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ACOUSTIC IMPROVEMENT MEASURES FOR THE CENTRAL HALL, UNIVERSITY OF YORK

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INTRODUCTION

The Central Hall of the University of York has the unusual distinction that since it was built in 1968 it has not only had its acoustic modified electronically by the introduction of an Assisted Resonance system, but it has also had its natural acoustics altered.

This paper describes the main features of the recent acoustic improvement measures for the auditorium which consist of modifications to the installed AR system, provision of an overstage reflector, and treatment to surfaces to increase natural reverberation.

The Central Hall was designed as a multi-purpose building and is used for (1) lectures and conferences - major usage; (2) examinations - two or three weeks a year; (3) pop concerts - one or two a week during term time; (4) films - two a week during term time; (5) music - limited in the past due to acoustic difficulties.

The auditorium, which seats approximately 1,200 people, has been used successfully for most of these uses; however, its use for music was found deficient, as would be expected from the decision to design the Hall with a dry acoustic suitable for major speech functions. The original reverberation time was less than 0.8 sec at 500Hz when the hall was opened.

To retain this acoustic for speech but to have livelier conditions for music, an Assisted Resonance system was installed in the period mid-1972 to early 1974 by AIRO Ltd, with advice from BRE[1]. The system had three settings which allowed the reverberation in the hall to take on three increased levels from the natural acoustics. Initially, some of the audiences noticed considerable improvement for music performance; however, the performers themselves found little benefit from the system and their dissatisfaction has limited the capability of the hall to hold musical events. (Certain international artistes went so far as to state that they would never perform there again!)

Some small modifications were tried in the hall, but the problem stayed unresolved in the 'seventies. However, in late 1978 BAP were retained by the University to investigate fully the acoustic deficiencies and to prepare firm proposals for modifications to achieve conditions for professional and amateur use for as great a range of classical music performance as possible.

Feasibility Study

The study concentrated firstly on the difficulties experienced by performers in the hall, as audience response whilst not enthusiastic did not really

reflect many serious complaints. It was also apparent from the outset that cost considerations would be very important. The study consisted of evaluation of research on stage design, evaluation of past cases of remedied poorly rated stages of "proven" design, clarification of limits on stage development at York, and development of remedial options. Separate studies were also made of the AR system, and the PA system, as well as analysis of what improvement could be achieved in listening conditions.

It was found that the complaints by musicians that they were unable to hear either themselves or each other, and also the difficulty of trying to play in a room with such a dry acoustic, related to the absorbent woodwool slab ceilings and the fact that the stage area was designed as a rectangle thrust out into a semi-circle which contained raked seating, see Figures 1 and 2b. There were no reflecting surfaces in front of, above, or to the sides of any performer, see Figure 2a. Solutions considered were either to use microphones and loudspeakers to relay delayed sound to the musicians, or to provide reflecting surfaces around the stage (in this case, only practical above the players), or to re-site them within the hall so that they could benefit from existing or easily modified surfaces nearby.

After considering many related matters such as lighting, cost restraints, and visual satisfaction, BAP recommended that an overhead orchestral reflector be installed. They also recommended that improvements should be made not only to performing but also to listening conditions and that this should be done by means of major modifications to the Assisted Resonance system and adjustments to the finishes of certain of the hall's surfaces. These recommendations were accepted in principle and an initial assessment was made of the budgetary requirements.

The Remedial Programme

After a long period of consideration and budget acquisition, a grant was obtained from the Arts Council for the acoustic improvement measures, and official authorisation was given in early 1984. The specific aims of the programme were defined to be firstly, to develop useful reflections around the stage to allow musicians to hear themselves and others in various parts of the orchestra; and secondly, generally to improve all acoustics by increasing natural reverberation, improving the AR system, and providing surfaces to enhance the distribution of early reflected sound.

The three elements of the programme were installation of an overstage reflector, treatment of the ceiling woodwool surfaces to reduce acoustic absorption, and modifications to the AR system. In fact, after the fixed budget had been established, it was only found possible to proceed with the first two measures; the work on the AR system had to be severely reduced to little more than a re-tune of the system, taking into account the livelier natural acoustics, and an overhaul of the 72 channels, 20 of which were found to be faulty.

The Overstage Reflector

The final version of the overstage reflector is shown on the sections, Figures 2a and 2b, and the plan, Figure 1. The reflector consists of three elements: the rear reflector panel which provides reflections from the back to the front

of the orchestra and to some extent across the stage; the inverted trough central reflector, which provides cross-stage reflections; and the front pyramids which provide reflections back to individual performers to assist them to hear themselves. The philosophy behind this design[2] and its practical successful application was that it should be compatible with the architecture of the building as well as having to function as a vehicle for the lighting, which had to be suitable for stage conditions and when the hall was used for examinations. The acoustic design called for a slightly larger rear reflector and for additional smaller pyramids, as well as a special front reflector panel. The compromise achieved to meet all these aims is shown in the Figures.

Increasing Natural Reverberation

The dry acoustic of the Central Hall derived from its relatively small volume (7,000m³), the use of curtains in front of the glazed side wall corridor, and a large ceiling made of untreated woodwool slabs. The Client agreed that the curtains could be drawn back during concert performance so that the remaining problem was to find an acceptable treatment to the existing dusty woodwool slabs.

Various surface treatments were considered, including gypsum plaster, plaster boards on laths, metal sheets, plastic vinyl applications, and specialist acrylic paints. In nearly all cases, no acoustic information was available and there was considerable concern about the possibility of condensation if the surface was 100% sealed, as would have been acoustically desirable. The best solution seemed to be a sand/cement slurry with PVA, or a sort of pebble/cement treatment. However, neither of these seemed easy to implement in an existing auditorium with seating underneath.

At this stage the contractor, who had by this time been brought into the discussions, suggested a material that he had used externally - a polymer-based coating. Trials were made, and measurements commissioned in the reverberation chamber of the University of Salford of the acoustic absorption to see if this material would be suitable. The laboratory test showed that the high frequency absorption of woodwool would be markedly reduced. Based on this evidence (and the fact that this was the only practical option within the budget, plus a pressing time factor), it was decided to use it to coat the woodwool surfaces that were accessible. The cost of access was of course more than the cost of the material, as the building had to be scaffolded for the treatment, which had to be applied in three coats.

After the Improvement Measures

The measured reverberation time due to the natural acoustics has increased considerably, see Figure 3. The RT with assisted resonance is now compatible with that prescribed for good concert conditions. There is now also much less change in the natural reverberation time, ie percentage lift, and the system can operate without risk of feedback or undue colouration. The work on the AR system included repairing many faulty channels, and with less reliance on the system resulting from the livelier natural acoustics, the system is said to be operating very well. It is now noticeable when it is on, as opposed to off, whereas in the 'seventies it was difficult to perceive any significant difference. Impulse measurements have been made in the hall by Dr M E Barron, and it is hoped that

these will soon be available.

The initial subjective reaction of those who have known the hall since 1968 is that the acoustic modifications have effected a marked improvement. The first public performance in the Central Hall after some of the modifications had been carried out was a concert on 25 January by the Northern Sinfonia; at this stage the overhead reflector was in, but the Assisted Resonance had not been fully commissioned and was not in use. The conductor, Richard Hickox, wrote to the University after the concert, and after remarking how the previous year he had found the hall's acoustics "appallingly dry and unhelpful", went on to say:

> "I was delighted to find such an improvement in the acoustics during my latest concert. Suddenly the place has come alive and the players now find it grateful to perform in."

Subsequently, a regular annual event took place in the hall - a Gilbert & Sullivan performance - and comments reported were that the hall is now much nice to perform in and much better to listen in.

The definitive test came with a concert by the BBC Philharmonic on 7 March, by which time all the improvement measures had been completed. It is pleasing to note that not only did the recording engineers, with many years experience of the conditions at York, notice a significant improvement, but audiences and performers also were pleased with the acoustics of this multi-purpose hall.

The Yorkshire Evening Post's music critic, Martin Dreyer, who has attended music performances in the Central Hall over many years, wrote the next day:

> "I defy anyone... to say that the acoustical properties of York University's Central Hall are not vastly improved. The 80 players of the BBC Philharmonic Orchestra ... produced a rich sheen of gorgeous tone. The new acoustic is buoyant and lively. Instruments coalesce as never before."

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Acknowledgments

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References

(1) P H Parkin: Architects Journal 31 July 1974, pp 297-300
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(2) J G Charles, D B Fleming and J Miller: Applied Acoustics 18, 1985
The Hall of the University of Warwick (approved for publication)

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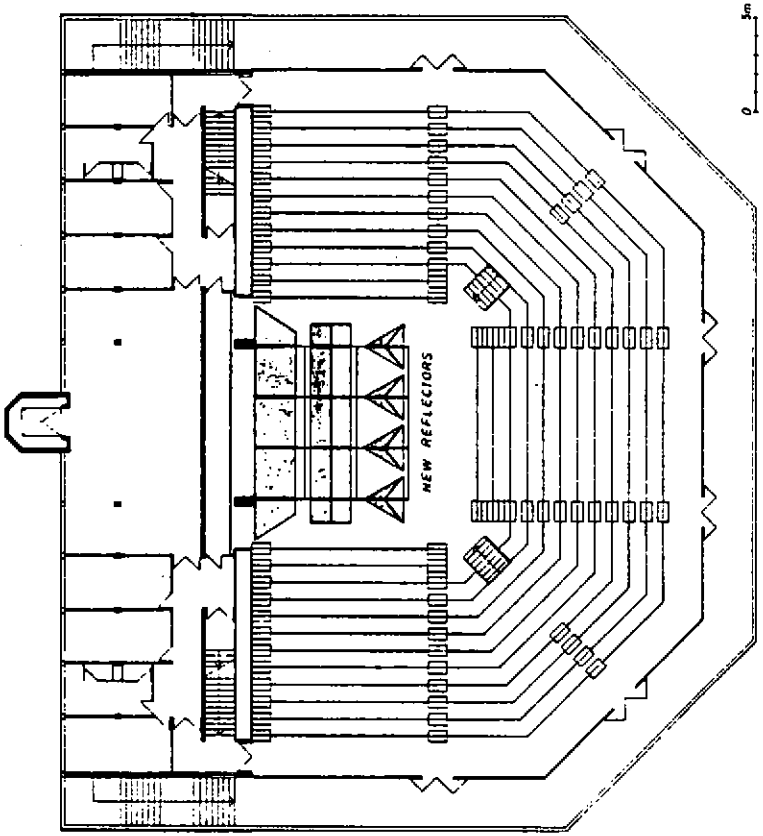

Figure 1: PLAN OF CENTRAL HALL

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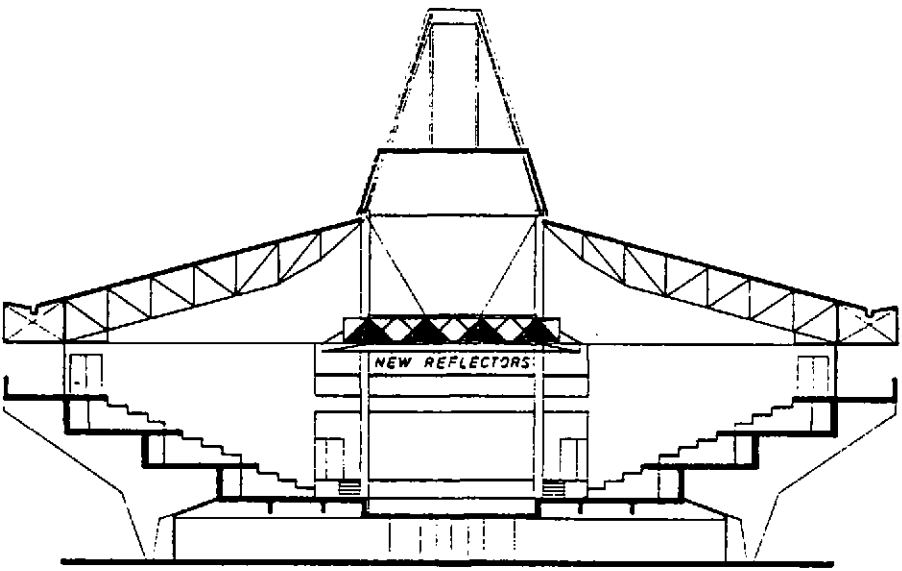

Figure 2a: SECTION ACROSS STAGE AND HALL

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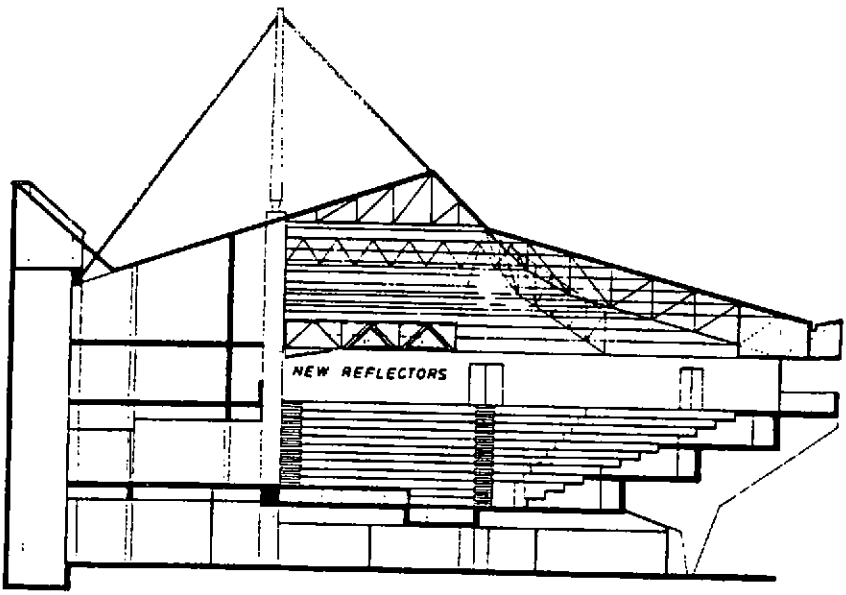

Figure 2b: SECTION THROUGH STAGE AND HALL

ACOUSTIC IMPROVEMENT MEASURES FOR THE CENTRAL HALL, UNIVERSITY OF YORK

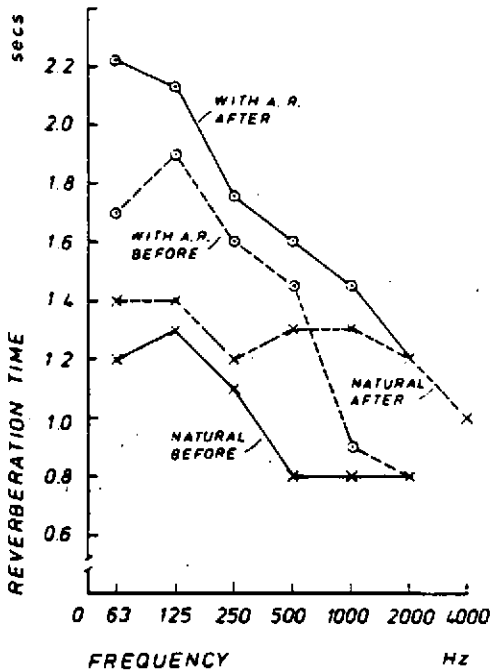

Figure 3: REVERBERATION TIMES