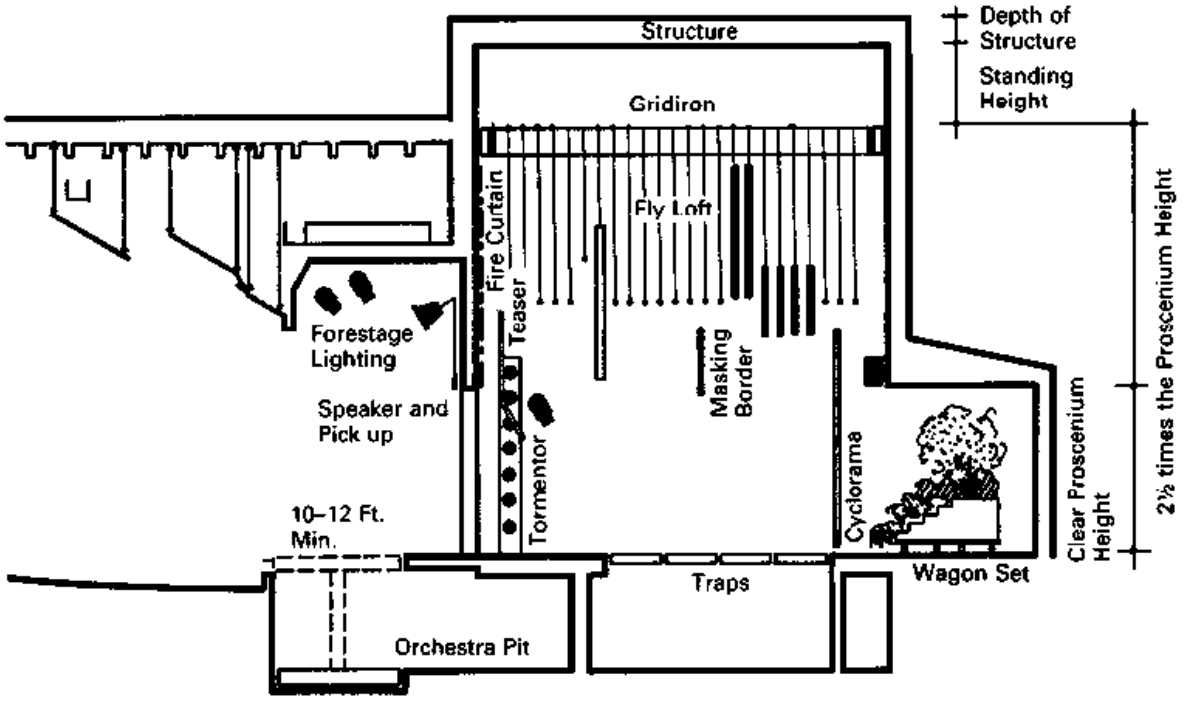

Figure 3

Stagehouse Accessories – vision related

1.3.1.6 HOUSELIGHTS. Permanent auditorium illumination is mentioned here because its operation parallels theatrical lighting. Separate dimmers are used and controlled from the theater lighting console. A preset dimmer sequence is often used to gradually reduce intensities of separate sources progressively, at the same time bringing up aisle lights and exit signs. In Music Rooms, the houselights rarely go dark; about 20 footcandles is often maintained for program reading.

1.3.1.7 CONCERT LIGHTING. Music Rooms without a stagehouse have a less extensive lighting system, because stagehouse and proscenium requirements are greatly reduced along with the need for a constantly changing program of color and intensity. Nevertheless, adjustable lighting from the house, followspots and enclosure/stage lighting need be furnished with suitable controls and dimmers. The ability to alter the color composition and pattern of concert lighting is important to obtaining desired mood and

scale relationships for the occasion. Performance area lighting must also be adapted to the musicians' comfort and seeing tasks, thus requiring high angle fixture placement, 70 footcandles with low specularity, and a relatively bright background field.

1.3.1.8 TOURING COMPANIES. Road shows and troupes, especially commercial entertainment and drama groups, often travel with their own lighting equipment including instruments, controls and cable. Facility for temporary equipment becomes important. Depending on the situation, portions of the installation's equipment-in-place may be used, especially on the house side. Therefore, the selection of compatible standard interlocks and modular systems is advised. The management should be very clear about what it has to offer and what the touring group anticipates using or connecting. In any case, a company switch is provided for the visitors' direct power takeoff.

1.3.2 MASKS, SCREENS, CLOSURES. These are usually the function of draperies, which define acting and scenery spaces; screen equipment, sets and actors' entries from view; surround stage space with light and color, or frame it in darkness; and close off or screen the stage from view between scenes. The relationship of draperies, lights and scenery within the stagehouse is best understood in terms of flyloft layout for the traditional Proscenium Stage. It also makes clearer the conceptual differences of the Open Stage. Rigging flyloft stage equipment is accomplished with parallel pipes slightly longer than the width of the proscenium, normally able to be hung every six inches from the proscenium to the back wall of the stagehouse. These pipes are suspended by hemp and wire ropes from a gridiron high above the stage floor, in order that drops and drapes may be drawn up clear of the acting space. A large number of lines is required because of the many pipes (or battens) and because each batten has several suspension points to limit deflection. Rigging the open stage is accomplished from a lighter-weight grid fixed 25 to 30 feet above the stage floor, about where the top of a proscenium would be. It functions as an attachment network for light pipes and drops, but very little is ever drawn up (or flown) above it. This grid is often a series of catwalks to which lines, pipes and lighting instruments are clamped directly. Variations include wire net "trampoline" grids through which lines are dropped. The proscenium wall is a substantial piece of structure,

since it must span a large opening, bear part of the heavy gridiron load, and separate the audience from the stagehouse with fire resistive construction.

1.3.2.1 FIRE CURTAIN. It is hoped that this apparatus is never used, and certainly will not be in the normal course of performance. Although it is not a vision-related accessory, it is always the first line of actual closure between the stage and house, operating automatically and independent of performance rigging upon activation of smoke and heat detectors. It retards the passage of flames, smoke and toxic gases in the event of fire, providing a margin of safety for evacuating the building. Non combustible construction of asbestos fabric and/or steel slats similar to a coiling tambour door is typical. It has been found that asbestos cloth loses its structural integrity under high heat; when used, it is incorporated in a steel frame. In some circumstances (see NFPA Standard 101), a water-flood system may be used to soak the house curtain or the fire curtain for a specified period, in lieu of or additional to shuttering.

1.3.2.2 FORESTAGE. Depending on Room configuration and uses, certain functions can take place in front of the proscenium. The stage may be equipped with a forestage or motorized pit lift capable of forming an apron in front of the principal curtain. In some cases, the proscenium is expanded in depth over this region and may contain supplemental borders and drapes, lighting, acoustical equipment, loudspeakers and movie screen. This arrangement can be useful where music or small scale performances are interspersed with full drama productions, allowing rehearsal and set up to take place within the stagehouse without interference from ongoing programs. Forestage draperies are typically simple by comparison, especially since the fire curtain function cannot be effective.

1.3.3 BACKGROUNDS. Including the fabric drops mentioned above, backgrounds may be the blank backwall of the stagehouse, or elaborate "'murals". One useful form of background is the cyclorama, which wraps around the scene space and may curve in two directions, vertically and horizontally. The cyclorama used to be a curved white plaster wall, but now is more often constructed of cloth and hung or stretched over a pipe frame

at the back wall, with a white or medium gray color. It has the advantage of portability and ease of maintenance, and can accept film projections from either side.

1.3.4 SETS AND PROPERTIES. Scene elements are created or selected for the specific literature presented. Scene pieces are constructed and vary in complexity from painted drops and flats to elaborate multilevel structures, replica interiors and the like ("box sets"). The term properties generally refers to individual pieces within the acting space, such as furniture, vehicles and items carried by the performers. Sets and properties may be broken down and reassembled or revised for several different productions.

1.3.5 VISUAL MONITORING FOR CONTROL. Coordination of performance accessories over time requires a viewpoint approximating that of the audience. Hence, a control room is best located at the rear of the house, where it is unobtrusive but in communication with the stage, lighting and rigging technicians, as well as the performers. It must have complete surveillance of the action.

1.3.6 TELEVISION BROADCAST. If video recording or broadcast is contemplated, required facilities must be anticipated in planning the Room. Camera placements should not interfere with audience sightlines and should not divert attention. If fixed or concealed camera positions are provided, they must be carefully preplanned. Also note that higher illumination levels (150 footcandles) are required for TV, especially color-casts. These circumstances must be evaluated for their influence on performance. A broadcast control booth need not impinge on the Room, since camera control deals with video images. Most broadcast networks furnish mobile vans for this purpose and require only cable entrance and camera positions as built-in components.

1.3.7 FILM PROJECTION. Except for its use as a scene accessory this capability is not an essential element, but after other functional requirements are met, slide and movie film projection may be deemed a useful accessory. The similarity between drama and cinema ends with the audience facing a framed image in a darkened room. Generally, a Frontal Room designed for drama can accommodate film by providing a flown screen, with

projectors adjacent to the lighting control booth addressing the screen at a right angle to avoid distortion of the image. Obviously, available projector locations may be less than satisfactory if their accommodation is not considered in the design. 16MM movies and 35MM slides are the most likely formats, but standard portable equipment does not have the light output sufficient for distances exceeding 30 or 40 feet. More powerful projectors, and equipment for 35MM and 70MM movies of commercial variety, require enclosed, ventilated, fire protected booths and permanent mounts, much like carbon arc followspots. While large format film can be ruled out, it is still recommended that a suitably positioned booth with at least two projector ports be installed at the rear center of a small house. For occasional use in a larger house, power supply to a demountable platform within range of the screen may be desired.

1.4 HEARING-RELATED ACCESSORIES. Electronic amplification, recording and playback, microphones, loudspeaker systems, and intercommunications readily come within the definition of accessory equipment as do any nonelectronic adjustable acoustic devices such as reflectors and absorbers. But it should not be forgotten that seemingly commonplace fittings like chairs and risers are equally important equipment components for the enhancement of performance quality and flexibility. A more thorough discussion of equipment functions and techniques is available elsewhere. This section is concerned with their implications in architectural (Room design) terms. Decisions about the seven topics discussed below will affect dimensional, structural and material considerations.

1.4.1 SOUND SOURCE POSITIONING. Successful music presentation requires the ability to locate musicians in varying relationships to each other and to the Room. This is important to balancing sound emerging from the stage. It provides essential flexibility for group size, instrumental makeup, and differences of presentation content. Consideration of accessory devices need to be given to the two principal areas of music performance**:** the stage (or platform) and the pit. For instance, the musicians' elevation relative to the audience tends to increase direct sound levels. Also, the position of musicians relative to the stage enclosure walls can be especially critical in elliptical and parabolic geometries sometimes found in large Rooms, and where sources of uneven intensity must be

balanced (such as soloists and ensemble, strings and brass). Similarly, a deep orchestra pit yields primarily reverberant sound. The treatment of the pit or the decision to do without one has considerable impact on the use of the Room acoustically quite as much as operationally; the pit is more than a convenient place to tuck the orchestra out of the way. For dance or musical drama, the pit substitutes for the enclosure needed by musicians to hear themselves. It also serves to blend and subdue musical accompaniment relative to voice on stage. Pit musicianship is a specialized art requiring experience and precision (so does stage singing). If a less experienced group is involved, the pit treatment can help by introducing absorption to reduce sound levels and allow for electronic amplification. Consider the two examples of all-music presentation: chorus and orchestra.

1.4.1.1 CHORUS. The chorus is compactly arranged on risers for geometric reinforcement, maximum projection, and ability to hear each other in circumstances that reflect maximum energy into the house. In this case, the orchestra is often located in a recessed pit, contributing reverberant tones without interfering with articulation of voices in the direct sound field. Rooms have often been designed primarily for chorus or orchestra with no pit, due to the misconception that a pit is a drama accessory.

1.4.1.2 ORCHESTRA. Arrangement of musicians on stage should be at the conductor's option. Some orchestras prefer to set up on the flat, others on risers. Smaller groups and contemporary material may benefit in particular from steep riser arrangements or careful location horizontally; many halls have developed "'soloist points". Finally, recall that musical instruments exhibit handedness, especially those with resonant chambers and sounding boards (violins and pianos) that may dictate a proper orientation to the listeners. Brass instruments are highly directional; the musician may have difficulty assessing the intensity of his efforts perceived by others. All of these are conditions tempered by position and arrangement. Among the devices to have on hand is a good assortment of portable riser platforms stored convenient to the stage. The most commonly used arrangements may be fitted to the stage, but should be modifiable by reassembly as needed. A 4' x 6' folding unit is a practical large size, with interchangeable legs in 8" increments. Normally, 36" to 40" tiers are wide enough for seated musicians and singers, while 24" widths are

better for standing chorus. Musicians' chairs should be carefully selected. They should be firm, "four-square" in stability, broad rather than contoured, and of unitized squeakless construction.

1.4.2 ENCLOSURES AND SHELLS. These function to condense spherical wave radiation and direct it toward the audience and into the house volume. In a Room without a shell (Thrust or Surround) vocal sound emerges with a 5db drop to the side and 10db to the rear. A 10db drop means the sound seems half as loud. An enclosure is built into the Room permanently. However, some degree of adjustability is usually incorporated in the enclosure itself, including moveable panels, additive reflective components, or absorptive elements. These enable the enclosure to be "tuned" to varying music group sizes, instrumental makeups, and desired sectional balance, though its effect is probably most noticeable in smaller Rooms and recital halls. For large Rooms, adjustment is mainly for the benefit of the musicians. The shell may be more easily understood to be "equipment" since it is demountable. It is necessary for a multi-purpose Room with stagehouse. The shell can be wholly or partially disassembled for storage off stage if there is no flyloft. The decision to have a shell, its design and placement, depends very much on the volume and shape of the Room, and all the uses to which it will be put. Shell design requires expertise. If a shell is to be used intermittently, lightweight highly portable construction is needed. Lightweight, however, means less low-frequency energy is reflected. This is typical of the flown shell, which may have self-supporting wall panels. If a shell will remain in place for some time, a more substantial bolt-together articulated panel system is common. The ceiling should be 20 to 25 feet above the musicians, and in large Rooms, may extend into a forestage canopy.

1.4.3 REFLECTORS, DIFFUSERS, ABSORBERS. Hard, dense surfaces of varying sizes reflect varying wave lengths. Convex and irregular surfaces break up and distribute reflections of characteristic wavelengths in many directions. Porous surfaces absorb high frequencies. Dense hangings and pliant material (such as people) absorb midfrequencies. Large resiliently mounted surfaces, with cavities behind them, absorb low frequencies.

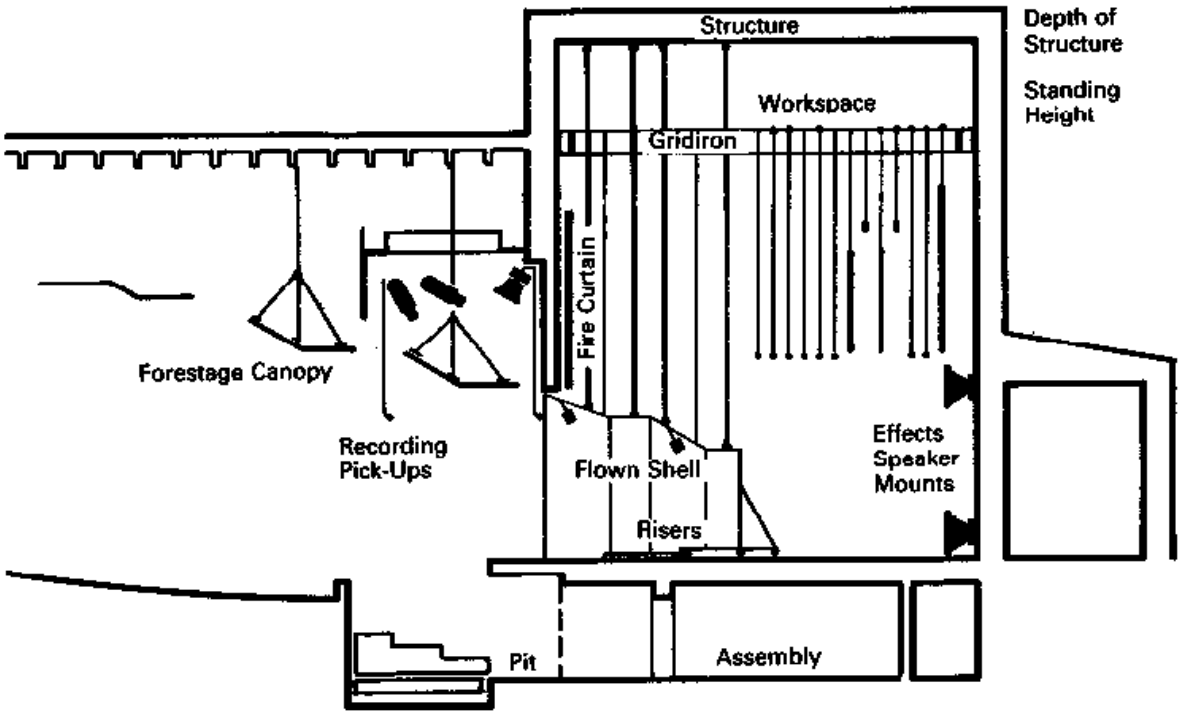

Figure 4

Stagehouse accessories – hearing related

The materials and details of construction enclosing a Room are critical factors in its performance acoustically. Reverberant decay is a function of the net reflective property of boundary surfaces and the volume in which the sound rattles around. While this is a general Room quality, adjustment in specific areas can be an accessory function. Typically adjustable reflector positions include the region over musicians (either in the stage enclosure or in a forestage canopy for pit orchestra), the region above and between musicians and audience (forestage canopy), and trouble spots likely to occur in found space conversions (acute corners, domes and focusing coves). Reflectors should almost always incorporate diffusion to scatter reflected waves. This is accomplished with convexity and surface irregularities. Absorption devices may be employed for several purposes:

- Reduce the reverberation time of a large volume for adaptation to speech.
- Permit rehearsal in a highly reverberant empty house.
- Compensate for low attendance rates.
- Alleviate echoes and focused reflections.
- Reduce sound levels emanating from the pit.

However, absorption must be properly used. Its addition results in lower overall sound levels, which may necessitate installation of electronic amplification. Absorptive material can be frequency-selective resulting in unnatural or unbalanced attenuation just as non-diffuse reflectors can intensify a given frequency. The common practice of alleviating harshness and focused reflections, or fluttering echoes by hanging draperies on one wall, would often yield more satisfactory results if diffusion was employed instead. Long, even reverberation is gained by provision of cubic volume in correct proportion to absorption; adding absorption when it isn't needed essentially defeats a Music Room's intent.

1.4.4 ADDITIVE/SUBTRACTIVE VOLUME. This is a recent approach to variable reverberation based on the volume/absorption principle. Efficient coupling or separation is critical to success. Subtraction is possible by sealing off a portion of the Room, or by moving musicians out of the enclosure and sealing it behind them. Addition is possible by two methods with variations: 1) physically expanding the volume of Room increases reverberation time generally, and 2) coupling other volumes in proximity to the source increases reverberation of a portion of the frequency spectrum. The sophisticated technology involved tends to limit application to special circumstances arising from Room configurations dictated by unusual program goals; the likelihood of such circumstances is small and more readily solved by firm decision. Although adaptive electronic systems will probably prove more feasible, consideration of coupled volumes may help avert related problems. Actually enlarging or decreasing effective Room volume at will is rarely practical. Given a deep upper balcony, it is possible to close it off by drawing a heavy, specially designed sectional partition between its front row and the ceiling. Schemes to mechanically raise and lower the ceiling itself have been plagued with problems of acoustical seals, integral lighting, mechanical systems, and great weight. Annexing

adjoining spaces and corridors fails on account of their contents, and practical dimensions determined by normal use. The coupled volume must become part of the Room. The most useful volumes are in proximity to the music source. Their use results in strengthened low frequencies for added “warmth”. One of these volumes is the stagehouse itself, connected through a large proscenium. The installation of a partially “transparent” shell reflects mid and high frequencies. Low frequencies enter the stagehouse where they reverberate and emerge into the house a short time later, effectively lengthening low frequency decay. However, the volume must be relatively free of absorptive materials, which limits the kind and quantity of drops stored there. Perhaps a more practical possibility is the utilization of understage volume in a similar fashion, with the ability to control absorption. In this case, the stage floor behaves like a drumhead or violin body. When the volume is coupled with the Room, it enhances reverberant field for the audience near the stage especially, who often suffer from high direct/reverberant ratios. This method has had application in non-stagehouse Rooms, too. Coupling has also been accomplished electronically, using the stagehouse as a reverberant chamber connected by microphones to speakers in the house. The advantage of electronic coupling is the ability to turn it off in multi-use Rooms, so that undue scene change noise is not transmitted during drama performances. Air-coupled volumes must be mechanically separated, with absorptive draperies added to deaden the space. There are also issues of fire separation to contend with. Actually enlarging or decreasing effective Room volume at will is rarely practical. Given a deep upper balcony, it is possible to close it off by drawing a heavy, specially designed sectional partition between its front row and the ceiling. Schemes to mechanically raise and lower the ceiling itself have been plagued with problems of acoustical seals, integral lighting, mechanical systems, and great weight. Annexing adjoining spaces and corridors fails on account of their contents, and practical dimensions determined by normal use. The coupled volume must become part of the Room. The practice of closing the proscenium or orchestra enclosure and staging small scale music performances in front of it carries with it the need for reflective surfaces around the musicians. These may be set up on the apron or lowered from a forestage canopy. The proscenium closure must be more dense and reflective than the typical house curtain.

1.4.5 ELECTRONICS AND SOUND SYSTEMS. As with demountable shells, it is easier to think of electronic components as accessory ‘equipment”. They serve three general functions in terms of performance acoustics: enhancement of natural acoustic qualities, amplification of sound, and theatrical sound effects. In terms of Room design impact, the first function (electro-acoustic enhancement) is most significant, as it deals with objectives that could otherwise be effected only by physical changes in the structure. This system’s sole purpose is to increase reverberation time by electronically introducing very small delays between input and output. The system must be designed for the Room and should only be performed by a qualified acoustical engineer. Amplification (sound reinforcement) raises the level of direct sound radiated into the Room. This too must be designed by a well informed specialist. Its architectural implications reside in the placement of loudspeakers, the choice of which must belong to the acoustician. Depending on Room use and configuration, loudspeakers may be located in a central cluster above the proscenium, in several groups above the proscenium, on both sides of the proscenium, or distributed in the house. Improper placement of loudspeakers and microphones can destroy the usefulness of the Room. An audio effects system provides the aural equivalent of visual (lighting and scenic) content-illusion, atmospheric mood and color, and thematic continuity. The effects system will be independent of the reinforcement system, for the very reason that directional illusion (or realism) may demand that sound effects originate offstage or behind the audience or in a moving pattern. Multiple outlet jacks are required for portable speakers controlled through a special effects console.

1.4.6 MONITORING AND CONTROL. Production lighting control from the lighting booth is especially relevant to drama productions where visual monitoring is essential. By the same token, sound control where electronic systems are involved should be properly monitored from an audience reference point, also normally located in the rear quarter of a frontal house. Whereas lighting control is often separated from the house by plate glass to avoid audible intrusion on the audience, sound control requires the actual sound in the Room to be heard to make the appropriate balance adjustment. The control console “cockpit” is best located in the audience area. Solid state electronics allow it to be quite

compact and tied into remote power amplifiers of the reinforcement system. Location and control wiring connections will be specified by the system designer.

1.4.7 COMMUNICATIONS. There are several important systems of communications to be considered. The principal design requirement is separation of message channels to limit them to those for whom the message is intended. This may involve separate wiring, input and output sources, and isolated enclosures. In this category are public address, broadcast and recording, performance monitoring and production communications. The purpose of public address is to make general announcements to groups of people, which may mean the seated audience, those assembled in the lobby or out-of-doors, and those assembled in the stagehouse or backstage during rehearsals. Its key architectural implication is the acoustic separation of message zones and restricted control of input channels to prevent unwitting intrusion on performance activities. This demands appropriate door seals (and the discipline to keep them closed) and level adjustments of the loudspeakers, with master controls in the control booth and stage manager's console. Archival recording and broadcast functions utilize signals from monitor microphones suspended in front of the proscenium over the first few rows of seats (or derived from the reinforcement system inputs) which hear what the audience hears. These signals may be fed directly to a remote broadcast/control booth (where an announcer's voice-over can be dubbed in) and/or to a recording control booth. Broadcast programs are either recorded for replay or relayed to the station for transmission. The architectural requirement is for cable entry to the building and provision of a soundproof announcer's booth with a view of the performance. The function of performance monitoring is to communicate the performance to latecomers waiting in a lobby area separate from the Room, and to artists and technicians backstage, thus permitting them to follow the performance from remote locations. It is intended to minimize interruptions and milling around while waiting to be seated or to enter the stage. The monitor system should be adjusted to operate without supervision and without being heard in the Room. The requirements of public address systems apply here as well. Finally, production communications are necessary during performance. One of these is the actors' call, enabling the stage manager to alert actors waiting for entry cues backstage. This may be

a visual signal light system operated from the stage manager's position in the wings and/or a voice communication "squawk box" from the control booth. A headset system connects the stage manager with technical staff in lighting positions, fly gallery and rigging control points, trap room and orchestra pit, sound reinforcement and effects control consoles, lighting control, and projection and followspot booths; in short, with all the action stations to be coordinated. Normally, a two-way single channel system (all-talk, all-listen) is sufficient for this activity. Jacks must be provided at all relevant positions, unless wireless receivers are employed. Selective station-to-station communication should also be provided via house telephone, connecting stage manager, house manager, control booth, stage door security, and similar points. This may be an extension of the outside line telephone system.