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ST. DAVID'S HALL, CARDIFF

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Summary

St. David's Hall is a new 2000-seat auditorium in Cardiff. This paper describes some aspects of the design during the period 1977-82 together with the results of some preliminary objective measurements. The prognosis based on these results appears to be extremely favourable for concert use. The first tentative subjective comments relating to the occupied hall with real musicians may be possible by the time of the Institute of Acoustics conference.

1. Introduction

Cardiff, the capital city of Wales, has long wanted and needed a hall suitable for use by the many musical groups that exist in that most musical of countries. Previous attempts to develop a Welsh National Arts Centre in the early seventies failed when a commercial developer pulled out.

The opportunity to acquire a large auditorium came in 1976/77 during the redevelopment of the city centre by the J. Seymour Harris Partnership. The decision was taken to add a civic building above two levels of shops as part of St. David's Centre, a shopping mall and other associated buildings; after some discussion, a concert hall was chosen. The design team started work in earnest in mid-1977, the piling contractors moved onto the site in August 1978 and the main contractors started building later in 1978.

2. The Brief and the Design

The brief laid down by Cardiff City Council called for a 2000-seat auditorium with particular emphasis on concert use. The one major type of performance which was explicitly ruled out was theatrical productions. However, popular music, light entertainment, some spectator sports and television recording performances were included. A large organ was called for and Ralph Downes was selected as the Consultant.

The design as it finally evolved placed the required emphasis on the concert use but accepted that, in the world of the 1980's any 2000-seat auditorium would have to fulfill a variety of needs with conferences as an important contender. The limited

budget available made any adjustable reverberation, whether mechanical or electroacoustical out of the question. No proscenium was considered as no theatrical performances were to take place. The stage and forestage, however, were designed with a number of lifts to allow a shallow pit, an augmented stage for spectator sports (boxing, wrestling, the ubiquitous snooker, etc.), and raised sections for orchestral and similar use. The layout of the seating which developed permits the movement of participants from any part of the auditorium to the stage without the necessity to pass outside the auditorium; this is an important aspect of conference design.

3. Acoustic Aims

Being a very traditional acoustic design partnership, Sandy Brown Associates set as their target a reverberation time of two seconds with a diffuse well-distributed sound field. With the requirements for good speech intelligibility in mind, however, it was decided not to allow the low frequency RT to rise to the extent that musical warmth might dictate; the long persistence of low frequency energy which contributes little or nothing to the intelligibility of speech would only serve to mask the more important higher frequency components.

In order to achieve the design aim of two seconds RT, a volume of 11 m^3/person was chosen and this, together with the seating layout which developed, defined the necessary height of the auditorium - a total volume of 22,000 m^3 and a maximum floor to ceiling height of 19.6 metres. Because the hall is built above two levels of shops, it was not possible to provide the necessary volume and still leave room for the services in a void above a suspended ceiling. The air conditioning ductwork, lighting bridges and other services are, therefore, included within the overall volume of the hall and provide a highly diffusing upper level. Thermal lagging of ductwork had to be fitted inside the ducts to prevent a disastrous amount of absorption at lower middle frequencies which would otherwise have resulted.

Although the basic structure of reinforced concrete is heavy the roof, which had to be supported on trusses over a maximum span of 44 metres, could only be of 200 mm Siporex. This construction could only be accepted because the air space above Cardiff is extremely quiet even so there have been reports of seagulls being heard in the auditorium! Careful painting of the inner surface of the Siporex was essential to reduce the sound absorption that would otherwise have resulted.

A low noise level wa.. also clearly essential both for speech and music and NR 20 was proposed. It was appreciated that the

realisation of this figure would be no easy task because the restricted boundaries of the site implied a close approach of plantrooms to the auditorium itself. In fact, the main auditorium ventilation plant is situated beneath the side tiers.

The design aims to break up the seating into restricted tiers having vertical side walls which serve to give some lateral reflections to each area. In this respect, the hall bears a familial resemblance to the Berlin Philharmonie. The recent discovery of the Fredenburg auditorium served also as a reassurance. The expressed intention was to install a number of reflecting surfaces at high level in the auditorium to assist in achieving the required lateral reflections and an adequate degree of diffusion. In practice, the presence of many other reflecting surfaces has apparently rendered this unnecessary and, at present, no additional reflectors have been added although this could be done at a later stage because the visual ceiling is of an acoustically transparent design.

4. Acoustic Model

A one-fiftieth scale acoustic model was built as part of the design development. It has been modified on three subsequent occasions but this was largely an attempt to keep up with and test successive architectural changes rather than necessary acoustical modifications. The model was tested at Cambridge University by Dr. Mike Barron and his collaborators.

The tests confirmed our expectations that a reasonably flat reverberation time-frequency characteristic was to be expected. The variation of reverberation time with position in the model suggested that a satisfactory degree of diffusion had been realised. This was confirmed by measurements of Early Decay Time which indicated linear decays departing by only 5% from the reverberation times.

The ratio of early-to-late energy measured at various positions in the auditorium was compared with Reichardt's criterion to give an indication of the balance between clarity and reverberance. The results at most positions in the auditorium agreed well with the theoretical value and indicated that an acoustically reverberant condition suitable for Romantic music should result. Seating positions in the tiers close to the stage naturally showed a much greater degree of clarity and the use of these tiers during conferences will be very desirable.

The total energy measured at various positions is also high and considered to be acceptable; the lowest value is found in a seat that is slightly screened by neighbouring balconies and not, as might be expected, at the most distant seats.

St. David's Hall, Cardiff

5. Measured Results

The auditorium was completed about two months ago but the Organ Consultant and his sub-contractor have been in occupation since then carrying out that long and tedious process known as voicing.

Reverberation time measurements have been made, however, and indicate a value of 2.1 seconds between 125 and 2000 Hz in the empty auditorium. A small amount of carpet and other materials remained to be added.

Noise levels from the auditorium ventilation have been reduced to NR 20.

Many additional measurements will have been carried out by September 10th, in particular a repeat of the tests which were carried out in the model. Some comments on these tests should be available at the meeting. The first subjective appraisals with an orchestra will also have occurred a few days earlier and will be reported.