MULTI-PURPOSE HALLS AND VARIABLE ACOUSTICS

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Orlowski, Rafal
Arup Acoustics
St Giles Hall
Pound Hill
Cambridge
UK
+44(0)1223 531100
+44(0)1223 361258
raf.orlowski@arup.com

ABSTRACT

An effective approach to providing variable acoustics in multi-purpose auditoria is a combination of changes in volume with changes in acoustic absorption. This approach is discussed with reference to two examples of recently built multi-purpose halls namely, Milton Keynes Theatre in England and the Concertgebouw in Bruges in Belgium.

INTRODUCTION

Multi-purpose halls play a very important role in the culture of towns and small cities. However, they need to cater for a wide range of performing arts, from intimate drama on the one hand to full orchestral concerts on the other; with musicals, ballet and opera in between.

Each of these performance types requires different acoustic conditions. Drama demands particularly high sound clarity for the spoken voice and a mid-frequency reverberation time of around 1 second. In opera, this clarity needs to be balanced by a degree of reverberance, to give fullness of tone to the singing voice and the orchestra. A reverberation time in the range 1.2 to 1.7 seconds is appropriate. For symphonic concerts, yet more reverberance is required to give ample resonance for orchestral sounds with a reverberation time in the range 1.8 to 2.2 seconds.

These diverse acoustic requirements need extensive acoustic variability. The main options for providing such variability are as follows:

- change in volume
- change in absorption
- reduction in the number of seats
- coupling into reverberation chambers

- electroacoustic systems

Changing the volume is a particularly effective method for changing the reverberation time. It has the advantage that the effect on sound level is minimal. However, providing large changes in auditorium volume requires ingenuity in architectural design and theatre engineering.

Adding absorption is simpler and is potentially equally good but the amount of absorption necessary to make useful changes is extensive. Broadly speaking, absorption equivalent to the seating absorption needs to be added to make a substantial difference. Locating so much absorption carries with it the risk that some useful reflecting surfaces may have to be obscured. Also adding absorption will reduce sound level which may result in too quiet a sound.

An effective solution for providing variable acoustics is a combination of changes in auditorium volume and changes in absorption.

Examples are given of two multi-purpose halls, acoustically designed by Arup Acoustics, which employ changes in volume combined with changes in absorption to vary the acoustics. Both these examples also use specially developed orchestral shells to control the sound of the orchestra.

The first example is a 1400 seat multi-purpose theatre in England at Milton Keynes [1].

The second example is a 1200 seat auditorium in Belgium at Bruges.

MILTON KEYNES THEATRE

Milton Keynes Theatre, which is the only major theatre in the large town of Milton Keynes, caters for performances of drama, musicals, opera, ballet and classical music. It has a resident professional orchestra – the Milton Keynes City Orchestra. The theatre was completed two years ago and currently claims to be Britain's most popular theatre.

The fundamental mechanism for changing the acoustics is the movable ceiling. In addition, movable drapes are provided on the sidewalls. The movable ceiling, which weighs 30 tons, is constructed of a steel framework clad with 25 mm thick plywood. Figure 1 gives a section through the auditorium showing three pre-determined heights for the moving ceiling. The distance between the maximum and minimum heights is 10 m.

For orchestral music, the ceiling is in its highest position and all the drapes are retracted. In addition, an orchestra enclosure is located above and behind the orchestral performance area. Its main purposes is to cut off the unwanted acoustic volume of the flytower and side stage which contain drapes and scenery. In addition, it provides support in the form of early reflections to the orchestra and reflects sound to the auditorium.

This configuration provides a volume of 8.5 m^3 per seat and gives maximum reverberance. The mid-frequency reverberation time is 1.6 seconds.

The intermediate ceiling height provides a lyric theatre suitable for opera and musicals. The volume per seat is 6 m^3. For opera the drapes remain retracted resulting in a reverberation time of 1.25 seconds. For musicals the drapes are extended to reduce reverberance for amplified sound.

The lowest ceiling position cuts off the highest balcony reducing the seating capacity to 980. The resulting volume per seat is 4.5 m^3 and with the drapes extended, the measured reverberation time is 1 second. This configuration provides appropriate conditions for drama.

In addition to changing the volume the ceiling provides early reflections over the seating area and its geometry has been carefully shaped to optimise this function.

The operation of the variable acoustics is a reasonably quick process – for example, the ceiling can be moved from its maximum to minimum height in a matter of minutes. The orchestra shell towers move on air castors and the shell ceiling is flown from above the proscenium. A number of the drapes are motorised. Changeovers of the auditorium configuration are carried out on a weekly basis as Milton Keynes Theatre is a receiving house taking productions from around Britain.

In terms of acoustic quality, Milton Keynes Theatre is proving excellent for opera and drama and very good for orchestral music. Performances using amplified music are also highly successful.

CONCERTGEBOUW, BRUGES

The City of Bruges had two main priorities for its new auditorium namely the performance of symphonic music and fully staged opera. In addition, provision had to be made for a wide range of other events including dance, jazz and film. Acoustically, therefore, the room had to be adaptable to both a symphonic acoustic and a (less reverberant) opera acoustic.

For fully staged opera it was necessary to provide a flytower which, in itself, is a large volume comparable with that of the auditorium. By combining part of this volume with the auditorium volume for the concert configuration, a significant reverberation time increase is possible above the opera mode. Figure 2 shows sections of the auditorium in both opera and concert modes.

An important acoustical requirement in the concert mode is that performers and audience share one room. This necessitated a very large structural proscenium opening – 14 m high and 18 m wide. For opera, there is a portal opening adjustable between 12 m and 16 m width, used with a variable height portal bridge.

Working with the theatre machinery consultants, a system of towers was designed which surround the orchestra but which are partially open, providing acoustical coupling to the backstage area. A very large framed ceiling panel above the backstage prevents loss of sound into the flytower. This panel flys up on electric winches and is stored vertically along the upper rear wall of the backstage. Additional panels are flown over the platform in concert condition. In this way, the reverberance desirable for most orchestral and choral music is ‘borrowed’ from the reverberant backstage. An opening performance of Haydn’s “The Creation” was the first major acoustic test for this arrangement and it proved to be very successful.

In opera mode the auditorium itself provides the (lower) reverberance required. Further fixed reflectors are provided above the orchestra pit to aid upstage singers and assist orchestral ensemble.

The auditorium includes variable absorption in the form of vertical acoustic banners and horizontal drapes. All are motorised and retract into housings in the walls and roof void when not needed. These drapes are extended for reinforced and amplified music. Subjective tests at a jazz concert (trio and singer) demonstrated that acoustic for amplified sound is successful.

The technique of utilising part of the flytower volume for orchestral concerts is not new and is popular in the design of North American multi-purpose halls where it has proved successful. Adopting and adapting this technique in the design of European multi-use auditoria is an approach with considerable potential.

REFERENCES

[1] R.J.Orlowski, The Design of variable acoustics at the new Milton Keynes Theatre. Proceedings of the Institute of Acoustics, Vol 21, Part 6 (1999)

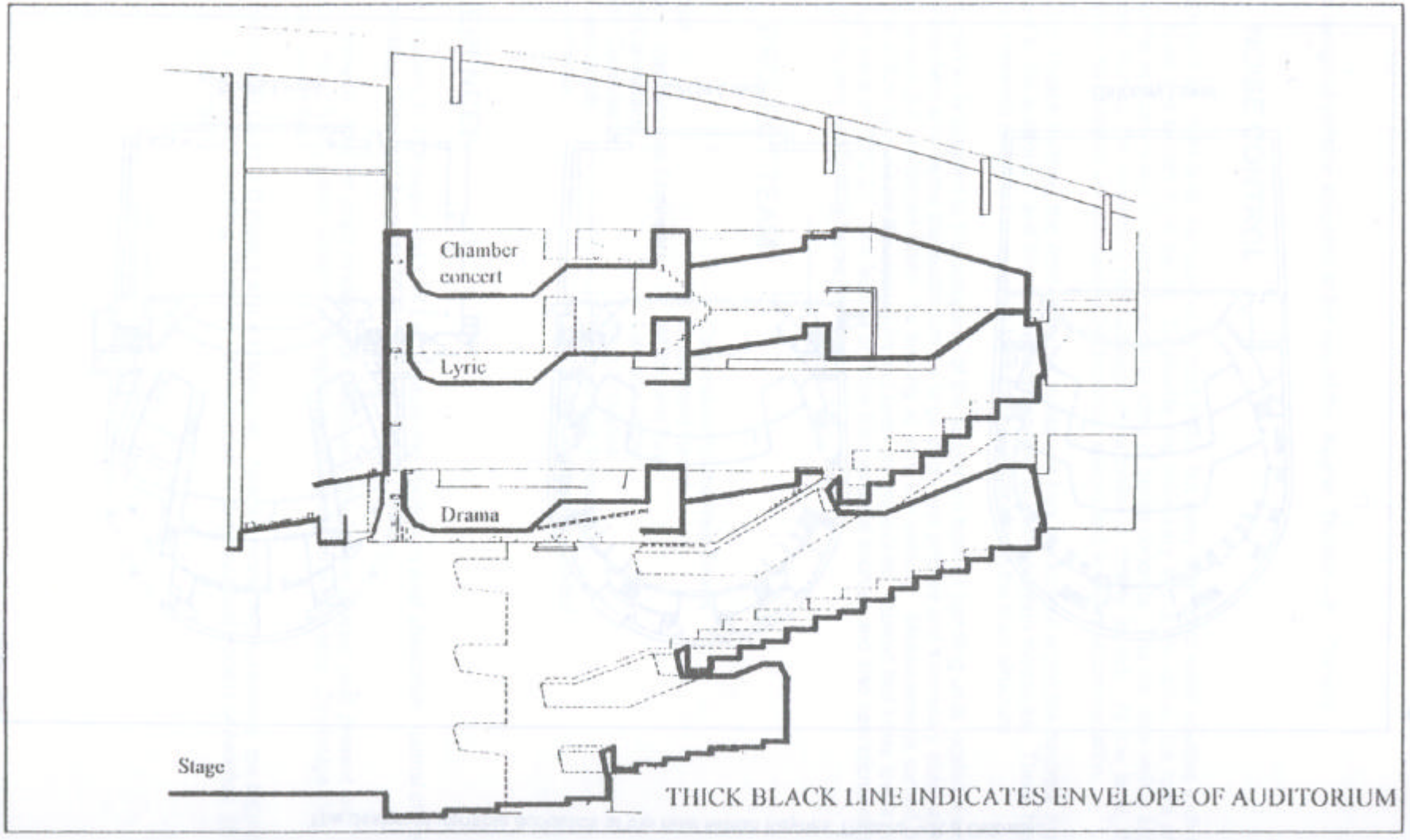

Figure 1: Milton Keynes Theatre. Section through the auditorium showing the three heights of the moving ceiling.

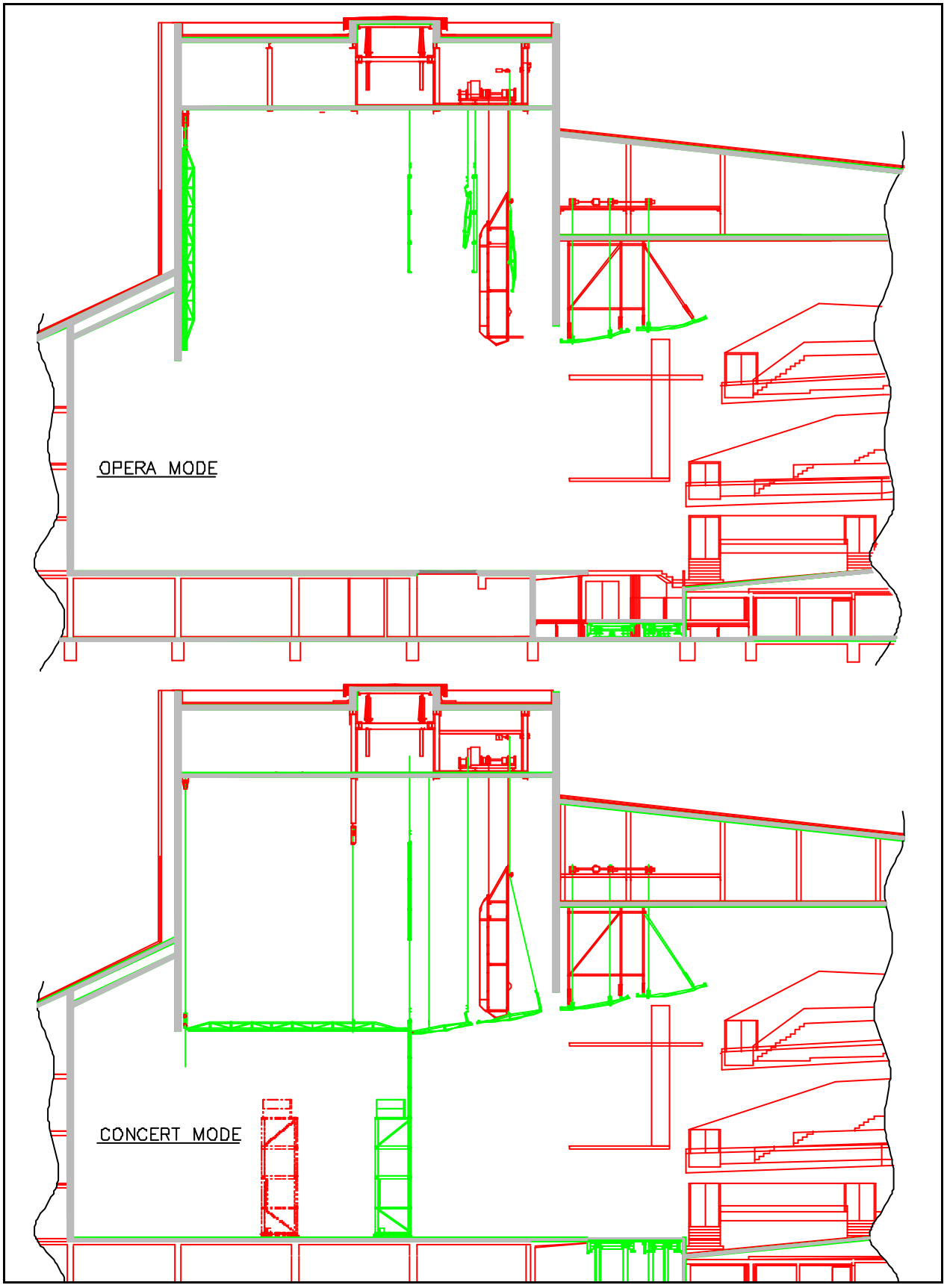

Figure 2: Concertgebouw, Bruges. Sections through flytower showing opera and concert arrangements.