BRITTEN OPERA HOUSE

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An Opera House Acoustic

In 1900 Wallace Sabine produced the first empirical equations for calculating reverberation time and applied these equations to the design of the Boston Symphony Hall. Since that time great attention has been paid to the correlation between the objective measurement and the acoustic properties of auditoria and the subjective assessment of the quality of the acoustic. The major part of this work, the research, the papers, the books has been and is concerned with the concert hall; very little of the work is specifically concerned with the theatre or opera house.

This is understandable when considering the ritual we associate with the performance of European Art Music in the concert hall or recital room – a concern with the quality of the sound of music which makes all the other human responses to the performer, the audience and the architecture of the auditorium pale into insignificance. Not so with the opera. As Kenneth Clark writes in "The Pursuit of Happiness", the 9th Chapter in "Civilization", 'Opera, next to Gothic architecture is one of the strangest inventions of Western Man. It could not have been foreseen by any logical process. Dr Johnson's much quoted definition, which as far as I can make out he never wrote – "an extravagant and irrational entertainment" is perfectly correct'.

The greatest artistic creation of the 'Rococo', Opera had its beginnings in the 17th Century and was perfected as an art form by the genius of Monteverdi. It came to the north from Catholic Italy and flourished in the Catholic capitals of Vienna, Munich and Prague. It has absorbed all the theatrical and musical traditions of the Masque, the Commedia dell'arte, the Commedia erudita, the Singspiel of Germany, the Pantomime of England and the Music Theatre of today. It is an entertainment of ceremony and ritual where, when it achieves the greatest impact, the musical and literary ideas are not only of equal importance, they complement and sustain the essential idea of the opera itself. Words and music are equally important.

The architect and acoustician should not however be looking for a compromise between the theatre, where speech intelligibility is paramount, and the concert hall, where the 'flux of reverberant energy' is the primary aim, but an acoustic where the geometry is so carefully contrived as to provide reflections to ensure that those parts of the opera which must be intelligible are heard, but against a background which does not reduce the richness and warmth of an orchestral sound and voice, and so threaten the drama of the occasion.

Acoustic knowledge, analytical and measuring techniques and subsequent theories have developed rapidly, particularly since 1950, but one of the most significant properties of an auditorium which can be calculated and predicted remains the frequency dependent reverberation time. All the other measurements and ratios used to define the quality of an acoustic are taken from models or the auditoria themselves, they are checks, but seldom effective design tools. Nevertheless from the correlation of these many measurements with subjective criteria there is confidence that the quality of the auditorium acoustic is very dependant on a powerful direct sound and on short delays or time gaps between the direct sound and the first and early reflections. It follows that the early energy in an auditorium is very important. It is this quality of high early energy which not only increases speech intelligibility, but improves the quality of both speech and music. Achieving this against a reverberation time long enough in the right frequencies to provide the warmth and richness for music, but not too long so that the words are masked or become unintelligible should be the aim for the geometry and acoustic of an opera house. This aim must also include a geometry which incorporates an approach to the orchestra pit design which ensures the fundamental criterion of the 'right' balance between the stage sound and the pit sound as far as possible throughout the auditorium.

A Teaching Opera House Acoustic

Against the background of achieving an 'ideal' opera house acoustic for the Britten Opera Theatre was the added dimension of providing an acoustic for young voices being trained, and developing at the beginning of their careers; voices which may not achieve their potential for a truly mature sound for perhaps 10-15 years. Singers must also be trained to use their voice and develop a 'tone' for a wide variety of opera houses volumes ranging from $2000m^3$ or less to $20{,}000m^3$ or more and concert halls with a greater range, and all with acoustics ranging from the painfully dry to the reverberant 'bathroom'. It was agreed with the Architect and the College at one of the earliest meetings that the Britten Opera Theatre should not have a too "flattering" acoustic but be reverberant enough to encourage the young voice and certainly not too dry and analytical so as to inhibit the young singer.

The compact size of the auditorium, between 400 and 420 seats in the original sketch design, simplified the acoustic design and made it relatively easy to realise high clarity, immediacy and intimacy. In the preliminary study, comparisons with other opera houses led to a recommendation to aim at a occupied reverberation time in the mid frequencies of 1.25 seconds. This is slightly longer than the Royal Opera House reverberation time of 1.1 seconds but appreciably longer when considered pro rata to its volume. It is very near to the reverberation time of the Buxton Opera House, Teatro la Fenice and the Markgräfliches Opernhaus Bayreuth, all of which have a volume between one and a half and twice the volume of the Britten Opera Theatre. Initial calculations and predictions indicated that the volume was too small to achieve the required reverberation time. After further design development the Architect and the College were persuaded of the need to increase the overall height by approximately 3m to the great benefit of the resultant acoustic, although this meant abandoning the garden planned for the roof of the Opera Theatre. The final measured reverberation time was 1.2 seconds when occupied, which compares with the aim of 1.25 seconds set in the design. The seated audience is by far the biggest single absorbing element in any auditorium and a great deal of attention was paid jointly with the Architect in the selection and subsequent testing of the seats. It was an additional aim to obtain a reverberation time in the empty condition as near as possible to the full condition. After careful seat selection based on recent experience in auditorium design, tests were carried out in a reverberant chamber, with and without an audience, using the latest techniques as recommended by Dr Orlofski following his recent research work at Salford University. This indicated only a slight increase in reverberation time in the unoccupied condition. This laboratory work was confirmed by the final measured reverberation time of 1.25 seconds in the unoccupied condition. This ensured that students were rehearsing without audience and performing with an audience in virtually identical acoustic conditions. The frequency dependant reverberation curves in the occupied and unoccupied condition are shown in Figure 1.

The geometry of this small opera house ensures strong reflections and abundant early energy. The convex profiling of the