Proceedings of the Institute of Acoustics

AN 'ULTRA-LITE' AURAL ENHANCEMENT SYSTEMS. PRELIMINARY INVESTIGATIONS

Simon Kahn

BITS & PIECES, 105 Charlton Church Lane, London SE7 7AB

1. INTRODUCTION

The BBC Concert Hall, a grade II listed building in Art Deco style, was first used in 1932 as a venue for orchestral and chamber music concerts (figure 1). In 1994 it was agreed that the Concert Hall was under-used, and it was refurbished as a replacement for 'The Paris' studio in Lower Regent Street and renamed 'The BBC Radio Theatre'. The refurbishment, in consultation with English Heritage and Westminster Council, involved extensive acoustic treatment to make the 300 seat auditorium suitable for speech based programmes, reducing the reverberation time from approximately 1.5s to about 0.75, without affecting the original appearance (figure 2) [1][2].

The Concert Hall boasts a unique Compton pipe organ, whose grille provided a focal point of the auditorium. Since 1975 it has been maintained by the BBC staff club's Organ Society, who regularly play the instrument to prevent deterioration, and give four concerts a year. Unfortunately, when played at full volume, the organ can be heard in other studios, and this restricts its use.

The Organ Society were concerned that the new acoustic treatment would make listening to the organ unsatisfactory (they considered a reverberation time of 3s necessary for organ recitals), and were promised an artificial reverberation system to compensate for the changes and a sum of money set aside for this purpose. The organ society carried out a simple experiment using available equipment in the Concert Hall before refurbishment and accepted this offer.
After appointment as the technical contractor, the author was invited to propose a scheme. By this stage, there were no accessible cable routes to the ceiling, almost all the building work was complete and funds were extremely limited.

For the Organ Society's experiment, a Lexicon reverberator was used and liked, so the Lexicon LARES system was initially considered. Although much cheaper than other available systems [3], the cost of this system proved to be significantly beyond the clients budget and so it was decided to test an 'Ultra-Lite' system within the available budget, loosely based on the LARES approach and available speaker positions, to see if satisfactory results could be obtained.

2. DESIGN

The LARES system consisted of Lexicon 480 reverberators with LARC remote controller and

custom software algorithms, giving a total of 8 outputs for a stereo input [4]. A particular feature of this system is immunity from feedback over a wide range of microphone positions, but this feature is less important as the organ is fixed at the far end of the theatre. The same number of channels can be obtained by using 4 Lexicon 'Reflex' reverberators, which can be controlled by the MRC remote controller. Although these units are not as sophisticated as the 480, a wide range of parameters can be varied, including pre-delay and diffusion. A schematic diagram is shown in figure 3. The MRC controller is MIDI compatible raising the possibility of different settings being programmed for selection on the organ console !

As the organ is played regularly, a system requiring extensive rigging was impractical, so a separate permanent installation was required. The listed building conditions, and the main function of the Radio Theatre as a prestige audience studio, means that a large number of visible loudspeakers and cables would not be acceptable.

The loudspeakers used in the Organ Society experiment were 8 BBC LS5/8's, stood in the aisles, and facing away from the main audience. The cost of these loudspeakers would have exceeded the total budget, and inconspicuous mounting would have been impossible. A compact loudspeaker was needed which would deliver a reasonable amount of power. Tannoy CPA5 speakers offered an excellent balance of size, power, cost and fidelity, and these were selected for trial.

With limited loudspeaker positions, the use of inexpensive reverberators allows each speaker to have its own reverberator, increasing the overall diffusion of the system. With the organ as a single fixed source, one pair of microphones was used to drive all the reverberators. In other applications, individual microphones could be used for each reverberator. Another advantage of this system is that it can be seen as 'modular' so that a simple system can be installed initially with further channels added at a later stage.

Allowing for installation and distribution a scheme was proposed (figure 4) that was thought likely to achieve reasonable results for the specific application. This 'Ultra-Lite' system is not a LARES, nor even the unofficial 'LARES-Lite' demo system [3]. The cost of this proposal was still more than the earmarked budget and after some discussion, it was agreed to try out a system trimmed further with the reduced aim of restoring the reverberation time to the original (1.5s), rather than trying to approach 3s, and with a warning from the author that this trial may prove the need for more money.

3. DEMONSTRATION

For the trial system, microphones were fed into the existing SSL console which was used for equalisation and distribution to the various reverberators, and only the main parameters of the Reflex units were altered, without the use of the MRC controller, for simplicity, and the Tannoy speakers were fed from existing PA amplifiers.

A number of microphone positions were tried, with the best results obtained from the 'buttresses' on the ceiling, facing slightly in to the organ. Extended Neumann KM140 microphones were used as they could be temporarily fixed, although in another position the difference to the reverb output between these microphones and others was slight.

At ceiling level, 4 lighting bars were rigged with a number of stage lights, two over the audience. Small loudspeakers could be placed on these bars without upsetting the aesthetics of the auditorium. Placing loudspeakers at high level only may have created an impression of the sound rising to the ceiling, losing the focus on the organ. At approximately head height, the sides of the auditorium are oak panelled, with a series of relief sculptures by Gilbert Mayes. Between these, at the base of each 'pillar' was an access hatch with a small space behind, and a small wooden shelf above. It was agreed to try placing speakers inside these voids, with the shelf opened to allow the sound upwards.

One of the features of the refurbishment was the inclusion of a netting 'canopy' fixed over the auditorium, which for the demonstration limited access to all but one lighting bar. 4 CPA5 speakers were rigged from this bar, facing up to the ceiling. 4 CPA5's were also placed in the panelling voids, with the covers replaced but the top edge left slightly open, to simulate the proposed hole in the shelves. A further pair of CPA5's were placed on vertical lighting bars at the sides of the balcony, again facing the ceiling, making 5 stereo channels.

The installation was rigged, using temporary cabling, in an afternoon and initial settings made until 9pm when, after the news, the organ was played, and the system appraised by members of the Organ Society. Adjustments to the Reflex reverberators were limited to the front panel controls of 'decay' and 'delay'.

For reference, two B&K4006 microphones were rigged in the middle of the auditorium, about 2.5 m apart, and the output recorded to DAT.

4. RESULTS

The principle aim of the demonstration was to allow a subjective assessment from the Organ Society. The general response was that the system as demonstrated was satisfactory. In spite of the simple rigging with exposed speaker cables, the audience often had to be told where the speakers were. An acceptable length of reverberation was quickly agreed, and different microphone positions were tried to balance the various 'voices' of the organ and minimise mechanical and wind noise. Some time was then spent on balancing the different speaker levels for all parts of the audience. As a result it was thought that overhead speaker positions should be further forward, as originally planned.

Objective measurements were made by replaying the DAT recording through a B&K 2112 filter

to a B&K 2305 chart recorder. The sound source was a series of chords played on the organ, with the aural enhancement alternated on and off. The octave band and full bandwidth RT60 (measured over 30dB) (figures 5 & 6). At 63 Hz the signal was less than 40dB above background noise and the measured reverberation times are not reliable. At all other frequencies the results are the average of 3 readings from different chords. The unenhanced reverberation times are above the design target but this may be due to using the Organ as a sound source. Although valid for comparison with the enhanced system, these measurements should not be taken as the usual reverberation times of the Radio Theatre. Decay curves were generally even, indicating a diffuse sound field.

The enhanced measurements show a significant increase in RT's at 1kHz and below. Although the amount of reverberation was set by subjective assessment, the wideband RT∞ of 1.5 seconds meets the design criteria, but is less than the Organ Society believed was necessary at the design stage. There was little increase in 8kHz and 16kHz bands. This may be due to the ceiling loudspeakers pointing upwards, towards acoustic treatment.

As a result of this demonstration, a final specification was proposed which has been accepted, and an order has been placed for a system which will be installed when a suitable gap in recording bookings can be found.

5. COSTS

The final quotation, including installation, exceeded the original budget guideline, but the demonstration had shown that this expenditure was necessary and would achieve the required result. Guestimate equipment costs for the Lexicon LARES system are approximately £25,000 plus £10,000 site license [5]. The equivalent equipment costs for the 'Ultra-Lite' system are less than £10,000. Significant savings on the total cost could have been made if early planning had allowed for the necessary high level loudspeaker positions.

6. CONCLUSION

The demonstration was arranged because the author could not guarantee the performance of a system within the available budget, and the purchaser was unwilling to exceed the planned budget without a demonstration that this was necessary. The demonstration resolved this problem and showed that for a specific application, a simple aural enhancement could achieve acceptable results. In other applications, such as an orchestral concert in a more open and reverberant space, or where the system is to be built into a new design, a more sophisticated proprietary system such as Lexicon 'LARES' may be required. All too often nowadays, funds are simply not available for a system that the supplier can be sure will satisfy what are ultimately subjective criteria. By arranging a demonstration, systems which cannot be 'guaranteed' to work on paper can be tested and a satisfactory compromise found or an unsatisfactory installation

avoided.

The proposed 'Ultra-Lite' system offers an inexpensive 'entry-level' system with possibilities for expansion and the option to integrate with performances through MIDI control !

7. ACKNOWLEDGEMENTS

The author wishes to thank Allan Lockhead of Tannoy and Brian Binding of HHB, for equipment loan to support the demonstration, to the South Bank University for use of measuring equipment and of course the BBC for commissioning the demonstration.

8. REFERENCES

[1] R SLAVID, 'Refurbishment : Acoustic changes to a listed interior Architects Journal **202** 6 p31 (1995)
[2] R GODWYN, 'Make it sound like the Paris' LineUp **44** p28 (1995)
[3] S WISE, 'Acoustic enhancement becomes affordable' Sound + Comms Systems Intl **1** p27 (1995)
[4] D GRIESINGER, 'Improving room acoustics ...' AES Convention **90** Preprint 3014 (1990)
[5] HARMON UK LARES price list (1995)

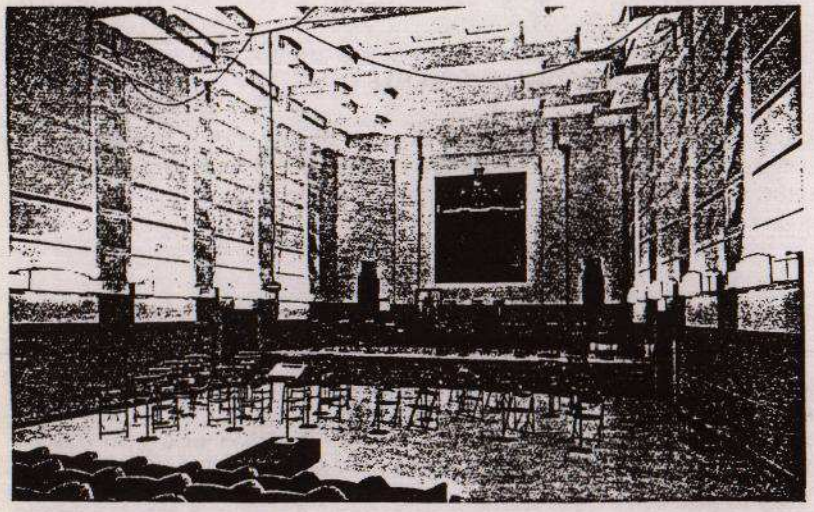

Figure 1 : BBC Concert Hall, Broadcating House, 1932

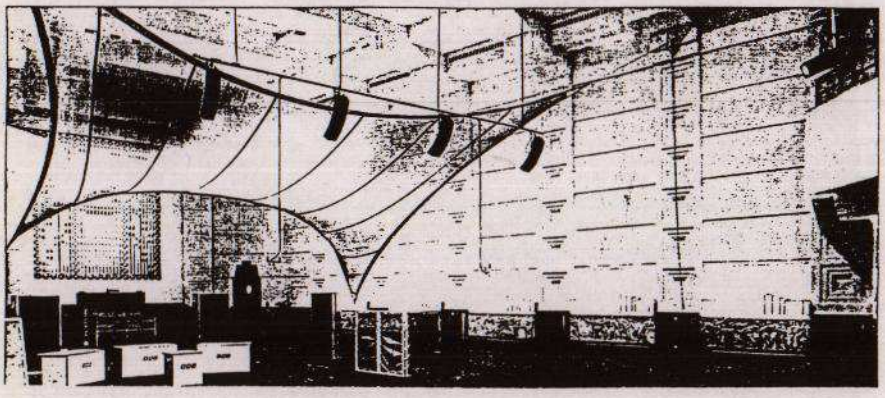

Figure 2 : Refurbishment as BBC Radio Theatre, Broadcasting House 1995

AN 'ULTRA-LITE' AURAL ENHANCEMENT SYSTEM

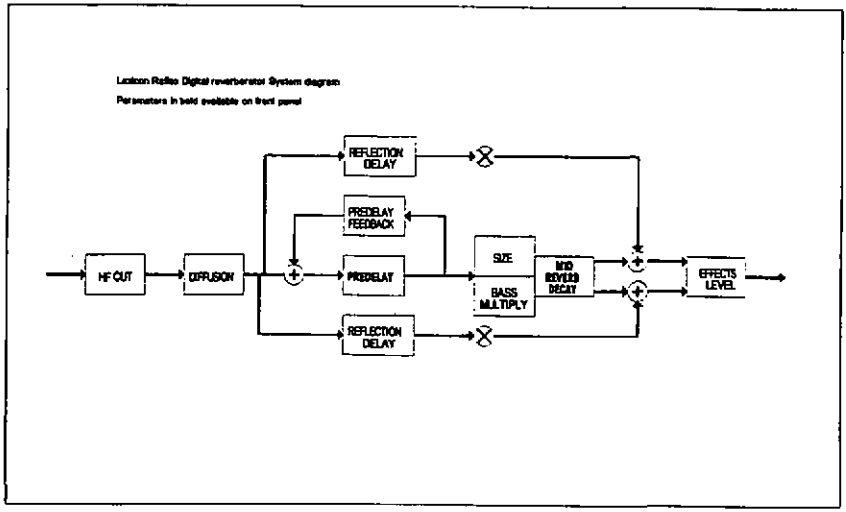

Figure 3 : Lexicon 'Reflex' reverberator functional diagram

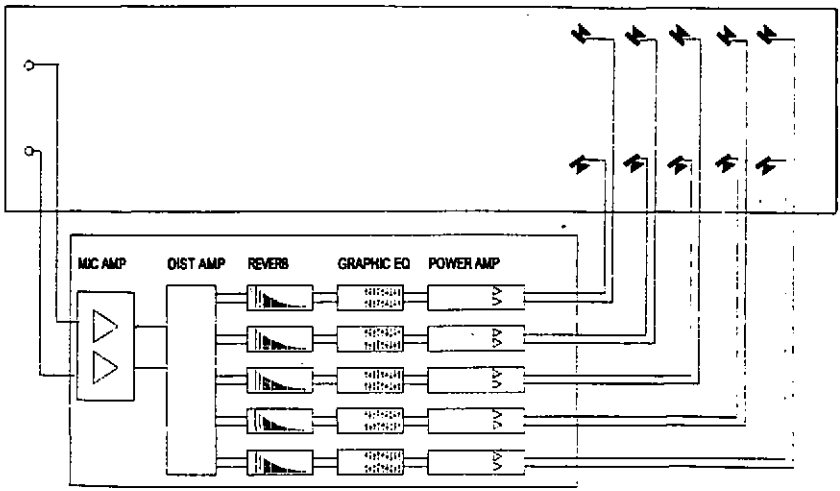

Figure 4 : 'Ultra-Lite' outline system diagram

AN 'ULTRA-LITE' AURAL ENHANCEMENT SYSTEM

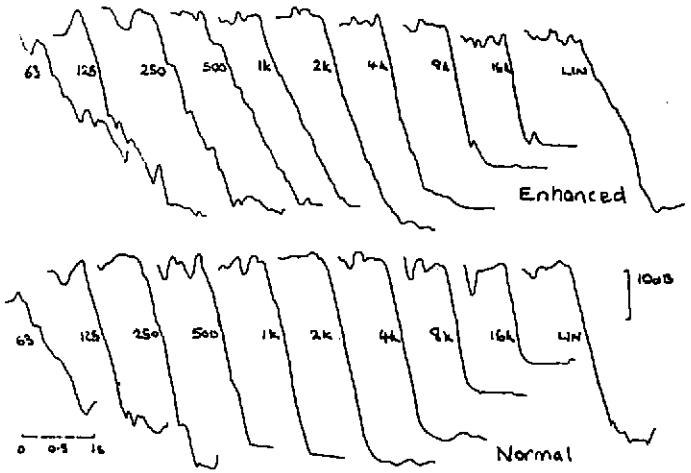

Figure 5 : Reverberation plots.

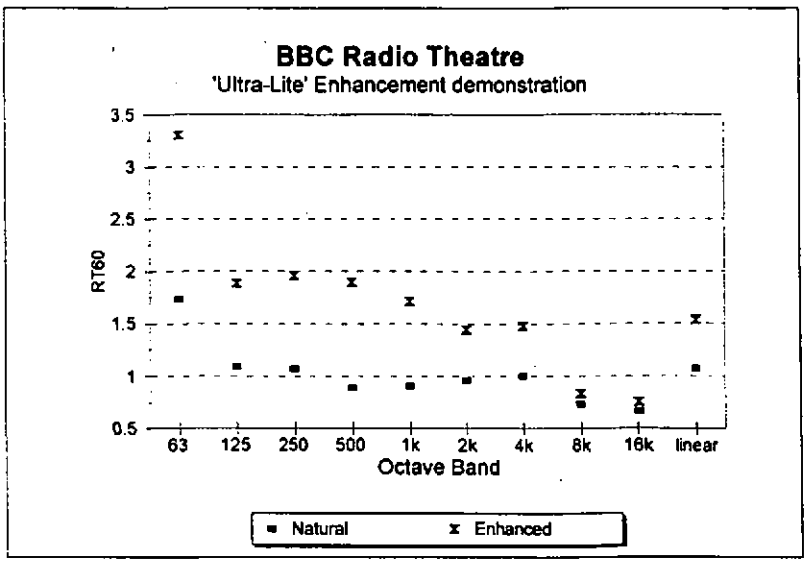

Figure 6 : Graph of reverberation times.