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ACOUSTIC ENHANCEMENT

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Acoustic enhancement is a term which is applied here to a means of improvement of the "warmth of response" of an auditorium by using a controlled pattern of electro-acoustic reflections. The author has been involved in the development of two such systems - a trial system for the Harrogate Centre and a system for the Newport Centre. This paper describes in outline some early findings of these attempts to find additional 'warmth of response' for multi-purpose spaces at reasonable cost.

Harrogate Centre

In the Autumn of 1984, we were asked by the management of the Harrogate Centre to evaluate the scope for improving the feel of the hall for performers and, if practical, the reverberant response of the auditorium (seating 2000) for the audience (see Fig 1).

The combined influences of concave curves in the initial planning of the hall, the intended wide range of use and the extensive sound reinforcement systems had produced a relatively 'dead' natural acoustic. Assisted Resonance was also installed, provided an extension of the room response and had proved valuable for many functions. However, it was felt that, if there could be yet further improvement, this should be examined. Performers expressed a wish for more 'response' from the hall and the geometry of the hall limited its potential for good listening to orchestral music - particularly the wide single tier plan form, which was important for conference use.

Four main options were considered:-

- Further modifications of auditorium geometry and acoustic treatment - conflicts of functional interests and financial implications discouraged this.
- Stretching and updating the AR system - a real option but scope for improvement was considered limited.
- Development of something new.
- A combination of something new with AR.

Based on reference to work on early reflection patterns and experience in the National Theatre and at Plymouth Theatre Royal of the 'liveness' which can be sensed under certain listening conditions where specific

late 'reflections' are produced, the author considered the potential for something new. Another component of the thinking at this stage was the possible benefit of using single reflections separated by time sufficiently to allow the number of reflections to be limited (limiting the building-up in level, limiting feedback and avoiding comb filter effects) without separating the reflections by so long a time as to allow the brain to find them audibly separate. There appeared to be a chance that a pattern of specific reflections (arranged by use of a multiple delay unit) fed into the auditorium from the right place, might make a useful contribution. A simple trial was arranged at the Harrogate Centre in collaboration with the Client and Bill Stevens of Acoustical Investigation and Research Organisation (AIRO). A crossed pair of AKG CK8 microphones were set on a bar forward of and approx 5 metres above the stage. Formula Sound wedge monitors were placed one each side of the auditorium at high level, directed at the seating (lateral reflections being in mind) and two at the rear on the front of the control balcony directed at the ceiling. Signals from the microphones were fed through the desk via KT DN70/DN700 delay lines and ½ octave equalisation (Formula Sound 519 GA). A KT DN780 Digital Reverberation Processor was also available.

With speech and singing, initial trials with the side loudspeakers (direct sound + 60ms delay setting) produced an immediate 'warming-up' of sound. Addition of further 'reflections' (90ms and 120ms) improved the results after adjustment to the EQ and relative level of the 'reflections'. It seemed prudent to direct mid-high frequency sound from the sides, low frequencies from the rear. Rear speakers were now brought in and the effect was dramatic, on stage and in the auditorium. Prolonged adjustments to delays, relative levels and EQ indicated that the beneficial effect was restricted to quite a limited zone of interaction of these variables. Nevertheless, substantial low frequency output from rear loudspeakers was possible without feedback. It was interesting to note that sound peaking locally around 1kHz was an important component of the equalisation. Side and rear loudspeaker outputs were then combined. With this combination very impressive results were achieved for both the performer and the listener in the auditorium. The addition of the digital reverberator, although providing a 'tail' to the sound, did not add much to the 'warmth' of the sound.

Encouraged by first attempts, further trials were carried out in February 1985. On this occasion, the effect of stage absorption was considered, an additional AMS 15-80 delay line was arranged, two additional loudspeakers were suspended over the side/rear seating. Four JBL twin 15" bass bins were set in the rear roof space to be tried as an alternative to the rear loudspeakers. An additional position for the microphone pair was tried (4 to 5m further from the stage, to cover part of the flat floor area). Using singing, speech and recorded music, trials led to a preference for use of the four lower rear loudspeakers with delays at 70ms, 110ms (-3dB), 160ms (-5dB) and 220ms (-10dB) combined with high front side loudspeakers on a single 30ms delay. After switching to the new microphone positions, a 1 to 2dB adjustment to overall gain restored the benefits. Combination of the system with the AR system was encouraging, the two apparently operating in a complementary

manner. This was reinforced by objective checks which indicated quite different characteristics. AIRO suggested use of regeneration, which they tried separately apparently with some additional benefit.

The effect of system off-on was an increase in mid-frequency RT of 15% in mid-stalls, 10% on stage, and an overall Lp increase of 1.5-2.0dB in mid stalls. Impulse response shows clear changes but not of the extent which might be expected from the scale of the subjective effect.

A trial with a school orchestra and in the presence of Harrogate councillors was received favourably by performers and audience. The possibility of a permanent installation is under consideration at the time of writing.

Newport Centre

A similar system has been introduced at the Newport Centre making use of elements of the show sound system. In this case, the hall is rectilinear, again seating approx. 2000 (see Fig 2). Absorbent treatment, to provide preferred conditions for a wide variety of functions, contributed to a short natural room response. Again, we received a request for investigation of the scope for improving the response for orchestral music and choral work. In this case, we were asked to move very quickly, to see whether we could produce improvement within a few weeks. Fortunately the building design had incorporated a show sound system with which we were very familiar.

A simple development of the principles applied at Harrogate was attempted, although the geometry of the Newport Centre called for modifications. A pair of AKG D190 microphones were set on a bar forward of and above the stage (in this case separately mounted, widely separated and directed across one another). The signal was fed through the mixer on four channels with separate KT time delays and Formula Sound EQ, remixed and fed to three JBL 4602 wedge loudspeakers which were set out across the rear lighting bridge.

An early trial involved feeding the delayed and equalised signal into the normal PA system. However direction of high frequency components on to the audience, as might be expected, produced undue awareness of reinforcement even at very low output levels. The wedge loudspeakers on the catwalk were then set to direct higher frequency components up to the ceiling and towards the stage. It was at this point that some success was achieved (see Fig 3).

Again, there were many adjustments to delays, EQ and relative levels. In an attempt to mimic the spectral change arising from long path reflections, a low frequency emphasis was placed on the channel with the longest delay. The relative levels of the third and fourth delays then became very significant. Finally the output of the channel with the longest delay was fed back through the other channels, then into the mix, producing a series of longer delayed signals (at reduced relative amplitudes). The delay and relative level settings were 66ms, 96ms (-5dB), 132ms (-10dB), 192ms (-8.5dB).

The benefit to 'warmth of response' was considered sufficient to warrant its use in rehearsal and then performances, from which very favourable comments were received (from performers and audience). The system is likely to prove a sufficient contribution to listening to permit extension of the range of performances. The capacity to achieve this with the elements of a simple show

sound system is encouraging for other cases where the need for some extension of the 'warmth of response' is called for at limited cost.

The time which has been available to pursue this development has been limited and Client requirements have not permitted the rigours of measured research to be applied. However, the progress made does indicate that there is a place for such systems. As ever, further work is needed, particularly in halls of differing geometry and perhaps in halls which are already more 'live'. In these cases too, there may be benefit from carefully tailored enhancement such as has been described here.

The author wishes to acknowledge the assistance of the staff of the Harrogate Centre and the Newport Centre, Rob Harris (colleague) and Bill Stevens of AIRO in these efforts.

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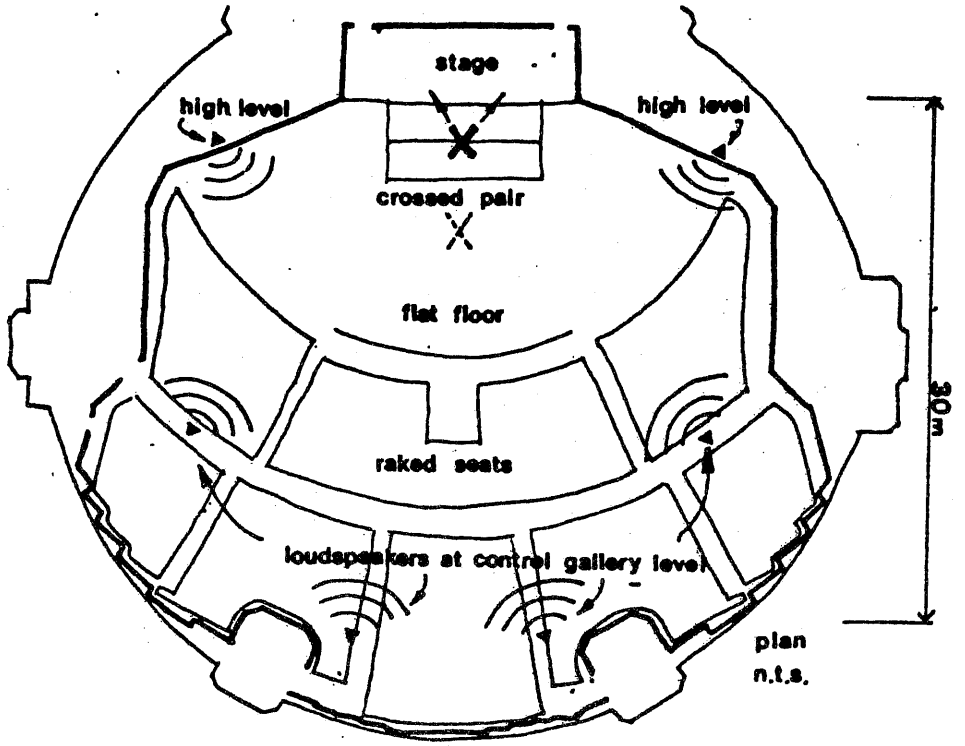

Fig 1. General Arrangement at Harrogate Centre

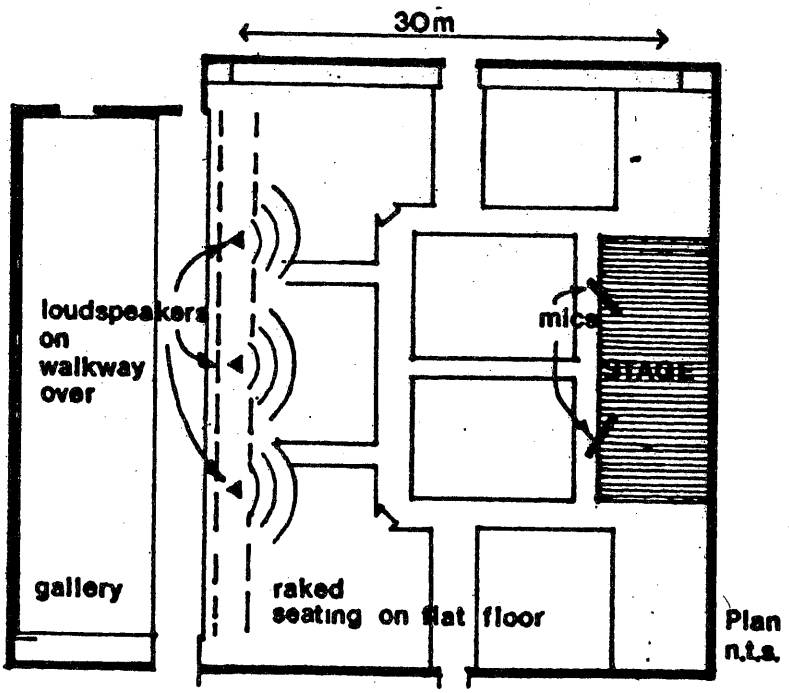

Fig 2. General Arrangement at Newport Centre

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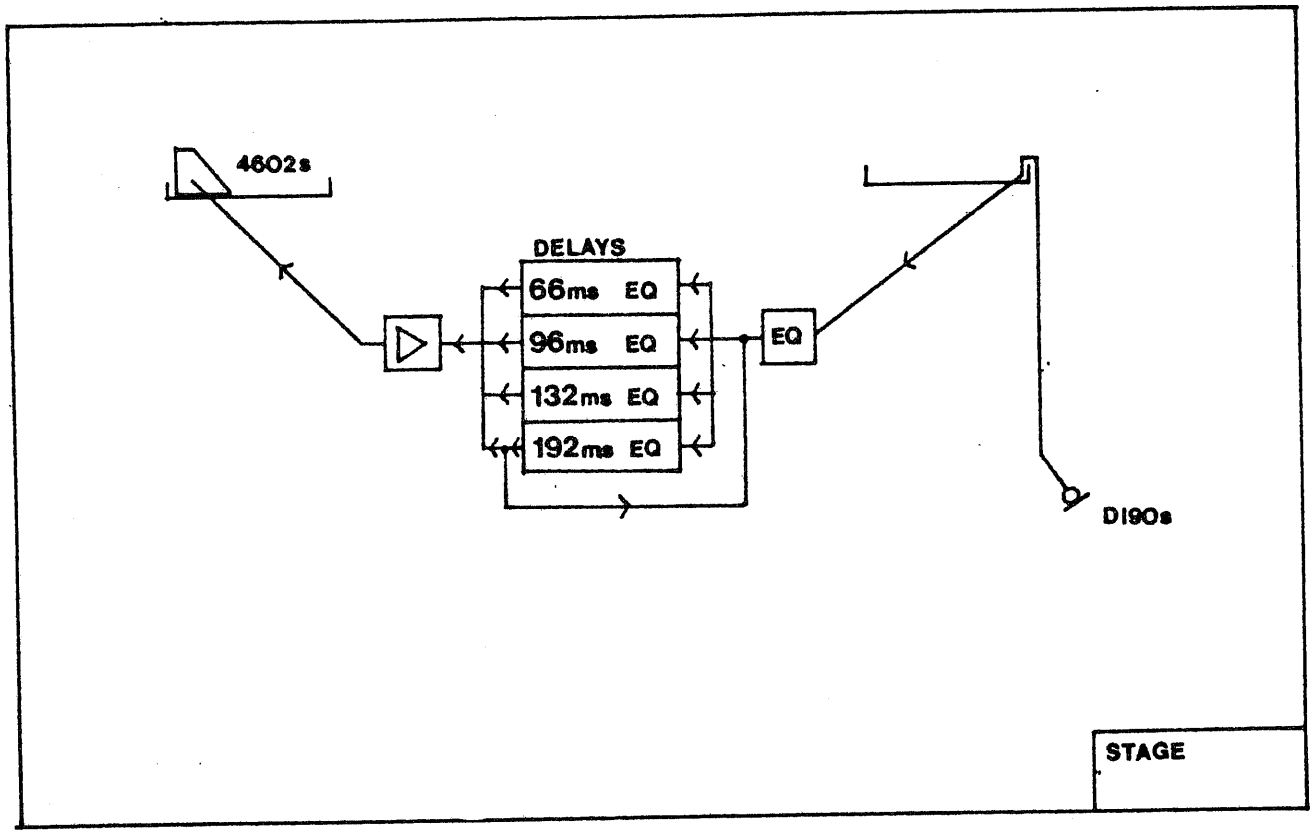

Fig 3. System outline - Newport Centre