A CONVENTION CENTER
FOR INDIANAPOLIS, INDIANA

by

E. Crawley Cooper

B.S. in Architecture, University of Cincinnati, (1957)

SUBMITTED IN PARTIAL FULFILMENT

OF THE REQUIREMENTS FOR THE

DEGREE OF MASTER IN ARCHITECTURE

at the

MASSACHUSETTS INSTITUTE OF
TECHNOLOGY

July, 1959

Signature of Author

Department of Architecture, July 29, 1959

Certified by . . .

Thesis Supervisor

Accepted by . . .

Chairman, Departmental Committee on
Graduate Students

I.
ABSTRACT

A CONVENTION CENTER

FOR INDIANAPOLIS, INDIZNA

E. Crawley Cooper, Author

Submitted to the Department of Architecture on July 29, 1959, in partial fulfillment of the requirements for the degree of Master in Architecture.

Purpose: 1. This project will help establish Indianapolis as a major nation-wide convention city.
2. The advertising and promotional benefits of the conventions will help raise the economic standard of living.
3. It will broaden the cultural base of the entire metropolitan area.
4. The center will contribute immensely to the positive revitalization of the city's core.
5. Finally, it will help establish civic interest and pride among the citizenry.

Site: 1. The proposed site is a level three block area bordering the south side of the State office buildings group between Capitol Avenue and West Street.
2. It is located within the central business district.
3. The property has a total land area of 567,000 square feet.

Program: The center includes:

1. A coliseum with 6,000 fixed seats surrounding a central flat area of approximately 120' x 210'
2. Meeting rooms, approximately 25 in number with varying capacities from 100 to 1,000 persons
3. Exhibit hall of approximately 70,000 square feet of net rentable area
4. Music hall seating 3,000 persons for symphony orchestra, theatricals, and meetings
5. Parking facilities for 1,000 cars

Objectives:

1. The design should be a bold statement to serve as a landmark for the city.
2. It must be generous in scale to accommodate crowds.
3. The project must include a large open pedestrian plaza.
4. There should be visual clarity in the organization of pedestrian movement, automobiles, service, and audience activities.
5. The design must allow independent usage of the separate functions.
6. Special design consideration should be given to the roofscape as the site has the potential of being surrounded by high rise buildings.

Solution:

The design consists of a raised pedestrian plaza covering the entire site. The audience activities occur in the music hall at the eastern end and the coliseum at the western terminal of the axis. Under this plaza, at street level, are the exhibit hall, meeting rooms, and covered circulation space. Parking occurs on three levels below grade in the central third of the site. A clock tower is located to the north of the plaza on axis with U.S. highway 40, accenting the convention center and the State capital buildings in the vista of the approaching motorist.

The structure consists of reinforced concrete. This is combined with steel cables in spanning the roof surfaces of the music hall and the coliseum.

Thesis Supervisor: Imre Halasz
Title: Assistant Professor of Architecture
Pietro Belluschi, Dean
School of Architecture and Planning
Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge 39, Massachusetts

Dear Dean Belluschi:

As required for the degree, Master in Architecture, I submit the following thesis entitled, "A Convention Center for Indianapolis, Indiana".

Sincerely,

E. Crawley Cooper
DEDICATION

Order is a lovely thing;
On disarray it lays its wing,
Teaching simplicity to sing.
It has a meek and lowly grace,
Quiet as a nun's face.

Anna Hempstead Branch
ACKNOWLEDGMENT

My gratitude is sincerely offered to those who have assisted me in the preparation of this thesis study...my professors at M.I.T., my friends in Indianapolis, my fellow students, my parents, and my wife, Jane.
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VII.
PURPOSE...
Indianapolis is a major transportation center. It is located near the geographic center of Indiana as well as the center of the population of the entire United States. This places the city at a great strategic advantage in competition with other cities for attracting mass gatherings and conventions.

The existing hotels of the city with more than five thousand usable rooms and the central location of some thirty-two hundred rooms make adequate accommodations available for the great majority of conventions.

A downtown convention center is all that is needed to give Indianapolis the greatest potential of the leading cities of the United States for attracting large conventions.

In effect, this center, by securing large numbers of visitors to the community, would increase the earning potential by an estimated six to seven million dollars a year according to the Indianapolis Chamber of Commerce. Most of this money would find its way into the financial blood stream of the area, stimulating and creating purchases and employment in a wide variety of services.

The new convention center could be a stimulus for the expansion of hotels which would provide greater accommodations for more and larger conventions with resultant increased values both to the center and to the commercial and social values of the area.

The availability of the facilities would, in addition, provide extra curricular activities. The inhabitants of the vicinity would be offered the opportunity to witness a wide variety of cultural, ed-
ucational, and sports activities that are available to those in other metropolises.

Millions of Americans with their rising incomes, increasing leisure, and higher levels of education, are enriching their lives through the arts. The number of operas and symphonies, and the expenditure for music and theatre are greater than ever. The recognition that enjoyment of the arts is essential to the spirit of man has developed more than ever the serious community responsibilities for the maintenance and development of these activities. The program attempts to provide a versatile center within practical limits capable of handling a variety of functions, thereby increasing its economic potential to the taxpayers. To neglect this opportunity would be to provide urban living without its important benefits.

By redeveloping this three block area in the central business district, a giant step toward the revitalization of downtown Indianapolis will be accomplished. It will rid the city of some of its worst structures and raise the property values of the neighboring blighted areas encouraging further improvements. It is through such large scale projects as this that we can hope to keep the core of our cities alive in this age of the automobile.

Finally, this convention center will provide a landmark of recognition to Indianapolis which will help to establish civic interest and pride among the citizenry.
The site must be within the central business district of Indianapolis. Without this location the convention purposes could not be satisfactorily met and the center essentially would be idle, inefficient, and ineffective. Conventions must relate directly to the hotels and shopping district. Conventioners require convenience: they want a minimum of walking between hotels, shopping districts, and other facilities. Generally, they choose those cities where this arrangement is prevalent. The basic factors affecting the choice of site are as follows:

1. Location must be within the central business district.
2. There should be favorable highway access.
3. Public transportation should be within easy walking distance.
4. Contiguous parking areas of sufficient additional capacity to that proposed should be available.
5. Adequate land area to provide suitable aesthetic treatment of structures and environment is needed.
6. The cost and availability of the land must be within reason.

In the Metropolitan Planning Department's estimation, the most suitable site for the proposed convention center is the three block area bounded by Washington, Missouri, Georgia, Senate, Maryland, and Capitol Avenue. Their reasons for this choice are:

1. Within easy walking distance of all downtown functions

1. See map; fig. 1.
2. See figure II for a financial breakdown.
Figure II.

Washington-Capitol-Maryland-Senate (Block A)

<table>
<thead>
<tr>
<th>Assessed Land</th>
<th>Assessed Buildings</th>
<th>Assessed Total</th>
<th>Actual Total*</th>
<th>Tax Loss Per Year**</th>
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<tbody>
<tr>
<td>$514,580</td>
<td>$1,30,020</td>
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Washington-Senate-Maryland-Missouri (Block B)

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Maryland-Senate-Georgia-Missouri (Block C)

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Grand Totals

<p>| | | | | |</p>
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<td>$1,982,970</td>
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</tbody>
</table>

*Assessed valuation is considered only one-third actual value.

**1958 tax rate is $7.145 per $100.00 assessed valuation.
2. Adjacent to existing and proposed parking facilities
3. Reasonably close to the proposed new expressway loop system
4. Adjacent to public transportation
5. Adequate in size to accommodate convention center facilities
6. Generally blighted condition of the area

Upon further investigation of the area I have altered that site choice to be the three blocks between the proposed west leg of the circumferential expressway at West Street to Capitol Avenue on the south side of Washington Street. My reasons for this choice coincide with the six previously mentioned by the Metropolitan Planning Department. However, additional advantages of this site are:

1. Opportunity to vacate Missouri Street between Washington and Maryland Streets, adding 37,800 square feet of land area to the site without sacrificing the function of the street system
2. A greater design potential to a linear site over an "L" shaped site
3. Consistent proximity to the State office buildings group across Washington Street in a generous landscape providing a better architectural relationship
4. The future re-routing of Washington Street through traffic to Maryland Street offering a greater pedestrian relationship to the State office buildings group. (This proposed traffic re-routing would be a barrier to the pedestrian cir-

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3. See map; fig. III
## Figure IV.

### Washington-Capitol-Maryland-Senate (Block A)

<table>
<thead>
<tr>
<th>Assessed Land</th>
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<th>Assessed Total</th>
<th>Actual Total*</th>
<th>Tax Loss Per Year**</th>
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### Washington-Senate-Maryland-Missouri (Block B)

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</tbody>
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### Washington-Missouri-Maryland-West (Block D)

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### Grand Totals

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*Assessed valuation is considered only one-third actual value.

**1958 tax rate is $7.145 per $100.00 assessed valuation.
The difference in actual cost is $352,020 which is a small percentage of the total while the advantages gained are great; therefore, this is the site choice for the thesis study.\(^1\)

Since the Belt Railroad tracks will eventually be moved west of West Street under the proposed expressway loop because of the location of the new state office building,\(^5\) it will not bisect the site of the proposed convention center.

The total land area of the chosen site will be 567,000 square feet or approximately thirteen acres.

\(^1\) See fig. IV for a financial breakdown.

\(^5\) This project is presently in the working drawing stage.
I. Financial

The following is a list of the estimated capital requirements:

<table>
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<tr>
<th>Item</th>
<th>Amount</th>
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</thead>
<tbody>
<tr>
<td>Property</td>
<td>6,300,930</td>
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<tr>
<td>Site preparation</td>
<td>250,000</td>
</tr>
<tr>
<td>Auditorium and meeting rooms</td>
<td>5,200,000</td>
</tr>
<tr>
<td>Exhibit hall</td>
<td>3,000,000</td>
</tr>
<tr>
<td>Music hall</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Parking</td>
<td>1,300,000</td>
</tr>
<tr>
<td>Architects fees</td>
<td>550,000</td>
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<tr>
<td>Contingency</td>
<td>1,800,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$19,900,930</strong></td>
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"Under the act, creating the Indianapolis Marion Building Authority, the capital funds necessary for the construction of the facilities must come from the sale of revenue bonds, and this would not directly affect the bonding capacity of either the city or the county. The annual cost of financing and operation represents an increase based on 1956 figures of approximately one per cent of the total appropriations within Marion County, and since the annual costs are considered almost entirely for the purposes of paying the fixed charges of amortization and interest, this fixed charge, annually decreasing in amount as amortization is paid, would, against an anticipated general increase in appropriations, represent a still
smaller percentage of the total appropriations within Marion County in the future. This amount of less than one percent for the cost of this project taken by itself would certainly indicate, regardless of how it might be divided between the county and the city, that it is not only small but a fraction of what would be considered normal contingency, considerations in the annual budget requirements within Marion County.

In other words, from an economic standpoint the project seems entirely feasible.

II. Management

Under an act of the Indiana State Legislature, the Indianapolis-Marion Building Authority was organized to finance, construct, equip, operate, and lease the new city-county office building. This same authority has the power to manage a convention center project providing they receive a referendum vote by the people in favor of such a project. Thus, Indianapolis has the potential and the tools to create this project. Certainly, it can only be a matter of time before it becomes a reality.

6."Report to the Indianapolis-Marion Building Authority", by the new Buildings Consulting Board, 1958, p. 40
III. Coliseum

This unit of the center should provide for the following functions:

a. Conventions
b. Religious meetings
c. Political meetings
d. Civic meetings
e. Fund raising activities
f. School commencements
g. Scout jamborees
h. Expositions
i. Band concerts
j. Stars: stage, screen, TV
k. Circuses
l. Rodeos
m. Horse shows
n. Dog shows
o. Ice carnivals
p. Basketball
q. Ice hockey
r. Ice skating
s. Boxing
t. Tennis
u. Wrestling
In the judgment of the International Association of Auditorium Managers Inc., the stipulated seating capacity of 6,000 mezzanine seats plus 2,500 temporary seating on the floor is in the proper order considering the population potential of the area. In their opinion if this coliseum were to be used for a brief concentrated period, catering to maximum use, the capacity could be considered of greater magnitude. However, since the coliseum will be used a maximum number of days throughout the year, the seating capacity should be of such order as to be reasonably filled most of the time. An empty house is a serious handicap. The operation and maintenance of seating far in excess of the reasonable demands, likewise, handicaps the efficient operation of the center.

IV. Meeting Rooms

This unit of the center should provide for the following functions:

a. Conventions
b. Organizations
c. Lectures
d. Educational classes
e. Ceremonials
f. Special women's groups

The meeting rooms consisting of approximately twenty-five units, with varying seating capacities of one hundred to one thousand persons, would adequately provide facilities for all types of meetings,
conventions, etc., and could by physical arrangement make possible numerous combinations. These meeting rooms as contemplated could be used in conjunction with other activities, or separately if desired.

V. Exhibit Hall

This unit of the center should provide for the following functions:

a. Conventions
b. Home show
c. Auto show
d. Flower show

The exhibit hall should have a gross area of approximately 150,000 square feet. This area, after allowing for aisles, storage, and work space, would provide a net minimum rentable exhibit space of approximately 70,000 square feet. This could be augmented by the 29,000 square feet available in the flat central area of the auditorium. This total area would be quite adequate to handle all but a handful of exhibits and conventions. According to the International Association of Auditorium Managers, Inc., a larger area than this would handicap the general run of the operation, and a smaller area would preclude the consideration of Indianapolis as a choice for many conventions.
VI. Music Hall

This unit of the center should provide for the following functions:

a. Symphony orchestra concerts  
b. Band concerts  
c. Choirs  
d. Soloists  
e. Quartets, etc.  
f. Theatricals  
g. Meetings  
h. Civic lectures  
i. Films  
j. Opera  
k. Ballet

This element of the convention center is primarily for concert performances. However, the building program places two basic handicaps on a successful design. First, the hall must be flexible enough to accommodate theatricals and motion picture productions. In effect, this means a multi-purpose design with the inevitable compromises. Secondly, the hall must have a capacity of 3,000 fixed seats. This is far too many for ideal performance conditions. It is impossible to provide the desired intimate listening environment and correct seeing conditions to this excessive audience. These handicaps are considered necessary evils to the economic stability of the project. It is considered a mistake by the Indianapolis—
Marion Authority to provide a center unable to pay its own way. Otherwise, the music hall would be a constant tax loss to the community. Under this situation, the program presents a greater challenge and requires a more determined effort. The design should reflect intelligent judgment in providing a satisfactory hall with a minimum of compromises.


Correct acoustical environment, however, is more illusive and requires a great sophistication, especially for a concert hall. For this reason, a discussion of the specific problems and considerations of acoustics necessary in music hall design is included.

A music hall offers challenging problems to the architect. It is to be occupied by people with great discernment and experience in the appreciation and presentation of music. The quality of that music is not only depended upon the composer, conductor, and musician, but also, the environment in which it is played. A thorough understanding of the characteristics of sound and the problems it involves is an absolute necessary.

The main problem of music hall design is unsolvable. This is the problem of precisely expressing the desired results of good design in scientific terms. Since music is a basic art form, it contains inherently many intangible aspects that defy exact definition.

16.
Indeed, this is a necessary characteristic of all art. Since the environment is such an important factor of music as art, it is impossible to pinpoint the characteristics of a perfect music hall. Thus, no absolutely perfect hall has been nor will be built. This problem can only be reduced to generalizations, thereby, forcing compromises.

We believe, for example, that the contemporary music of Stravinsky sounds better in a hall with a relatively low reverberation time, while the classic music of Beethoven seems richer with a more generous reverberation time. Ideally, a perfect music hall would have a controllable reverberation time for each selection to be performed. This proves extremely impractical in the design.

Reverberation time is not the only time factor that has proved important in good music halls. The age of the building itself, traditionally has been essential to the public and critics alike in judging a design's worth. Of course, this is a human failing that must not be confused with intelligent reasoning. No doubt, it is due to the reputations of the performing artists over the years as well as the inherent love for sentimentality in the human mind.

The basic requirements for a good concert hall are the same for all listening situations. They are:

1. Quiet hall
2. Adequate loudness of performance
3. Proper distribution of sound
4. Correct reverberation time for function
The first and most difficult requirement of music hall design is to achieve a quiet room devoid of all unwanted sound. This means that every possible care must be exercised in providing a minimum background noise level in the listening space. The constant masking noise or "acoustic perfume" approach to hiding the unwanted sounds is unacceptable.

The noise from outside sources, such as airplanes, traffic, sirens, etc., must not be allowed to penetrate to the audience. This means that the music hall envelope must be surrounded by walls and roof of sufficient mass to isolate these sounds.

Care must be taken to prevent any sound leaks in this envelope by providing sound locks or air locks between the hall itself and the lobby space. The detailing of the door gaskets to insure absolute separation is critical. Ventilation openings to the outside are a chief source of trouble in this respect and are a real headache to the architect. Often involved and devious means must be used to insure this minimum transmission loss to the enclosing envelope.

Noises from within the music hall are equally disturbing. Mechanical equipment noises are chief concern to the designer who must provide a quiet listening room. In selecting the mechanical equipment it is important to consider it as a sound source and give intelligent consideration to the sound intensity of the equipment. Air moving equipment is especially critical, since its noise usually has an open path of travel to the listening room. Many manufacturers of air diffusers, fans, etc., now rate their equipment in terms of its
acoustic power and it is possible to compare products in this respect.

Transformers, boilers, compressors, bus bars, fluorescent light ballasts, cooling towers, and plumbing all contribute unwanted structure and air borne sound to a music hall.

Structure borne noise requires great care in design detailing. These problems can seldom be solved as an after thought. The equipment must not be connected rigidly to the structure. This vibration isolation is achieved through the use of soft, resilient mounts. Thick glass fiber mats, not cork, are often used as a resilient pad. Spring type and rubber-in-shear mounts are also practical ways of separating vibration from structure. On large vibrating equipment such as compressors, elevator machinery, etc., a large concrete inertia block is placed on a glass fiber pad as a base. The equipment is then resiliently mounted to the inertia block giving a double isolating characteristic.

Extreme care must be taken in these installations to insure complete separation of the vibrating source and the structure. The slightest short circuit or rigid connection will give immediate structure borne vibrations and noise. Conduit connections must have flexible loops and duct connections must be unpainted canvas or other limp material. This initial care and expense of installation not only will contribute to the good acoustical characteristics of the music hall, but will add to the life of the equipment itself.
Air borne sound is controlled by enclosing the source with heavy impervious material. Once again, it is important to supervise the construction closely to make certain there are no air leaks. Pipe chases and other openings should be tightly caulked and sealed.

Because sound absorptive material located within the sound source room will help contribute to the transmission loss to a receiving room, it is a wise idea to have a generous surface of thick glass fiber in the mechanical equipment room.

Ductwork provides an excellent path of travel for noise. Since sound diminishes with distance, many times it is a wise idea to lengthen the path of travel. Of course, this is directly opposed to efficient ventilating practices. Carefully calculated air pressures must be compared with the sound attenuation in the length of ductwork. The ducts, themselves, may be lined with thick absorptive material to increase the sound intensity loss over the length. This too adds to the friction of air flow through the duct, and will possibly increase the fan size over that used for an unlined duct. This dicotomy often exists in the solution of acoustical problems.

Commercial package attenuators are available for ductwork in reducing the air borne sound. Supply and return plenums may be lined with thick absorptive material to reduce this air borne problem. Noise will travel just as well as from a fan through a return air duct as through a supply duct.

Careful consideration must be given to the problem of a quiet listening room in the initial stages of design. Since the human ear
is so sensitive to sound, it would be impossible to have the space too quiet. It is definitely a major problem to obtain an acceptable low background noise level for a music hall.

Once the low background level has been achieved, the problem of providing adequate loudness is relatively minor. Considerable latitude may be exercised in determining the most favorable size of a music hall. A variation of one hundred percent in the volume of the space will make a difference of only 2 to 3 db in the average sound intensity level of the music. The size of the hall is more determined by adequate sight and distance lines than by the need for adequate loudness. However, it would be a mistake to crowd a large orchestra in a small hall or to expect a quartet to sound right in a vast hall.

The problem of adequate loudness does become more critical in a music hall which also serves as an auditorium for speech. This is solved by the use of a good quality, highly directional central speech reinforcement system located above the proscenium opening. With this type of system it is possible to achieve a room with an acceptable reverberation time for music, and yet have the speech clearly audible.

At any rate, the music should never be reproduced and reinforced electronically. It is entirely unnecessary and only distorts the true sound for the audience.

The proper distribution of sound is an extremely important and often neglected aspect of music hall design. A curious notion of
Proper sound distribution is held by many including the late Frank Lloyd Wright. This is the idea that the direction of air flow in music hall ventilation design is of great importance to good results. It would seem at first that the ventilation system would affect the acoustics. The air is the medium that transmits sound, and the wind does have an action in changing the propagation of sound. Practically, however, it is found that the effect of the usual ventilation currents on the acoustics in a room is small.

Under special circumstances, the heating and ventilating systems may prove disadvantageous. A current of hot air in the center of a room will seriously disturb the action of sound waves. Any irregularity in the air currents that causes alternate sheets of cold and heated air to be set up will modify the regular progress of the sound waves and produce confusion. The object is to keep the air as homogenous and steady as possible.

Actually, the proper distribution of sound is dependent upon the shape of the room. In the design of this music hall it is not only necessary to avoid shapes which will produce acoustical defects, such as echoes and interfering reflections, but it is of prime importance to design shapes which will facilitate the most advantageous reflection of sound to all the listeners in the room. A good general rule is to avoid large scale smooth concave surfaces. This shape in any form means disaster to the music hall acoustics. It will focus sounds in certain points, thereby, creating "hot spots" and completely neglect other seating areas, thereby, creating
"dead spots". The ideal in good reflection is to provide even distribution to all audience areas. Ray diagrams should be carefully studied in plan and section to determine the distribution characteristics of the shape. It is important for the listener to receive reflected sound energy within the first 20 milliseconds following the direct sound to his ears. This serves to enrich and clarify the quality as well as reinforce its strength. This particular characteristic is very important in music appreciation. Since the path of travel can be observed in plan and section drawings, and the speed of sound is known, it is a simple matter to place reflector panels at strategic locations to give this desirable 20 milliseconds delayed reflected sound to the majority of the audience.

Sound waves are relatively large, so reflector panels must be of a large scale too. They should be at least seven feet square. Smaller panels will only reflect high frequency sounds.

In shaping the listening space it is of great importance to ensure that the reflections reaching the audience area are not excessive in time delay. Generally, if the travel path of reflected energy is 65 feet greater than the path of the direct sound, an undesirable echo will result. That is, the reflected energy will actually be heard as a separate sound. Even when the reflected sound is delayed as much as 50 feet, it unites with the direct sound sufficiently out of phase to produce a blurring sensation.

The speed of sound in air is roughly 1100 feet per second; therefore, sound travels about one foot in a millisecond.
In a hall of 3,000 seats it may be difficult or impossible to avoid large differences of path between direct and reflected sound. In such cases it is advisable to break up the surfaces by introducing irregularities in contour, and thus, prevent interfering reflections or echoes.

Often this unwanted delayed reflection occurs from the rear wall. This is controlled by tilting the surface downward to ground the path that sound travels, or by treatment with sound absorptive materials. If sound absorptive treatment is used it is especially important to make it thick and efficient evenly over the whole frequency spectrum. Otherwise, insufficient echo control will result at certain frequencies.

If the side walls have a concave curve, noticeable distortion of sound energy will occur which is termed "creep". This surface will also create "hot spots" in the audience area.

A slight inward inclination of the side walls is an effective means of directing reflections to the seating area. The tilting of the side walls also prevents multiple reflections between parallel walls from a source between the two surfaces. This phenomenon is known as "flutter".

As a rule, good design of balcony recesses requires a shallow depth and a high opening. This permits a good amount of energy into the space. On the other hand, if the balcony recess is relatively deep, or the opening low, the intensity level under the soffit will be considerably below the level in the main volume of the hall.
Ideally, every member of the audience should be able to see at least one third of the main ceiling. In addition, the balcony sof-fit should always slope down toward the rear to act as a reflector. Large scale coffers and changes in contour of the surfaces add much to the general break-up and mixing of sound energy. This is very good in music hall design because it gives a well diffused sound pattern. This contribution to a linear sound delay curve fills the gap between the first few reflections and generally frees the space from echoes and sound colorations.

It is important to consider a canopy or overhead reflector for the stage area. This adds to the first reflection intensities as well as serving as a sound board for the musicians themselves. It is true that the sound energy that is directed back to the stage will mean a loss of valuable energy to the audience. But, it is also true that the musician is stimulated to greater performance if he can hear the blended and balanced sound of the rest of the orchestra. It is generally thought that a hard reflective stage enclosure is beneficial to both the audience and the performer and should be carefully considered in any music hall design. In any event, the surrounding surfaces should be hard and reflective. This means that no back or side curtains should be allowed. It is especially important that the stage reflectors have a moderate degree of diffusion. This is accomplished with large scale irregularities or coffers within the reflecting surfaces.
A satisfactory reverberation time is the last important factor in music hall design. Reverberation characteristics are dependent on the volume and the amount of sound absorptive units. As a general rule, in volume to audience proportions, it is usually true that if the hall has fewer than 150 cubic feet per person it is too small. Likewise, if a hall has larger than 400 cubic feet per person it is too large.

With all other factors remaining constant, reverberation time increases with volume. This means that by adding cubage, longer reverberation times may be achieved. This can be consciously done; however, after a volume reaches about a million cubic feet, it is questionable whether it can ever be acceptable to the audience because the sound loses its strength just trying to fill the space. In such a large room the time delays between successive reflections become large so that the reverberation tends to be disembodied from the note that produced it. The acoustic effect that results approaches that found in large arenas. Therefore, one million cubic feet is about a maximum size for music halls.

Since the reverberation time is dependent upon the amount of absorption in the room, it is of importance to discuss absorption characteristics. The absorbing power of a seated audience, chorus, and orchestra increases in proportion to the floor area it occupies, nearly independent of the number of seated people in that area. As an example, a 100 square feet area of audience evenly distributed will absorb the same amount whether there are 16 or 30 persons in 26.
it. This means that the more closely spaced the seating, the longer possible reverberation time will result from the same amount of audience. The Indiana building code places a minimum seat spacing of eighteen inches wide and thirty-three inches back to back for all audience assembly buildings. Historically however, the popular old music halls of Europe have many examples of much closer spacing. In order to insure proper sight lines for the audience, it is common to vary randomly the seat spacing from eighteen to at least twenty-four inches. This, of course, adds to the absorption characteristics of the hall. Comfort tells us that we need more than thirty-three back to back spacing now that people are generally taller. This places a tax on the music hall acoustics. Ideally, for acoustical purposes only, the seat spacing should be kept at an absolute minimum to increase the reverberation time of the hall.

If the volume to surface area relationship is in the neighborhood of ten feet, the shape has nothing to do in determining reverberation time.

Even though added absorption lowers the reverberation time, it is important to have upholstered seats throughout the hall. This is done to stabilize the known absorptive quality of the room whether it be full, half full, or empty. It is possible with upholstered seats to achieve a relatively constant reverberation time independent of the size of the audience. The empty upholstered seat absorbs sound with relatively the same capacity as a seated person. This is a great tool in designing a hall for a specific reverbera-
tion time independent of audience size.

Ideally, the decay curve of the reverberation time should flatten out a little in the lower frequencies. In other words it is important to have the music hall space a little on the "boomie" side. A study of all of the absorption characteristics of the materials used at each frequency band is necessary in predicting this decay curve slope. Most all sound absorbing materials are more efficient over one particular frequency band than another. For this reason, it is important to balance carefully the materials used to keep this over all reverberation time relatively constant. A dead room to high frequencies can be very reverberant in the low frequency band and produce a distorted "boomie" sound. If the opposite case is true, the result will be a noticeable distortion giving a "ting" characteristic to the sound.

In large volumes air absorption becomes an important design consideration. The amount of absorption is proportional to the humidity. Air absorption is influential to the high frequencies. As an example, for a typical hall with sixty percent relative humidity, the air absorption of 6,000 c.p.s. is so great that it adds as much to the total absorption as though the audience were increased by twenty percent. Since the hall must be air conditioned to give the necessary air changes required by the Indiana State code, the relative humidity of the air becomes a known value that can be controlled and taken into account during the design process.
Since each type of use requires a different reverberation time, consideration should be given to the desired reverberation time. The optimum reverberation time in the mid-frequencies for this hall is considered about 1.3 seconds. This is the correct time for this use and capacity of a hall. \(^7\) It is apparent that a hall cannot at one time be ideal for a variety of uses. The architect must face the decision of what reverberation time to choose, and be prepared to defend this choice against attack by those persons with special interests in an optimum value for their particular purpose. It is a problem of intelligent compromise that is unavoidable.

Reverberation time is generally independent of relative position in a well shaped hall. It is dependent on the volume, audience, orchestra, and chorus seating area and the sound absorbing characteristics of the materials in the room. In a room with good distribution and diffusion characteristics, the audience and the unoccupied upholstered seats should provide the majority of absorption in the space. Air absorption and surface materials will, of course, contribute absorption qualities to the space, but ideally, they should be minimized to only balancing the spectrum of reverberation time and pinpointing exactly the desired result.

\(^7\) This opinion was established from Professor Leo Beranek's table of optimum mid-frequency reverberation times in a rough draft of his unpublished book, *Concert Hall Acoustics.*

29.
Indeed, music hall design is full of pitfalls and opportunities for error. Even when the designer with careful consideration is successful in achieving the desired results, he is still vulnerable for valid criticism just as the composer, conductor, and musician. This is due to the artistic quality of the medium of music. Once again it is important to stress the truth that the perfect or ideal music hall is only possible in man's mind, and the best we may hope to achieve is to approximate this ideal.

VII. Parking

This unit of the center should provide car storage space for the following:

a. Convention center crowds
b. State office employees
c. Downtown shoppers

"One of the first requisites of all these centres of community life is the separation of pedestrians and automobiles."8.

Recently, it has been the practice to replace the older outmoded structures of Indianapolis with new parking garages to meet the growing demands for car storage space. The Indianapolis Off Street Parking Commission along with the Metropolitan Planning Department have indorsed this action. Unfortunately, this building by building replanning is doing little to improve the over-all design

8 J. L. Sert, "Centres of Community Life", Heart of the City, Pellegrini and Cudahy, (New York, 1952), p. 11
of the central business district. The haphazard pattern of lifeless parking warehouses is, in fact, contributing to the eventual dullness of the city's core. 9.

Care must be taken to insure activity in pedestrian areas, especially in the large scale projects as this proposed convention center. Therefore, the parking space for the center must be allocated to the proper location in the hierarchy of values.

"The capacity of a parking lot can be slightly increased by skimping on dimensions of stalls and aisles,....where skilled operators park the cars. But beyond this preliminary small advantage.... any further increase of parking density can be gained only at the expense of customer's waiting time."10.

Because of this truth as well as the increasing cost of labor, self-parking areas are preferred for this convention center. Also, the Indianapolis Off Street Parking Commission has indicated the growing trend of self-parking garages in the central business district. Therefore, generous stall and aisle space are a basic criteria.

9. Of course, the obvious solution is to place more emphasis on rapid transit and less on the automobile. However, this seems unlikely for sometime to come.

This program is a development from the suggested requirements by the International Association of Auditorium Managers to the Indianapolis-Marion Building Authority. The specific requirements resulted from a study of the functions proposed to occur within the center. An investigation of recommended standards, similar convention facilities, and building code requirements produced this outline program.

I. Coliseum

A. Public Space

1. Lobby
   a. Minimum of six ticket takers
   b. Minimum allowable exit width: 62'-6"
   c. Adequate in size to allow generous circulation space

2. Arena
   a. Level concrete floor with embedded refrigeration pipes
   b. Movable chair capacity: 2,500
   c. Clear of all visual obstructions
   d. Approximate size: 120' x 240'

3. Fixed Seating
   a. 6,000 persons
   b. Clear of all visual obstructions
   c. Minimum allowable seat spacing: 30" back to back, 18" wide
   d. No seat more than six seats from an aisle
4. **Box Office**
   a. Adjacent to manager's office
   b. Advance ticket seller: 100 sq. ft.
   c. Eight ticket sellers: 240 sq. ft.

5. **Men's Toilet Facilities**
   a. Minimum, twenty-two water closets
   b. Minimum, twenty-nine urinals
   c. Minimum, seventeen lavatories

6. **Women's Toilet Facilities**
   a. Minimum, thirty-four water closets
   b. Minimum, seventeen lavatories

7. **Ice Skate Rental Booth**
   a. 500 sq. ft.

8. **Concessions**
   a. Located on arena level
   b. Surrounded by generous open space

**B. Restricted Space**

1. **Manager's Office**
   a. Adjacent to box office
   b. Two small private offices: 120 sq. ft. each
   c. General office: 200 sq. ft.
   d. Toilet facilities
   e. Closet space
2. Platform
   a. No provision for scenery
   b. Approximately 1500 sq. ft.

3. Speaker's Lounge
   a. Adjacent to platform
   b. Closet space
   c. Approximately 300 sq. ft.

4. Platform Storage Room
   a. 500 sq. ft.

5. Men's Toilet
   a. Adjacent to platform
   b. One water closet
   c. One urinal
   d. One lavatory

6. Women's Toilet
   a. Adjacent to platform
   b. One water closet
   c. One lavatory

7. Bulk Storage Room
   a. Space for 2,500 chairs
   b. Space for packing crates and boxes
   c. 3,000 sq. ft.

8. Employee's Locker Room
   a. Fifteen lockers
   b. Toilet facilities
9. Home Team Dressing Room
   a. Twenty-five lockers
   b. Toilet facilities
   c. Gang type showers: five heads
   d. Equipment storage: 250 sq. ft.

10. Visiting Team Dressing Room
    a. Twenty-five lockers
    b. Toilet facilities
    c. Gang type shower: five heads
    d. Equipment storage: 250 sq. ft.

11. First Aid Room
    a. Toilet facilities
    b. 100 sq. ft.

12. Mechanical Equipment Space
    a. Circulating brine refrigerating system consisting of
       chiller, storage tank, and compressors
    b. Electrical distribution panels
    c. Air conditioning controls
    d. No boiler, city steam available
    e. Transformers and generators
    f. Approximately 3,000 sq. ft.

13. Lighting and TV Platforms
    a. Located near ceiling on three sides
    b. 160 sq. ft. each
14. Receiving Dock
   a. 25' wide
   b. Adjacent to flat arena
   c. Adjacent to storage space
   d. Located to provide off-street delivery

15. Janitor's closets
   a. Adjacent to all public toilets
   b. Slop sink
   c. 25 sq. ft. each

16. Ice Maintenance Storage
   a. Motorized ice plane
   b. Shovels and other equipment
   c. 200 sq. ft.

17. Snow Pit
   a. Adjacent to ice floor
   b. Approximately 100 sq. ft.

II. Meeting Rooms

A. Public Space

1. Meeting Rooms
   a. Flexible arrangement
   b. Twenty-five units
   c. Varying capacities
   d. 30,000 sq. ft.

2. Men's Toilet
   a. Minimum, nine water closets
b. Minimum, twelve urinals

c. Minimum, eight lavatories

3. Women's Toilet

a. Minimum, fifteen water closets
b. Minimum, eight lavatories

B. Restricted Space

1. Janitor's Closets

a. Adjacent to all public toilets
b. Slop sink
c. 25 sq. ft.

2. Mechanical Equipment Space

a. Electrical distribution panels
b. Air conditioning controls
c. Transformers and generators
d. No boiler, city steam available
e. 600 sq. ft.

3. Storage Space

a. Furniture, etc.
b. Organization's material
c. 500 sq. ft.

III. Exhibit Hall

A. Public Space

1. Exhibit area

a. 70,000 sq. ft.; rentable area
b. Minimum aisle width: ten feet

37.
2. Men's Toilet
   a. Minimum, nine water closets
   b. Minimum, twelve urinals
   c. Minimum, seven lavatories

3. Women's Toilets
   a. Minimum, fourteen water closets
   b. Minimum, seven lavatories

B. Restricted Space

1. Storage Space
   a. Packing crates and boxes
   b. Approximately 30,000 sq. ft.

2. Janitor's closets
   a. Adjacent to all public toilets
   b. Slop sink
   c. 25 sq. ft. each

3. Mechanical Equipment Space
   a. Electrical distribution panels
   b. Air conditioning controls
   c. Transformers and generators
   d. No boiler, city steam available
   e. 1,000 sq. ft.

4. Office
   a. 200 sq. ft.

5. First Aid Room
   a. Toilet facilities
   b. 100 sq. ft.
IV. Music Hall

A. Public Space

1. Foyer
   a. Must be on same level with back of main floor
   b. Minimum exit width: 35'-0"
   c. Maximum allowable floor slope; 1:10
   d. Minimum area 3,000 sq. ft.

2. Box Office
   a. Adjacent to manager's office
   b. Advance ticket seller: 100 sq. ft.
   c. Three ticket sellers: 90 sq. ft.

3. Lobby
   a. Minimum exit width: 35'-0"
   b. Three ticket takers
   c. Minimum area: 5,400 sq. ft.

4. Check Room
   a. Fifteen attendants
   b. Counter width: 45 ft.
   c. Adjacent to manager's office if possible
   d. 2,500 sq. ft.

5. Lounge
   a. Telephones near entrance
   b. Concession area within this space
   c. Possible exhibition space
   d. 24,000 sq. ft.
6. Men's Toilet
   a. Minimum, eight water closets
   b. Minimum, ten urinals
   c. Minimum, six lavatories
   d. Smoking room large enough to provide a private lounge

7. Women's Toilet
   a. Minimum, twelve water closets
   b. Minimum, six lavatories
   c. Minimum of five dressing table spaces
   d. Powder room

8. Auditorium Space
   a. Fixed upholstered seats
   b. Capacity: 3,000 persons
   c. Minimum seat spacing 33" back to back, 18" wide
   d. No seat more than six seats from aisle
   e. Clear of visual obstructions
   f. Special attention to acoustic characteristics

B. Restricted Space

1. Manager's Office
   a. Adjacent to box office
   b. Two small private offices: 120 sq. ft. each
   c. General office: 250 sq. ft.
   d. Toilet facilities
   e. Closet space
2. Usher's Room
   a. Twelve lockers
   b. Toilet facilities
   c. Two showers
   d. 250 sq. ft.

3. Stage
   a. Acting area, approximately 1,500 sq. ft.
   b. Stage size, approximately 120' x 60'
   c. Adjacent to receiving dock and workshop with large sliding fire door opening (minimum, 8' wide)
   d. Traps over majority of acting area
   e. Flying light gallery above proscenium
   f. Fly gallery at side and 30' above stage
   g. Overhead gridiron, three times \( \frac{\text{height}}{\text{height}+\text{height}+\text{height}} \) of proscenium opening
   h. Loading gallery, 6' below gridiron
   i. Proscenium wall of not less than four hour fire resistive construction
   j. Proscenium opening equipped with a self closing fire resistive curtain
   k. Proscenium wall may have in addition to the main opening, one opening at the orchestra pit level, and an opening at each side, each of which shall be not more than twenty-five sq. ft. in area.

\[ k1. \]
1. Must have direct access to the outside by a minimum of 3' wide passageway on each side of the stage

m. Electrician's switchboard, approximately 12' wide and 7' high, located at the side and 7' above the stage

n. Stacking rack for flat scenery

o. Cyclorama

p. Portable stage covering for sound reflections

q. A fusible link roof ventilator opening above the center of the stage area, minimum area: 300 sq. ft.

4. Orchestra Pit

a. Equipped with elevator floor to change to auditorium floor or forestage

b. 850 sq. ft.

5. Electrician's Store Room

a. Storage of electrical equipment

b. Adjacent to workshop and storage area

c. 200 sq. ft.

6. Green Room

a. Lounge facilities for thirty-five persons

b. Small kitchenette

c. Adjacent to stage

d. 1,500 sq. ft.

7. Office Dressing Rooms

a. Adjacent to stage
b. Used by director, producer, and stage manager
c. Each room with a lavatory
d. Three rooms: 400 sq. ft.

8. Private Dressing Rooms
   a. Adjacent to stage
   b. Each room with a lavatory
c. Twelve rooms: 120 sq. ft. each

9. Chorus Dressing Room
   a. Five rooms; 300 sq. ft. each
   b. Ample closet space
   c. Three lavatories in each room
d. Two full length mirrors in each room

10. Stage Doorkeeper's Room
    a. Adjacent to stage entrance
    b. Telephone booth
    c. Letter rack
    d. 50 sq. ft.

11. Trunk Room
    a. Adjacent to stage doorkeeper's room
    b. 100 sq. ft.

12. Stage Toilets
    a. Adjacent to each chorus room
    b. Two water closets each
    c. Three showers each
d. One bathtub each
13. Wardrobe Room
   a. Closet space
   b. 500 sq. ft.

14. Library and Board Room
   a. Location arbitrary
   b. 300 sq. ft.

15. Archives Room
   a. Adjacent to library and board room
   b. 100 sq. ft.

16. First Aid Room
   a. Toilet facilities
   b. 100 sq. ft.

17. Staff Locker and Toilet Room
   a. Lockers for thirty men
   b. Small lounge area
   c. Two water closets
   d. Two urinals
   e. Four lavatories
   f. Five showers
   g. Approximately 450 sq. ft.

18. Musician's Locker and Toilet Room
   a. Lockers for Seventy-five musicians
   b. Instrument storage cabinets
   c. Three water closets
   d. Six urinals
e. Six lavatories
f. 900 sq. ft.

19. Conductor's Dressing Room
   a. Closet space
   b. Toilet facilities
   c. 100 sq. ft.

20. Workshop
    a. Adjacent to stage and receiving dock
    b. 30' minimum ceiling height
    c. Ceiling track system on 15' centers
    d. Carpentry area
    e. Painting area
    f. 6,000 sq. ft.

21. Painter's Office
    a. Adjacent to workshop
    b. 80 sq. ft.

22. Paint Storage Room
    a. Adjacent to workshop
    b. Slop sink
    c. Small stove or hot plate
    c. 80 sq. ft.

23. Property and Storage Room
    a. Cabinet space
    b. Closet space
    c. 6,000 sq. ft.
24. Mechanical Equipment Room
   a. Electrical distribution panels
   b. Air conditioning controls
   c. Transformers and generators
   d. No boiler, city steam available
   e. Approximately 2,500 sq. ft.

25. Control and Projection Booth
   a. Toilet facilities
   b. Rewind room: 40 sq. ft.
   c. Generator room: 50 sq. ft.
   d. Projection room: 250 sq. ft.
   e. Vented to outside
   f. Two exits with fusible links

26. Janitor's Closets
   a. Adjacent to all public toilets
   b. Slop sink
   c. 25 sq. ft. each

27. Receiving Dock
   a. Adjacent to stage and workshop
   b. Located to provide off-street delivery
   c. 25' wide, 15' high

V. Car Parking

A. Public Space

1. Parking Facilities
   a. Covered garage for a minimum of 1000 cars.
b. Self parking facilities

2. Cashier's Booths
   a. One per exit lane
   b. 25 sq. ft. each

B. Restricted Space

1. Office
   a. Adjacent to cashier
   b. Vault
   c. Closet space
   d. 200 sq. ft.

2. Employee's Toilet
   a. Two urinals
   b. One water closet
   c. Two lavatories
OBJECTIVES...
It is my opinion that the truly talented designer is capable of making a poetic expression in architecture without sacrificing the basic realistic requirements of his society. At present, we have certain disciplines, mostly economic, that usually rule over the theoretical ideal. This proposed convention center program is a good example of these realistic requirements.

Immediately, the designer is aware of the conflicts of compromise that calls for a multi-purpose music unit capable of functioning as a theatre and movie as well. The fact that the coliseum will serve as a sports garden and a convention hall also restricts to a great extent the design possibilities. Nevertheless, the city of Indianapolis realizes its needs for these functions and is prepared to undertake the project. Thus, the architect is faced with the requirements of his society and must be willing to accept them as working parameters. This makes his problem far more difficult and challenging.

Successfully satisfying these needs of society into architecture is the real problem of the designer. Clearly then, this is the chief goal of my thesis subject.

Since certain initial design decisions will influence greatly the finished scheme, I have established these several objectives as a guide.

This is a public project that will serve as a landmark for the city. It must be beyond the purely utilitarian character and be a bold, poetic expression of substantial architecture. It
must be generous in its dimensions to satisfy these needs as well as those of large crowds.

"... in general, that all these community centres will have open areas for public gatherings, such as public squares and promenades."

The open plaza for pedestrians only is a basic necessity for this urban center.

A distinct separation of pedestrian movement, automobiles, service, and audience activity is a design goal. Visual clarity of the organization of these various elements within the project should be apparent to the pedestrian as well as the approaching motorist.

The various major elements of the center must be so arranged to allow for independent usage of the separate functions.

Finally, since this convention center is located within the central business district having the potential of being surrounded by high rise buildings, special consideration should be given to the design as seen from above.

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SOLUTION...