Innovative approaches to the design of symphony halls

J. Christopher Jaffe

Jaffe Holden Acoustics, Inc.,
114A Washington Street, Norwalk, CT 06854 USA

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1. Introduction

There have been two new and innovative developments in concert hall acoustic design related to our profession. One has been the advent of new technology such as CATT and ODEON computer modeling and auralization and Yamaha Acoustic Field Control-type orchestral enhancement systems and the other is related to the one hundred years of experience that practicing acousticians have gained in the process of designing hundreds of symphonic venues such as concert halls, recital halls, multi-use concert halls and symphonic music pavilions. Although much of the new technology developed by scientists and academics has been reported and recorded by acoustical societies throughout the world, the practical experience of professional acousticians has not been well documented. This paper presents two new and innovative concert hall design approaches developed by Jaffe Holden Acoustics based on experience gained by working on tunable symphonic concert enclosures in Multi-Use Halls and One-Room Concert Halls over the last forty years.

2. Stage platform reverberation chambers

The use of reverberation chambers to vary the symphonic acoustic environment in a multi-use or one-room concert hall that must accommodate a variety of program presentations has proven to be extremely successful. In our work, we have advocated using spaces closest to the source (the orchestra itself) as the preferred way to implement this technique. By developing reverberation in a contained volume close to the source, one can increase the sound level of early reverberation in a hall, as well as extend the overall reverberation in an audience area having shorter decay times.

2.1. Multi-use concert halls and the concert hall shaper

In Multi-use concert halls, one can use the stage house as the coupled space having the longer reverberation times. In the nineteen sixties when many orchestras in the United States were playing in vaudeville/movie houses that were built in the nineteen twenties and thirties, it was possible to use the stage house in this manner. These theatres had hard and dense concrete or filled and sealed block walls with a volume of 7,500 to 8,000 cubic meters, allowing us to successfully increase mid and low frequency reverberation times in these facilities [1,2].

The demountable shells designed for these halls had tunable ceiling reflectors suspended from the stage house grid. These panels were placed parallel to the proscenium and located above the different instrumental sections of the orchestra. There were individual panels for the string, woodwind, and brass and percussion sections of the orchestras as well as one for the chorus when required. The panels were approximately 1.8 m wide and spaced approximately 0.07 m apart. One could further increase the coupling interface by placing a sound transparent scrim curtain in the opening between the bottom of the hard plaster proscenium wall and the edge of the first downstage shell panel. Shells of this design were successfully used by the Cincinnati, Detroit, and Pittsburgh Orchestras in the nineteen sixties (See Fig. 1).

However, in the late seventies and eighties, new multi-use concert halls were being built with larger stage houses (12,000 cubic meters) and other local constituent groups, such as the ballet and the opera, began sharing these spaces with symphony orchestras on a regular basis. Building managers were scheduling orchestra rehearsals in the morning, ballet rehearsals in the afternoon and a symphony concert that same evening. Scenery for the ballet was stored in the stage house during orchestral rehearsals and concerts and the stage house volume became an absorptive space rather than a reverberant one (See Fig. 2).

For this reason, a different approach to stage house coupling had to be developed and this led to the concept of the Concert Hall Shaper, an adaptation of the techniques used earlier for the presentation of orchestras in the smaller volume stage houses of the old vaudeville/movie theatres. The Concert Hall Shaper is a second ceiling that is positioned in the stage house that cuts off the upper volume of the stage house leaving a lower volume of 7,000 cubic meters, an amount similar to the volume of the old vaudeville theatres (See Fig. 3).

The Shaper is constructed of a hard dense material and incorporates orchestral ceiling reflectors and musician's reading lights as an integral part of the assembly. The unit carries its own winches which raise and lower the shell reflectors and the orchestral lighting fixtures. It takes a little over an hour to set and strike this device providing hall managers complete flexibility of scheduling (See Figs. 4, 5, 6, and 7).

Concert Hall Shapers were designed for Hall C at the Tokyo International Forum, The Bass Hall in Fort Worth Texas and the Oklahoma Civic Center Music Hall in Oklahoma City. The Concert Hall Shaper is an excellent example of an innovative adaptation of a technique that worked so well in the older and smaller vaudeville/movie houses of a different era (See Fig. 8).
2.2. One-room concert halls with reverberant chambers [3]

In one room concert halls we create reverberant chambers left and right of the orchestra platform to couple directly into the hall. Adjustable grilles are cut into the walls surrounding the orchestra platform to accommodate different sized ensembles. The chamber grilles can be completely closed for amplified popular music performances (See Figs. 9 and 10).

3. Orchestra moved forward into the hall

All one-room concert halls have the orchestra and the
audience in a single space. In the multi-use concert hall, the orchestra is traditionally placed behind the proscenium arch in some form of acoustic enclosure. In most situations, unless a Concert Hall Shaper is employed, conductors have been known to complain that they feel like they are playing in a separate acoustic space from that enclosing the audience.

To counteract this problem, we began to design new halls so that a major portion of the ensemble was placed on pit lifts forward of the proscenium. The low powered strings and woodwinds as well as the conductor were now located in the same space as the audience. True, the brass, horns and percussion were still behind the arch, but due to the higher power levels of these sections, the feeling of a second room does not occur. Care must be taken in the design of the hall, since this technique places audiences for other events farther away from the stage and increases the steepness of risers in balconies to obtain proper sight lines. (See Figs. 11, 12)

The success of a classical music venue is dependent on the qualitative judgments of the musical community which includes audiences, artists, and professional music critics.
Measurements taken by acousticians of the characteristics of concert halls are only valid to the degree that they match subjective qualitative judgments. This correlation was brilliantly understood and brought to the attention of the scientific community by Leo Beranek.

In order to validate the innovative approaches to concert hall designs described in this letter, we are listing both quantitative and qualitative data and comments which support the fact that halls incorporating these designs have proven to be acoustically excellent for symphonic presentation.

Comments from Critics/Owner/Users on Halls designed with these new innovative approaches:

**Weidner Center — Multi-Use Proscenium Theater — Orchestra Platform Forward**

“We have one of the dozen or so best halls in the country from the standpoint of acoustics.”

Dr. E. Weidner, Dean Emeritus, Univ. Wisconsin — Green Bay

**Kennedy Center — Concert Hall — One Room Rectangular Shoe Box**

“It is truly a room in which all Americans can enjoy music under ideal conditions.”

Lawrence J. Wilker, President, John F. Kennedy Center

**Bass Hall — Multi-Use Proscenium Theater — Concert Hall Shaper**

“Bass Hall is one of the great concert halls this century.”

William Little, Music Critic, Toronto Star

### Table 1 Comparative Measurements of Original Beranek Criteria of Halls using new innovative design directions with three of the world’s great traditional rectangular concert halls [4]. Quantitative Measurements of Multi-Purpose and Single Room Concert Halls Described Above:

<table>
<thead>
<tr>
<th>Hall</th>
<th>RT-mid (Lateral)</th>
<th>Bass Ratio (Overhead)</th>
<th>ITDG (Lateral)</th>
<th>ITDG (Overhead)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weidner Center*</td>
<td>1.8</td>
<td>1.2</td>
<td>44</td>
<td>30</td>
</tr>
<tr>
<td>(orchestra platform forward)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kennedy Center*</td>
<td>1.8</td>
<td>1.1</td>
<td>33</td>
<td>40</td>
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<tr>
<td>(orchestra platform chambers)</td>
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<td></td>
</tr>
<tr>
<td>Bass Hall**</td>
<td>1.9</td>
<td>1.1</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>(concert hall shaper)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vienna***</td>
<td>2.0</td>
<td>1.1</td>
<td>16</td>
<td>40</td>
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<td>Amsterdam***</td>
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<td>40</td>
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<tr>
<td>Boston***</td>
<td>1.9</td>
<td>1.0</td>
<td>25</td>
<td>35</td>
</tr>
</tbody>
</table>

* Measured Unoccupied 1992—Calculated Occupied Beranek/Hidaka, ASA Vol. 104
** Measured Unoccupied—Calculated—JHS Δ Measurements, April, 1998
*** Measurements taken from Beranek’s Survey 1962

### 4. Summary

This letter documents the fact that the use of reverberation chambers close to the orchestral platform or moving an orchestra forward into a portion of the audience seating area will enable a multi-use proscenium theater to develop a symphonic aural environment comparable to the most respected concert halls in the world.

In addition, the technique of using reverberation chambers close to the orchestral platform in one-room concert halls can enhance early and late reverberation in rooms having reverberation times several tenths of a second short of optimum.

### References


