DEVELOPMENTS IN DESIGN: THE ALSION KONSERTSAL, SONDERBORG, DENMARK AND HALL 1, THE SAGE, GATESHEAD

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1 ABSTRACT

The brief for a concert hall today generally requires not only excellent acoustics for classical music but also high quality amplified sound for performances such as jazz, world music and rock & roll. These diverse performance genres require different acoustic conditions which in turn need extensive acoustic variability.

Two examples will be presented of concert halls which provide acoustic variability to accommodate amplified sound.

The first is the Alsion Concert Hall in Sonderborg in Denmark figure 1, completed in 2007, which has 1000 seats and is the new home of the South Denmark Symphony Orchestra. A unique feature of this hall is that the variable acoustic system is invisible so that the audience always sees the same elegant architectural interior, whatever the performance.

The second auditorium is Hall 1 at the Sage figure 2 which was completed in 2004 and has 1700 seats; it is the new home of the Northern Sinfonia. The variable acoustic system in this hall is by horizontally moving curtains and movable ceiling panels. This hall will be visited during the conference.

2 THE ACOUSTIC BRIEF

The requirement of the brief for both halls was to provide an acoustic quality that was to be uncompromised for the performance of both classical and amplified music.

The halls would have to accommodate a wide range of uses including classical orchestra and chamber music, concert format opera and ballet together with a wide range of amplified events ranging from jazz, folk music, world music and conferences.

3 AUDITORIUM GEOMETRY AND VOLUME

The Alsion concert hall was designed to be at the centre of a long string of rectangular university buildings and so there was a good precedent for the plan form of the concert hall to also be rectangular. In the case of Hall 1 at The Sage, the rectangular shape was favoured because of its traditional acoustic success, at halls such as the Muskivereinsaal in Vienna.

The width of both the halls was chosen to be close to 20m in order to provide strong lateral sound to the audience.

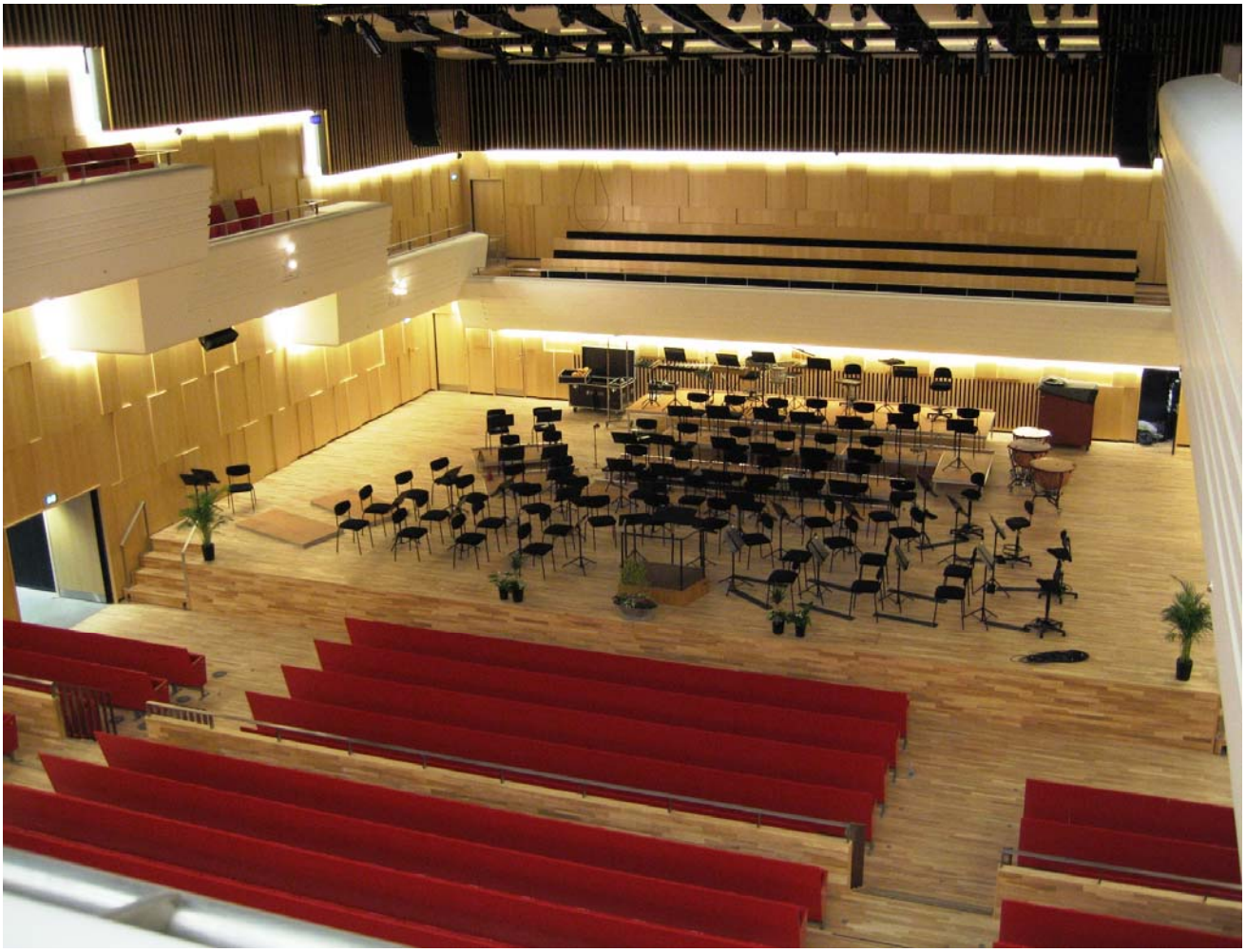

FIGURE 1 THE ALSION KONSERTSAL, SONDERBORG, DENMARK

4 SURFACE FINISHES

The surface finishes in the halls are predominantly hard and reflective to maintain reverberance at all frequencies.

At Alsion the walls of the inner envelope are clad at low level with solid timber panels fixed directly to the concrete. At higher levels and on the ceiling, the surface is bare concrete. However, what is unique at Alsion is that the upper walls are decorated with a screen of vertical timber battens which is also extended horizontally across the ceiling. The screen of timber battens forms a 300mm wide zone behind it which serves two acoustic functions. First, it contains an array of diffusing elements and secondly, it hides acoustic banners when they are required for varying the acoustic characteristics of the hall. The spacing between the individual timber battens in the screen is not regular and was carefully determined to avoid any absorption or sound coloration effects. Tests on

sample panels of battens were carried out in a reverberation chamber to check and adjust absorption.

Further tests were carried out in an anechoic chamber to examine any sound coloration effects. The spacing's finally selected were a balance between acoustic neutrality and visual screening.

By contrast, the surface finishes at The Sage consist entirely of timber panelling which is profiled to provide diffusion. The timber panelling is made up of several layers to permit surface decoration and also to provide sufficient mass to control low frequency absorption. Although surface finishes in both halls are predominantly hard, the amount of surface diffusion prevents specular reflections from loudspeaker sources.

FIGURE 2 HALL 1, THE SAGE, GATESHEAD

5 DIFFUSION

The strategy for diffusion in both halls was to provide limited high frequency diffusion on the walls at low level to maintain the strength of early and early lateral reflections. The diffusion becomes more pronounced on the ceiling.

At Alsion, the diffusion on the lower side walls is provided by simply stepping the timber wall panels in and out in a random chequerboard arrangement. The degree of stepping is increased around the stage enclosure to provide a little more diffusion in this area. On the upper walls and ceiling, diffusion is provided by shallow pyramids of various sizes. The timber battens provide diffusion at high frequencies.

At The Sage, the entire walls are covered in vertical timber battens which are stepped in and out to provide diffusion. Although this diffusion is a beneficial condition for the room acoustics for classical music, it is also beneficial for preventing sharp reflections and echoes from loudspeaker sound. The extent of the diffusing surfaces in both halls means that reflections from loudspeakers are controlled in all situations.

6 ORCHESTRAL REFLECTIONS

To provide the musicians on stage with sufficient early sound so that they can hear each other well and also hear themselves, an appropriate sequence of early reflections is required.

At Alsion this is done by suspending an orchestral reflector at a height of around 10m above the stage. The reflector comprises individual rectangular reflector elements arranged in a rectangular array. Each reflector element is made from solid timber and has dimensions 1m x 2.3m. The shape is slightly convex in long section when viewed from the stage to provide an even coverage of reflected sound. A significant advantage of such a reflector array is that gaps between reflectors provide space for movable lighting trusses and loudspeakers. Loudspeakers can be moved along rails and lowered into required positions and then retracted to leave an uncluttered aspect of the stage.

At The Sage, Gateshead, a series of large-scale motorized reflectors extend across the whole width of the hall. The height of the reflectors can be varied to optimize their performance for different music types and they can be raised as necessary to allow height for special rigging beneath. The reflectors are curved along the long section of the building and have a degree of diffusing modulation in their surface. The surface mass of the reflectors was high (12mm thick plywood with 5 layers of 12.5mm thick plasterboard bonded to the upper surface) to minimize absorption of low frequency sound.

7 ABSORPTION OF SEATING

For Alsion, the architect decided to design a new seat for the concert hall and therefore it was important to provide him with specific acoustic guidelines for the design. In essence, the seat follows a minimalist design with a hard timber back and a hard surface to the underside of the seat. Upholstery is restricted to those areas covered by a seated person and the thickness of the upholstery is around 50mm. Laboratory testing of prototype seats, which was considered essential, showed a typical seat absorption characteristic with mid-frequency absorption coefficients of 0.6 and 0.7 for unoccupied and occupied seats respectively. The measured performance met the required acoustic specification and this helps to ensure a minimal change in reverberation time

between occupied and unoccupied conditions as well as maintaining the overall length of the reverberation time.

Clearly, acoustically absorbent seating will control loudspeaker sound in areas which are sometimes unoccupied.

At The Sage, Gateshead, the seats were designed to keep exposed absorption to a minimum when occupied to maximize reverberance in the hall for orchestral performances. For rehearsals, it was the design intent for the variable acoustic drapes to control reverberation with no audience present. As with Alsion, the seats have a hard timber back and underside.

8 VARIABLE ACOUSTICS

The fundamental requirement of both concert hall briefs was to provide an acoustic suitable for classical orchestral, ensemble and choral music. No variable absorption elements are exposed when the halls are in this primary condition. However, to accommodate amplified events, variable absorption systems can be brought into use.

At Alsion, the system consists of acoustic banners which can be lowered from the perimeter of the ceiling into the slot between the decorative timber wall battens and the concrete wall behind. The banners can be deployed on the side walls and the stage wall and can cover the majority of these walls between the ceiling and the balcony. It is possible to lower the banners to intermediate positions so that a wide range of acoustic variability is possible.

An advantage of this scheme for variable absorption is that the appearance of the hall does not change substantially with the deployment of banners.

At The Sage, Gateshead, motorized acoustic curtains can be moved out of cupboards horizontally along the walls and can cover 95% of the total wall area at four levels. The curtains are two layers of black wool serge stitched together and hung with 50% fullness.

In addition to the variable absorption, the acoustic volume of The Sage, Gateshead can be adjusted by altering the height of the six ceiling panels which cover the majority of the ceiling area. The usable height range is 11m to 18m above performance platform level.

During commissioning, 10 different room acoustic ‘settings’ were refined for different uses of the hall such as full symphony orchestra, chamber orchestra, jazz/folk and rock concerts. Each uses a different ceiling reflector and curtain configuration.

9 SOUND INSULATION

Unamplified music requires low background noise conditions. It is essential to prevent noise ingress. Amplified music produces longer term high sound pressure levels within the hall, but a higher level of room background noise can often be permitted. However, with an increased likelihood of sustained and repetitive low frequency content, amplified music requires that sound egress is controlled.

At Alsion, there was only one hall in the building, sandwiched between educational spaces on one side and a science park on the other. The most critical eternal noise source was the local railway station directly behind the building. Fortunately, this is the end of the line, and trains are relatively

infrequent during the normal concert periods of the day. Budgets prevented vibration isolation and structures that would guarantee that the trains would be heard. An internal background noise limit was set, which through keenness the mechanical services contactor improved on. In practice, the lower, delivered noise level has proven to be preferred by the building users, who would rather risk the possibility of hearing one train during a concert and retain the wide dynamic range that the hall delivers. Noise egress to the adjoining spaces had been sufficiently limited that over nearly a year of operations, not one complaint has been received.

At The Sage, there are three halls inside the building envelope. Structural isolation measures separate these spaces, so that a symphony rehearsal or performance in one room is unaware of the sound levels from a rather raucus amplified event next door. These isolation joints are expressed in the building and can be seen slicing through floor, walls and balustrades at foyer level Background noise levels inside the halls have been kept low.

10 ACOUSTIC MODELLING

Acoustic modelling of all the designs was carried out predominantly using a computer model (Odeon and CATT). This proved valuable for checking and optimising geometrical features such as side balconies and also for monitoring the values of key acoustic parameters. Additional confidence in the predicted characteristics was gained by testing physical scale models.

11 TESTING AND COMMISSIONING

At Alsion, a comprehensive series of objective measurements and subjective tests were carried out at the beginning of 2007. Objective measurements involved measuring six key acoustic parameters which were compared with the original design criteria – all values met their targets – a good result. Subjective assessments were carried out during public performances of a symphony concert and an operetta. The results indicated excellent acoustics. The orchestral sound has high clarity which is balanced by long reverberance and ample loudness. The tonal quality was judged to be ‘beautiful’ and listeners were highly ‘enveloped’ in sound.

At an amplified concert of jazz music, with the acoustic curtains fully deployed, the sound was very clear and uncoloured with no late reflections. The building has also proven very successful for louder pop / rock style performances.

Hall 1 at The Sage, Gateshead was subject to extensive acoustic testing during a period of three months at the end of 2004. Occupied and unoccupied measurements were made with the hall in several of the acoustic ‘settings’. Subjective listening tests were made with the BBC Philharmonic and the resident orchestra the Northern Sinfonia, involving dialogue with the musicians to help refine the performer conditions. This was followed by listening tests of a world music ensemble, folk group, string quintet, solo pianist, solo baritone, brass band, jazz ensemble and rock band. Some of the sessions were unoccupied and some were with invited audience. Each session provided the opportunity to refine each of the acoustic ‘settings’ to optimize the sound for a particular musical style.

Hall 1 has now had a long period of use and has developed a very high reputation for both the natural sound and amplified sound. It has achieved its goal as a hall for all music.

12 CONCLUSIONS

In the design of concert halls today, the brief usually expresses a clear requirement for accommodating performances which require the provision of high quality amplified sound as well as excellent acoustics for classical music.

To ensure this high quality of amplified sound, it is necessary to introduce both a suitable amount of acoustic absorption in the space and an appropriate degree of diffusion on the walls without detracting from the natural acoustic.

The examples given of the Alsion concert hall and Hall 1 at The Sage Gateshead show how these requirements can be incorporated with the result that both the natural and amplified sound can have very high quality.