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AN ASSESSMENT OF THE ACOUSTICS OF THE GUILDHALL PRESTON

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1 INTRODUCTION

Plans for Preston Guildhall were drawn up in the early 1970's in response to the Department of Transport's proposal to build a ring road through the existing Public Hall. The Grand Hall was completed in 1972 with a brief to house choral and orchestral events and civic functions. Twenty five years later, thanks to a grant from the National Lottery, funds have become available to replace the aging seats. During this period the Hall has built a good reputation locally, and a major concern of the Borough architect is to ensure that the replacement seats will not diminish its popularity by altering the acoustics. However, the opportunity has also taken to carry out a more general acoustic evaluation and if possible to identify potential improvements.

The Hall is an elongated hexagon (figures 1-3), with the stage unusually on the long side, above which is a flown acoustic reflector (figure 3), apparently the largest in Europe when first installed. A key feature is the potential flexibility in the seating configurations due to the stackable seating. Three seating plans are frequently used, described broadly as "Stage" and "Sports Hall" settings (figures 1 and 2), and an "Arena" setting which is somewhere between the two. Additionally, there are numerous variations on these formats to suit particular circumstances. This flexibility is a crucial aspect of the success of the Hall, both because as Preston's only major venue there is a need to house a wide variety of local events, and secondly because of increasing commercial pressure to attract revenue from, for example, televised snooker and bowls. The Hall management has shown an impressive degree of imagination in accommodating a wide variety of events, and as the following list illustrates the current programme goes far beyond that envisaged in the original brief:

'Stage' format (2142 seats):	Orchestral, choral, brass band, rock, comedians, speech days, conferences
'Arena' format (1674 seats):	Rock, music festivals, snooker (televised),boxing/wrestling, exhibitions, dances, tattoo
'Sports Hall' format (1244 seats):	Bowls (televised), tennis, badminton, table tennis (televised), exhibitions.

The challenge for the acoustician is to optimize acoustic conditions for these highly variable activities. An assessment is underway at present including subjective evaluation based on interviews with users of the Hall, site measurement of acoustic properties and computer modeling.

2 SUBJECTIVE ASSESSMENT

Members of the Royal Liverpool Orchestra and Choir were interviewed and generally felt that, for a multi-purpose hall of its type, the acoustics are good. Possibly only Northampton Derngate is superior, and Derby Assembly Rooms is felt to be inferior. Not surprisingly, dedicated concert halls were preferred such as Blackburn, St George's Hall and Liverpool Philharmonic. The main criticism is that from a performer's viewpoint the Hall is "hard work". This was attributed partly to the relatively dry acoustics, and partly due to the open layout of the stage which leaves them with the impression of "playing into nothingness". The feeling of ensemble on stage was said to be relatively poor, with the sound not particularly well blended. Again, this would be due to the open stage layout. Singers too felt the Hall to be a good example of its type. Their main criticism was that they were physically too far apart from other members of the choir. They could hear the orchestra reasonably well, but some felt that the sound "didn't go anywhere" which is essentially consistent with musician's comments.

From this listener's point of view, the overall impression, was probably more favourable than the performer's comments would suggest. Generally the main criticism was lack of envelopment, which was attributed to the wide plan and the consequent lack of early lateral reflections. Seats at the rear of the floor seating also suffer a coloured sound which was attributed to the relatively poor sight lines to these seats. Generally, orchestral concerts have a loyal audience who comment favourably on the acoustics, and the Hall has a good reputation locally.

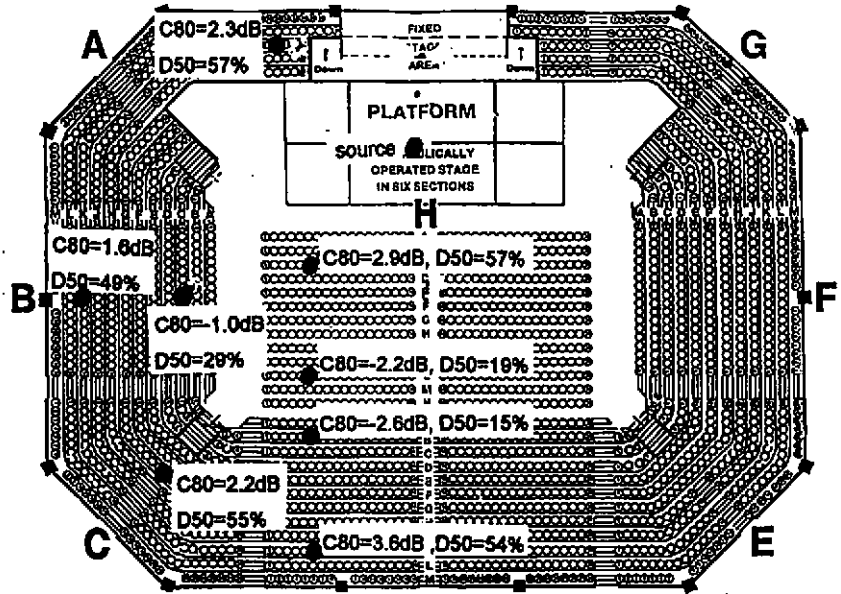

Figure 1: Seating plan in 'stage' format and measurement results

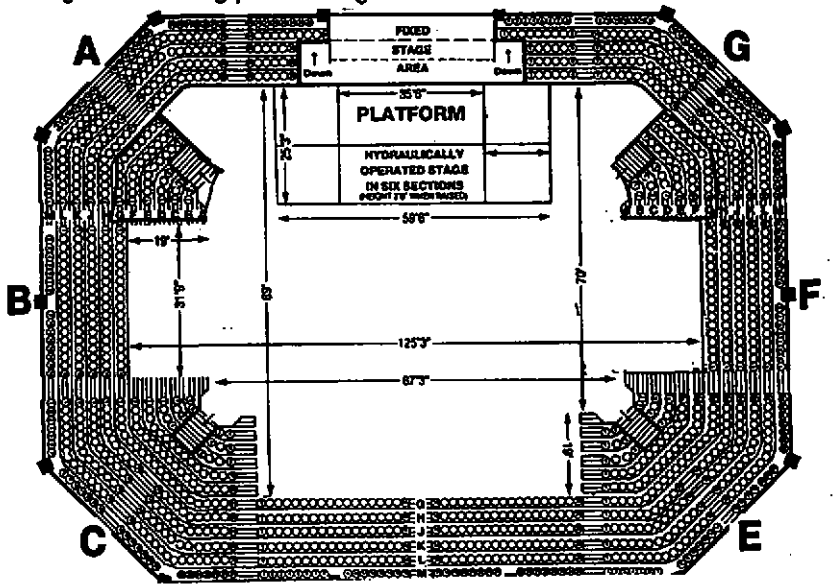

Figure 2: Seating plan in 'sports hall' format

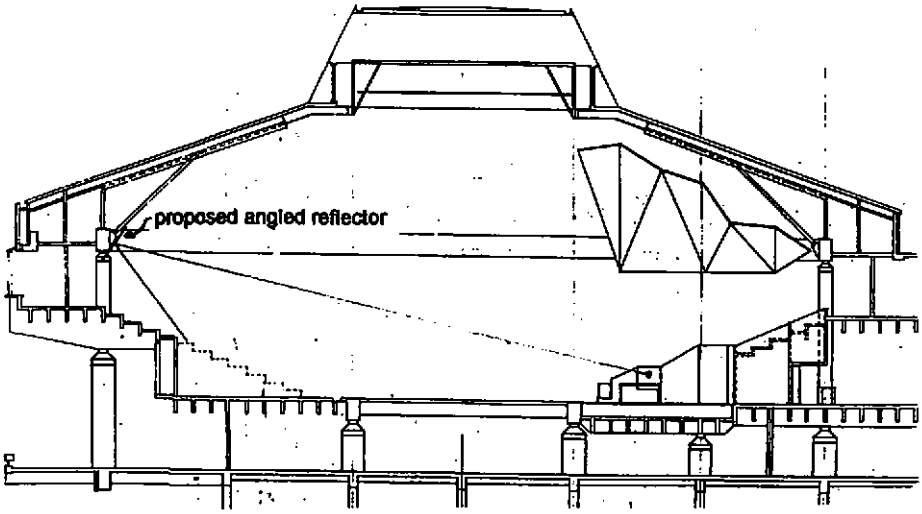

Figure 3: Section through Hall showing stage and acoustic reflector

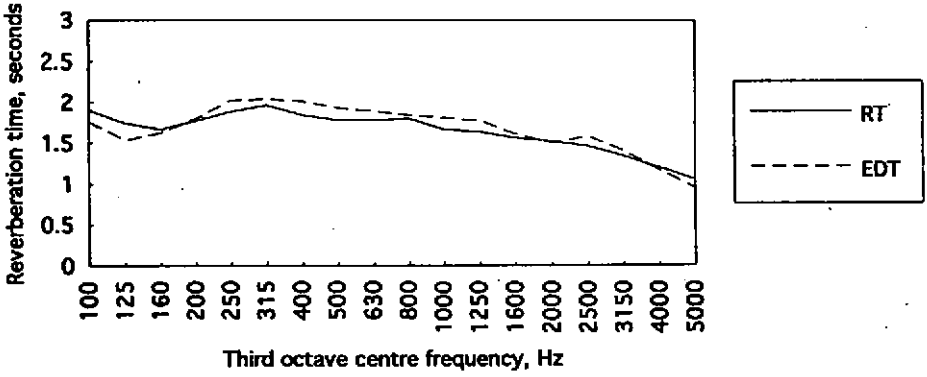

Figure 4. Measured RT and EDT

The sound manager for the BBC on events such as bowls, badminton and snooker, also felt the Hall to be a good example of its type, presenting no problems acoustically at present. A longer reverberation time than at present would tend to make things more difficult, and a shorter one would if anything make things slightly easier. Thus, acoustic treatment to reduce reverberance would be slightly beneficial. His main concern was a practical one, that any future acoustic treatment such as suspended absorbers should not impede suspensions for microphones, lights etc.

Of concern to the management were the occasional complaints of poor speech intelligibility during performances, particularly by comedians. The Hall was not originally designed for speech, but since comedians now form an important part of the programme it creates a strong incentive to improve the acoustics in this respect.

3 OBJECTIVE ASSESSMENT

Measurements were taken with the Hall set in 'stage' format. Seats were in the vertical position except for the first 7 rows of B, D and F blocks which were horizontal. Curtains beneath the balcony were drawn across the windows. The stage platform was in its raised position. Seats were unoccupied during the measurements. MLSSA software version 9.0: was used with a maximum length sequence signal played through an array of loudspeakers approximating an omni-directional source. Source and receiver positions are shown in figure 1.

Figure 4 shows the RT and EDT averaged over 8 audience positions. The average RT for the Hall is 1.75 seconds unoccupied, and the estimated value fully occupied 1.5 seconds. From these results one would expect reasonable if slightly dry conditions for music, and somewhat too live conditions for speech with some loss of intelligibility, which are entirely consistent with the subjective assessment above. Interestingly, the reverberation time at Northampton Derngate, which is judged as good or better by musicians, is 1.7 seconds (occupied) and at Derby Assembly Rooms, which is judged less good, it is 1 second (occupied) [1].

The results of the objective clarity (C80), and the early energy fraction (D50) are interesting, both showing a similar trend (figure 1). Close to the stage the values are above the recommended criteria [1] but decrease to a minimum at medium distance from the stage and then increase towards the back of the Hall. Thus, the seats in an arc covering the rear of the floor seating (the cheapest seats) and the front of the raked seating (the most expensive) have early energy ratios below recommended. The impulse responses (figure 5) help to throw some light on these findings illustrating that the first reflections to the seats inside this arc are weak and arrive too late to help speech intelligibility (figure 5 b and c), whereas seats in the

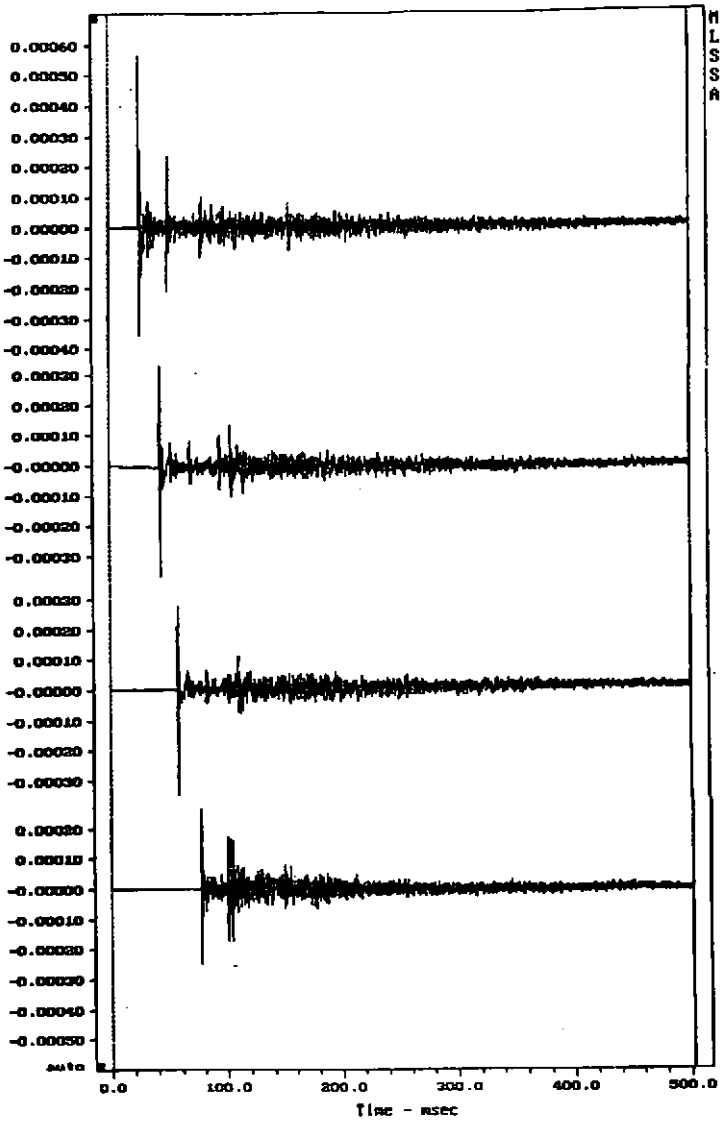

Figure 5: Impulse response functions (a) 4 m, (b) 11 m, (c) 15 m, (d) 23 m from front of stage

rear few rows are close enough to the ceiling to be getting useful early reflections (figure 5d), and those near the stage have a strong direct component (figure 5a).

4 COMPUTER MODEL

A computer model was built using Raynoise software package [2]. Early indications are that the model is proving particularly valuable in analyzing the role of the reflector above the stage, and results will be reported in more detail at the conference.

5 DISCUSSION OF RESULTS

In common with many multi-purpose halls of this type the main acoustic conflict is between un-amplified music and speech. The RT, at about 1,5 seconds is a compromise tending to favour music rather than speech, which probably reflects the priorities in the original brief. This compromise has served Preston remarkably well over the past 25 years, but it is not surprising that some problems have been experienced with speech intelligibility especially given the limited scope for providing early reflections. The main recommendation is therefore to improve speech intelligibility, without compromising concert performance. There appears to be scope for such improvements by introducing variable acoustics to optimize the RT for particular events, combined with modifications to the sound reinforcement system so as to maximise early energy ratios (the Hall is too large for unassisted speech).

The possibility of variable volume has been investigated but does not look promising. The management proposed a false proscenium in line with the front of the stage. However, this would not be of solid construction as at Northampton Derngate [1], but for practical reasons would have to consist of drapes. As such it would not reduce the effective volume of the space, and would unfortunately not allow a reduced volume 'theatre' setting suitable for unassisted speech.

The main scope for variable acoustics is to provide additional removable absorption in the form of additional drapes attached to a flying truss in the centre of the ceiling, or above the ring beam at eaves level. It is envisaged that these would be used for any events involving speech, amplified music concerts and televised events as appropriate. At present it is not certain whether drapes will provide sufficient low frequency absorption to maintain a reasonably flat RT, although in this respect the shape of the existing RT spectrum is reasonably favourable, with no low frequency rise (fig. 4) due to the relatively large area of wooden paneling. It may also be necessary to provide variable broad band or low frequency absorbers to keep the spectrum reasonably flat.

For use as a concert hall there is a little scope for increasing the RT by removing blackout curtains. The most critical aspect however, is considered to be to increase the early reflected sound as far as possible. In this respect the plan and section do not provide much opportunity. One promising idea is to add angled reflectors to the balcony fronts as illustrated in figure 3. This will certainly benefit seats at the top of the raked seating. However, the reflection path is too long to benefit the seats in most need, that is back rows of floor seating. The only other possibility for additional early reflections is from overhead reflectors, and the Hall management are understandably cautious about the reaction of their audiences, many of whom have been coming regularly to concerts since the Hall first opened, to such 'high profile' measures. The reflection paths from the existing large overhead reflector are directed more towards the back than the centre of the Hall, although with the benefit of impulse response and ray tracing techniques it now appears that seats in the centre of the Hall are more in need of such reinforcement. Again, the possibility of modifications to the reflector is treated cautiously by the management.

In order to improve conditions for performers on stage it has been proposed to incorporate low walls to the side of the thrust stage, although scope is limited by the need to maintain sight lines. The suspended reflector provides some feedback for performers as it was originally intended to do, but musician's comments about 'remoteness' suggest that stronger reflections would be preferable, and impulse response measurements taken on stage tend to confirm this. A lowering of the reflector has been suggested but it remains to be seen whether this will be taken up.

6. CONCLUSION

The key to current and future success of the Hall, as with those in many other provincial towns, is the flexibility to be able to cope with a wide variety of events. So far, this flexibility has not been restricted on acoustic grounds in that situations where events could not take place purely because of acoustic limitations have been avoided, but only just. Variable acoustics combined with careful sound system design seems to be the way forward, so that the acoustics can be made to match the event as closely as possible.

REFERENCES

[1] M BARRON, 'Auditorium Acoustics and Architectural Design', E & FN Spon, (1993)

[2] Numerical Integration Technologies, 'Raynoise'.