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The Acoustic Design of Partially Enclosed Orchestra Pits - Preliminary Results.

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1. Introduction

Along with the tendency for more and more opera companies to insist on playing with the full complement of musicians as set out in the music score, it has become policy among the Arts Councils to encourage more regional touring. These trends have resulted in a number of orchestra pits being built or modified to a much larger size than was at one time customary. It is usually unacceptable to have the orchestra occupying a large portion of the stalls area, so the pit has to be recessed beneath the stage. Experience with these pits has shown that very severe problems can result from covering part of the orchestra, and that successful design is not yet understood. This paper reports preliminary observations and suggestions arising from the first few months of a research project aimed at producing design guidelines for partially covered pits.

2. Categories of People Affected by the Pit Acoustic

There are four sets of people involved in an operatic performance, each of whom experiences different needs and problems in relation to the pit.

2.1 Audience

So far two questionnaire surveys havebeen carried out, covering in total 1150 audience members at the Theatre Royal, Glasgow and The Playhouse, Edinburgh. The former typifies the horseshoe theatre type, seating 1500, and it now contains a large deeply recessed pit. The latter seats 2900 in a rectangular cinema auditorium, and has a large wide pit, only moderately recessed. (See Fig. 1).

These theatres are representative at the two main theatre and pit configurations in use at present, except for recently built theatres.

Despite the great difference between the theatres, a similar (and high) degree of acoustical satisfaction was expressed at both, except that 67% at The Playhouse thought the orchestra was slightly too loud or much too loud for the singers, compared with 32% at the Theatre Royal, and 29% considered that the brass or percussion dominated the sound excessively at The Playhouse, in contrast to 19% at the Theatre Royal. Audiences at theatres with orchestra pits are there primarily for a theatrical experience, not an acoustical one. As long as no major inadequacies occur, then it is probably not justified to expend a lot of design effort to achieve high spatial impression etc. Rather, thought should be given to those more closely involved with the pit and stage, i.e. the performers.

2.2 Singers

The principal need of singers is to be able to judge correctly their timing and intonation in relation to the other singers and the orchestra. The question of balance against the orchestra is often left to the conductor by the singers, since they are in a similar situation to a concerto soloist who expects his performance to be adjusted to by the orchestra rather than vice versa.

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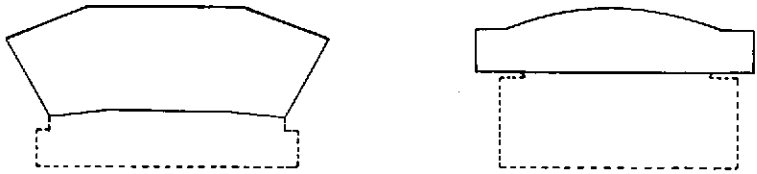
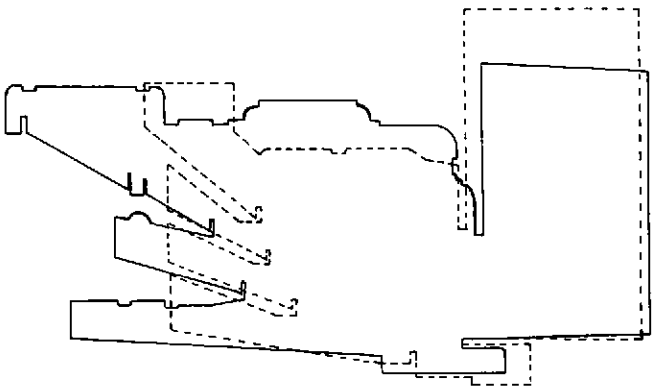


Playhouse (a) 1:300 Theatre Royal



(b) 1:400

Fig. 1: (a) Plan views of orchestra pits at Playhouse, Edinburgh, and Theatre Royal, Glasgow. (b) Comparative sections through theatres: solid line, Playhouse, dashed line Theatre Royal.

2.3 Conductors

The conductor has to try to assess the overall sound as received by the audience, and must be able to effectively direct the forces on and below stage to optimise it. This means he should ideally hear a sound similar to that received in the auditorium, a situation which is rarely obtained in any auditorium.

2.4 Musicians

The musicians are the people most intimately involved with the pit acoustic. They have to judge timing intonation and phrasing with each other and the singers, and try to achieve for the audience a good balance between the different elements of the music and song. The present study is predominantly concerned with the musicians, and the rest of this paper concentrates on them.

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3. Problems experienced by Musicians

3.1 Non-acoustical Factors

While some of the most critical difficulties are caused by acoustical inadequacy, a large part of the responsibility for pit musicians being a generally dissatisfied group lies with other factors. If these factors are not taken care of, the orchestra will often, even before the performance starts, be demoralised and poorly motivated. The main non-acoustical problems are:

(a) poor bandroom facilities;
(b) inadequate or unsafe access to players' seats, and precarious seat positions;
(c) poor or awkward view of conductor and fellow players;
(d) lack of space to play in comfort, confidence and safety (especially strings and percussion players);
(e) general lack of cleanliness below stage.

Some of these problems could be easily solved with a little more integration of orchestral facilities into the overall design and a little more investment. Non-acoustical factors must be kept constantly in mind. Solving them may highlight acoustic problems, and vice versa.

3.2 Acoustical Factors

Almost all pit musicians regularly experience excessive levels; those beneath the stage do so almost every time they play. As well as brass and percussion affecting everyone, the wind instruments are often uncomfortably loud for the rear string players. During a performance of Die Fledermaus (not an especially loud piece) at The Playhouse, peak levels of 107 dB(A) were recorded in the rear of the pit, and the Leq (5 minute) varied from 77 dB(A) to 99 dB(A). During the whole of The Cunning Little Vixen at the Theatre Royal the Leq (5 minute) never fell below 86 dB(A) in the covered part of the pit, and peak levels reached 110 dB(A). Many musicians complain that they cannot hear themselves when loud instruments are playing. To ensure accurate intonation and attack they play louder and louder, and the balance suffers. Alternatively they give up trying and play along without caring.

75% of players say they never or only occasionally feel sufficient rapport with the audience area. In the pit it is often not possible to gain any idea of how one's instrument is carrying to the auditorium. The conductor cannot always be telling everyone just how loud to play, and anyway he often suffers a similar problem.

When playing, musicians beneath the stage, supposedly accompanying the singers, often cannot hear them at all.

Although many early reflections are provided by the surfaces around the orchestra, the sound paths of direct and early reflected sound are often through a mass of absorbent bodies. Furthermore, the early reflections from the player's own instrument and his immediate neighbours may be so loud as to mask the quieter sounds from across the pit. It is not possible to provide the horizontal reflectors above the orchestra sometimes found in concert halls.

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In a low-ceilinged pit filled with highly absorbent bodies and poorly coupled acoustically to the auditorium it becomes very rarely that a musician gets enough support from the acoustic to feel his tone is satisfactory. R.T.s may be very short too, as little as 0.3 seconds in the Theatre Royal. With the very loud direct and early sound below the stage, one does not experience any feeling of reverberance in the normal sense. In the uncovered part, all the reverberance comes from the auditorium.

4. Tentative Suggestions for Improvements

While the study has so far been limited to two pits, a wide range of musicians' experiences have been gathered as well, and it is possible to make some general suggestions which might be borne in mind when designing pits.

The pit should have as much space and headroom as possible, and the surfaces should have more high frequency absorption than the usual surfaces provide. Local areas of absorbent should be considered around the brass and percussion.

Short of bringing the orchestra out of the pit altogether, there is little that can be done by natural acoustics. The most promising possibility is the use of feedback from the reverberant field in the auditorium distributed by low level loudspeakers in the pit. The level can be sufficiently high to add warmth to the pit acoustic without increasing the overall SPL, and it would help players to judge the effect in the auditorium of their playing. This method also seems to be the best way of alleviating the unnatural acoustic of the pit.

The effect of having reflecting front wall to the pit is usually minimal at the back of the pit. It is common practice to provide a relay from the pit to the stage for the singers. It might be helpful to provide one in the opposite direction, but the measured prescribed for excessive levels should also help.

Reducing the overall SPL within the pit should aid internal ensemble. Placing the orchestra on one level would also increase contact between the wind and strings.

5. Conclusions

The early part of the present research project has shown that severe problems exist, especially for musicians. In particular, those of excessive sound level and lack of contact require attention. Although, as yet, no detailed guidelines can be laid down, it is apparent that a number of measures not previously included in pit design should be considered. With a relatively small increase in finance for pit construction and rehabilitation it should be possible to make significant improvements. It has to be remembered, however, that in their present relation to the stage and auditorium, orchestra pits are bound to be very much a compromise, and all the participants will never be fully satisfied.

Acknowledgements

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