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"THEATRE ROYAL, PLYMOUTH"

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This paper describes in outline the main features of the acoustic design for the main auditorium in the new Theatre Royal, Plymouth* with some notes on the smaller studio auditorium.

Sound Insulation

The building is situated close to a busy dual carriageway and roundabout in the centre of Plymouth. The need to limit disturbance by external noise has resulted in the use of dense blockwork walling and a prescreeded woodwool decking for roofing (which is partially screened by lower elements of the building), use of lobbies on exit doors and flaps on some smoke venting.

The two auditoria are well separated on plan. Even so, substantial attention has to be paid to means of limiting noise transfer between them via circulation routes. The need for a compact building also restricted the scope for separation of the rehearsal room from the main auditorium. However, substantial structure between the two allows mutual protection for all but the loudest activities. Space also restricted the scope for a buffer zone between the stage and scene dock and a 30 dB sound door was introduced primarily to act in series with the shutters to the loading bay to exclude external noise, at the same time providing nominal separation from the Scene Dock. Two sets of similarly rated sound doors were also used between the Scene Dock and the Studio Theatre. The main auditorium is substantially shielded from external noise by ancillary accommodation.

Main Auditorium

The main auditorium seats over 1,200 and is asymmetrical at stalls level. A moving ceiling may be lowered to link with the front of the upper circle and reduce the seating capacity to around 700 and reduce the scale of the space. The auditorium is intended primarily for drama but there was a requirement to satisfy the needs of other functions (including orchestral music).

Although a higher built volume was preferred, it became necessary during the progress of the design to reduce the size of the auditorium such that the volume per seat is only a little over $3m^3$.

The profile of the moving ceiling was developed to encourage overhead reflections. Model tests at 1:50 at Cambridge were used to refine this geometry to measure early energy fractions and to provide a further reference on likely reverberation response. Results indicated that the deep

* Acoustic consultancy for this project was carried out by the author at SRL and later in association with SRL.

balcony overhangs could be providing shielding of the seating, helping to keep the RT up in the main volume of the hall. Early energy was predicted to be very strong throughout the remainder of the auditorium.

To counter shadowing under the balconies, some electro-acoustic enhancement has been arranged in a form which is as passive as possible. The show relay feed (from a gunshot microphone over the front of the stage) is routed via delay to separately controlled rings of dual cone loudspeakers in the balcony soffits. This provides redress for loss of higher frequencies and 'fills out' the sound.

Acoustic treatment in the auditorium involves use of low pile carpet, limited areas of timber panelling, some modelling of wall surfaces alongside the stage and use of a slatted front to balconies allowing scope for local tratement if required.

To extend the scope for a variety of performances, a 90-channel Assisted Resonance system was selected. Tuned resonators in slots in the rear of the moving ceiling feed two rings of loudspeakers - one over the stalls, one over the front of the upper circle. Substantial advances in control techniques have been developed by AIRO and the system performance is currently being refined as musical events occur in the auditorium. Alternatively spaced between the show relay feed loudspeakers under the balconies are loudspeakers feeding all-channel Assisted Resonance into these areas.

A further provision for music on stage is a lightweight partial enclosure/shell. With such a low auditorium volume, the need for reinforcement of loudness in the audience is small. However, to encourage orchestral blend and to control the sound and visual aspects of playing within a very large fly tower, partial enclosure was considered appropriate. This was done using lightweight screens behind the orchestra (which in turn could be used at the rear of the orchestra pit) and an overhead diffusing panel set almost horizontal but slightly lifted towards the audience. The screens are formed from aluminium frames carrying stretched structural fabric held in tension like a drum skin. The overhead reflector is a pvc-coated polyester inflatable exposing convex curves on the underside and supporting orchestra lighting on lightweight framework.

This approach, in conjunction with orchestral rostra, will allow reasonable speed in setting out the stage - an important factor in an auditorium to be used for many other purposes. The deflated canopy is stored vertically in the fly tower. The results in acoustic terms appear to be good, although to date the number of musical events has been limited.

There is strong interaction between the very large stage tower and the auditorium. The influence of fly tower contents can mean a change of up to +0.7 seconds in the mid frequency RT even though a considerable quantity of absorbent fly tower lining has been provided. Although with a relatively empty tower, there is a significant double slope in the decay curve, this does appear to sound quite good and could possibly prove useful on occasions. The orchestra pit contains lifts allowing a range of layouts on plan and section.

Early indications are that the natural room acoustics will prove very good, although the building was only recently opened and much more experience is needed.

Aspects of the electro-acoustics in this auditorium are referred to in a separate paper at this conference.

Noise from services has been limited to levels just above NR20, using low velocity supply from above and extract from below the circle, from under upper circle seating and also at high level.

Studio Auditorium

This takes the form of an elongated polygon and is a simple blockwork construction with a roof soffit in woodwool slab permanent shuttering and a gallery at high level. Room response varies substantially with occupancy. Empty RT's are given in Table 1. Noise from services is designed to meet NR25.

TABLE 1. Measured Natural Reverberation Times (Unoccupied)

	OCTAVE BAND CENTRE FREQUENCY Hz.						
	125	250	500	1K	2K	4K	
Main Auditorium Fly Tower contents 'normal'	1.3	1.2	1.0	0.9	0.85	0.65	Seconds
Studio Theatre - shell (no seating)	1.5	1.5	1.3	1.25	1.2	1.1	Seconds

N.B. In the case of the main auditorium, the presence of an audience is found not to affect RT's by greater than 0.1 seconds for normal stage tower contents. Naturally, the Studio Theatre RT shortens to a degree subject to the extent of seating and scenery used.

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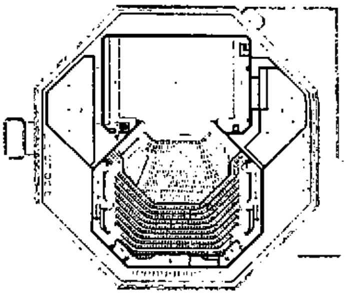

FIG. 1 Plan at High Level

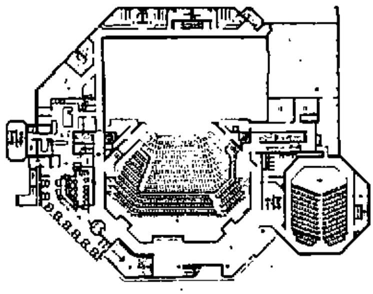

FIG. 2 Plan at Low Level

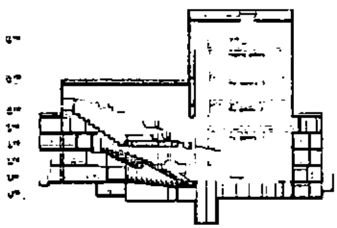

FIG. 3 Section Ceiling Down

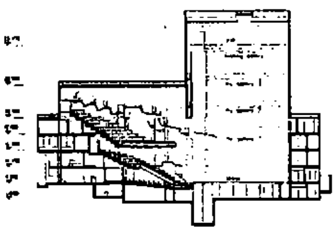

FIG. 4 Section Ceiling Up

Architect	:	PETER MORO PARTNERSHIP
Theatre Consultants	:	CARR & ANGIER
Structure/Services	:	OVE ARUP & PARTNERS