PRESENTS

The LOGOMO Hall

by Janne Riionheimo, Henrik Möller and Anssi Ruusuvuori

Introduction

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In general the reception of the hall has been very positive. Rock and pop sound engineers have been surprised with the definition of the hall, and the musicians have commended the sound on the stage. Music critics have given good ratings for classical concerts where the Constellation system has been in use.

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The LOGOMO Hall

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1 Introduction

The giant complex of Logomo is situated in Turku, the oldest city in Finland. Logomo is intended to be a new home for various cultural, creative and business events. Logomo is still under construction, but its centrepiece, the main hall, was opened in November 2011. By the end of 2014 there will be a further four performance arenas, studio areas, exhibition spaces, office spaces, a restaurant and workrooms for artists. The future performance spaces include a movie theatre, a black box theatre and two lecture halls.

2 Initial design

The lack of a big venue for rock shows and theatre plays, visiting West End and Broadway musicals and shows with high quality sound production systems, was a driving force for the new multipurpose Logomo hall. From the beginning it was clear that the hall was to fulfil the requirements for various types of activities:

- reinforced music (rock, pop, jazz, schlager…)
- conferences
- music theatre, musicals, revues…
- classical theatre
- opera

The starting point was that the acoustics of the hall should be appropriate for reinforced music. The aim was not to design a classical acoustic concert hall for which the dimensions of the hall (28x60m) wouldn't be appropriate. In terms of acoustics the desired versatility for the multipurpose hall would need massive variable acoustic structures or an excessive amount of curtains. However, the combination of an acoustic concert hall and a high quality hall for reinforced music would still be a compromise. It was decided that the variability in the sound field will be achieved by an electronic system. Within the timeline for the design Mayer Sound Constellation system was voted in.

For the hall to be suitable for differently sized activities physical versatility should be acquired. The final decision was a massive movable seating stand that rides back and forth on compressed air cushions. The stand (called here "the tribune”) can be positioned in three different locations to form three configurations for the hall: small (S), medium (M) and large (L).

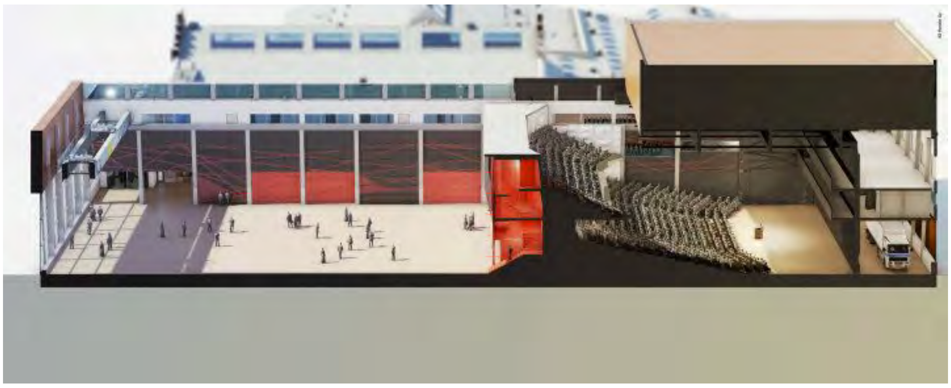

Figure 1. **Logomo hall in S-configuration**

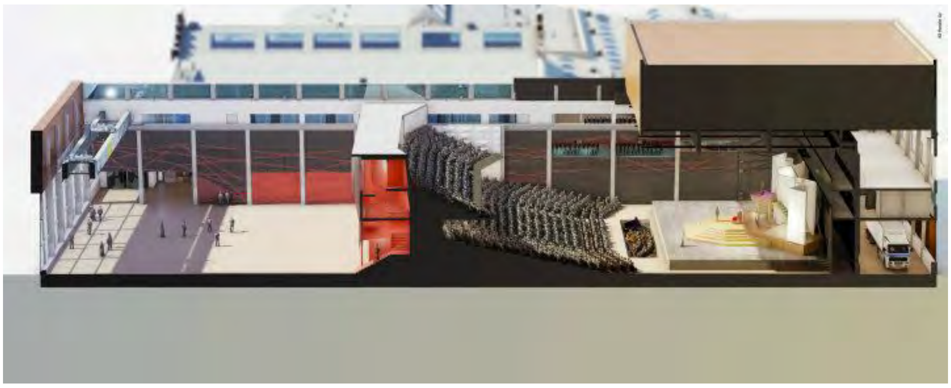

Figure 2. **Logomo hall in M-configuration**

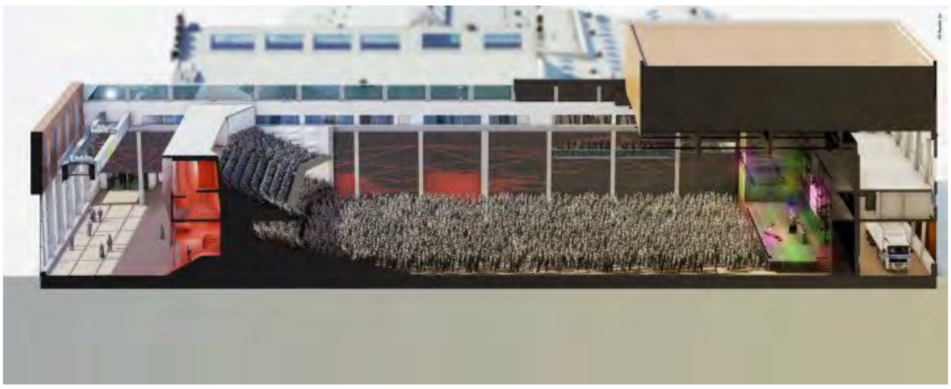

Figure 3. **Logomo hall in L-configuration**

The constellation system can be used in all three configurations. When the hall space shrinks the lobby area behind the tribune enlarges and forms a practical area for banquettes, exhibitions etc. The cloakroom has been lowered in the back of the tribune.

The tribune itself has a sloped audience area for 1100 people in two levels. There are 360 fixed seats on the balcony and 800 fixed seats in the stalls. Seven first rows in the stalls (300 seats) can be folded under when the floor is intended for a standing audience. In addition there are 3 compartments, which can accommodate 150 sitting people.

2.1 Small

In its smallest form the concert hall's area is 500m^2 while the lobby area behind the tribune is 2000m^2. Compact 1100-seat space provides an ideal venue for conferences or a chamber orchestra.

2.2 Medium

In the medium configuration the hall seats up to 1700 people with removable chairs on the floor. The concert hall area is 900m^2 and lobby 1600m^2. This configuration is the main opera mode.

2.3 Large

In its largest configuration the shape of the hall is an elongated rectangle accommodating 3500 standing people in a rock concert. The concert hall area is 1700m^2 (60 m x 28 m) and lobby 1000m^2. With the retractable audience area opened and with removable chairs on the floor the hall still seats 2160 people.

3 Initial acoustic planning

After the classical concert hall was left out from the design, our work was more straightforward. Our goals in the acoustic design were:

- Relatively short reverberation time between 0,9-1,5 s. During conversations with Mayer Sound designers we agreed that 1 second in M-configuration would be ideal for Constellation system.
- Sufficiently strong lateral reflections, which is a prerequisite for a high quality listening environment for any music style. This is related to shaping of sidewalls.
- Balanced sound field with high definition everywhere in the audience both during acoustic performances and reinforced concerts.
- Enough reflections coming back to the stage with time intervals not too far from each other. These reflections support performers on the stage and mask possible individual "slap" echo from the tribune especially in L-configuration when the distance between the stage and the tribune is over 50 m.
- Low background noise levels (environmental noise and HVCA noise)

In rock concert halls an important factor is the clarity in the bass frequencies. In [1] it is noted that rock concert halls with a flat reverberation time profile across frequencies are rated higher that the halls with a longer reverberation in the bass, which is the normal requirement for classical acoustic concert hall. Additionally, the 63 Hz octave band has to be included in the acoustic design. However, a slight rise in the bass frequency reverberation would be beneficial for the Constellation system where the artificial reverberation is generated by amplifying and processing the "normal acoustics" of the hall. More amplifying power is needed for a hall with a declining bass reverberation.

3.1 Sound isolation

A fundamental factor in acoustic design is sufficiently low background noise levels were critical. One problem was that the movable tribune had to be as lightweight as possible in order to be lifted up by the air casters. Also the six wide sliding doors with acoustic treatments attached on them had to be lightweight. The absolute tightness of the movable parts would be impossible to achieve. The solution was that the lobby, aisles and conference rooms around the hall provided a "silent zone" against environmental noise and against the noise from the other parts of the building. All the surrounding spaces are heavily absorbed.

Another problem was that the HVCA machine room was positioned above the stage. Using proper isolators and suspended ceiling structures we could keep the HVCA noise below the limits.

The hall's whole roof was to be rebuilt and replaced by lightweight wooden sandwich elements. Our concern was the sound isolation against environmental noise, particularly noise from the nearby railway yard. Because of the wide span (28 m) of the hall an additional suspended ceiling was not an option. The noise from the hall through the ceiling to the neighbouring apartment building was modelled with CADNA software, which gave the limits for the sound pressure levels inside the halls. Fortunately the HVCA machine room forms a noise barrier between the hall’s roof and the apartment building.

3.2 Acoustic treatments

In the initial phase of the design the acoustics for the preliminary structures of walls and ceiling were calculated and predicted. A desire to leave the old structural concrete beams and pillars exposed was expressed, so the acoustic treatments were to be placed between and in flush with the pillars. Perforated board structures and diffusive surfaces were proposed for the walls and perforated boards for the ceiling. One of the problems was that the architectural concept changed during the project’s timeline and the final structures were not decided until the end of the design phase so the model had to be updated throughout the project.

The final concept for the sidewalls was partly perforated metal sheets. Perforated parts formed the architectural “stripe concept” that can also be seen in the sliding doors, where the stripes are reflective instead of being absorptive as in the sidewalls. The supply air is also circulated through the perforation. The cavity between metal sheets and sound isolation walls is filled with mineral wool for absorption. The same “stripe concept” is also the basis for the diffuser structures that occupy the three spaces between the pillars. The ceiling as well as the stage walls are clad with perforated MDF-boards.

A mostly absorptive rolling stand forms the rear wall for the hall. Reflections from the tribune’s side and rear walls were still needed, the solution for which was a partly absorptive partly diffusive/reflective aluminium “diamond” structure.

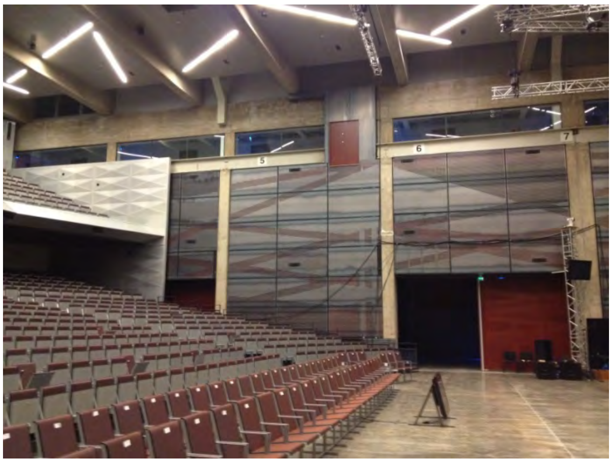

Figure 4. **Sidewall "stripe" concept**

Figure 5. **"Stripe" concept in a sliding door**

Figure 4. **Sidewall diffuser structures**

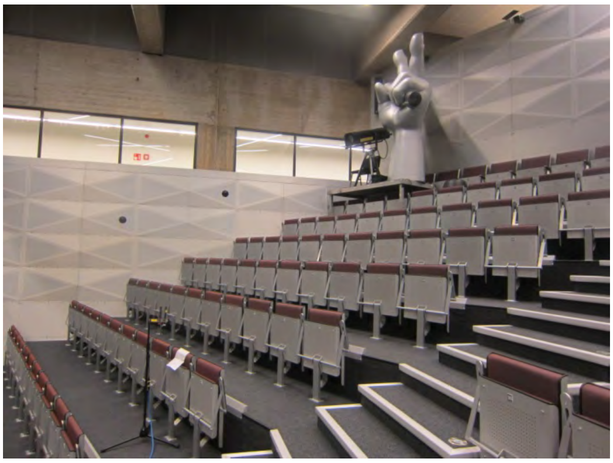

Figure 5. **"Diamond" diffusers in the tribune**

4 Acoustic predictions

The acoustics were planned and predicted using ODEON modelling software. The model was updated throughout the project and whenever some structural changes were to be made the acoustics were recomputed/recalculated. During the construction phase drywall layers were left out from the tribune due to the load limits and the entire roof was replaced with a more lightweight structure. Also the locations and areas of ventilation grills as well as ventilation cavities in the tribune were redesigned, which affected the percentage of perforation in the sidewalls. This consequently had a notable effect on the acoustics of the hall, so the amount of the required absorptive area kept changing.

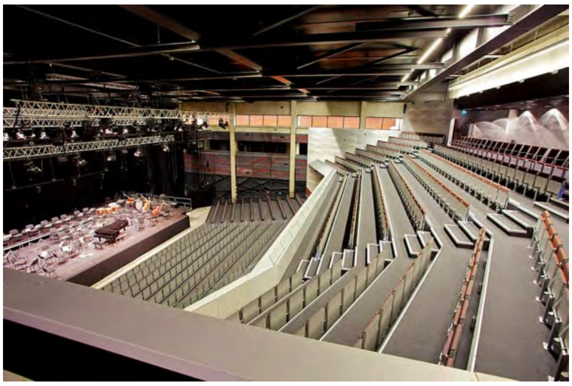

Figure 6. **Hall in S-configuration**

Figure 7. **Hall in L-configuration with removable chairs**

5 Measurement results

The final measurements were made in M and L configurations three months after the opening of the hall. Some details were still under construction and the final stage structure as well as stage curtains will not be installed until the summer of 2012. First seven rows of the retractable seating were under maintenance and folded away. Due to the talent show going on in the hall the shape of the stage and stage curtains weren't in their final arrangement but the hall itself was practically as in the model.

The final measurements in figure 10 show that the reverberation time of the empty hall in M-configuration fulfils the design goal of 1 s in the middle frequencies. The decline of reverberation in the low frequency region was surprising as a flat or slightly rising reverberation time in the bass was anticipated. Presumably the reason for that was the lightened tribune structures and the "safe" estimation of low frequency absorption of the metal sheets. However, the bass accuracy in the dry hall has been praised so the only downside is the increased need for amplifying power in the Constellation system.

Two parameters C80 and D50 in figure 11 and 12 show that the ratio of early to late sound energy is appropriate for reinforced music giving rhythmic punch, clarity and good intelligibility for performances.

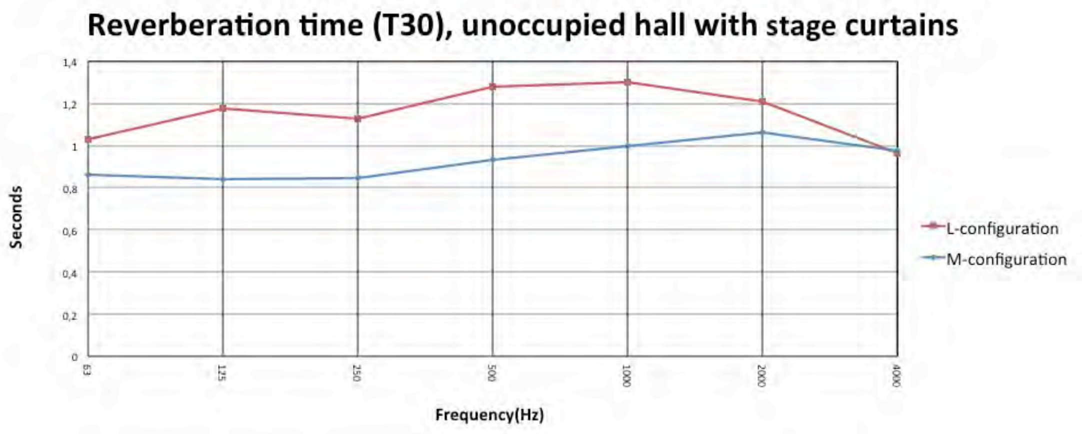

Figure 8. **Reverberation time in the unoccupied hall in L and M configurations**

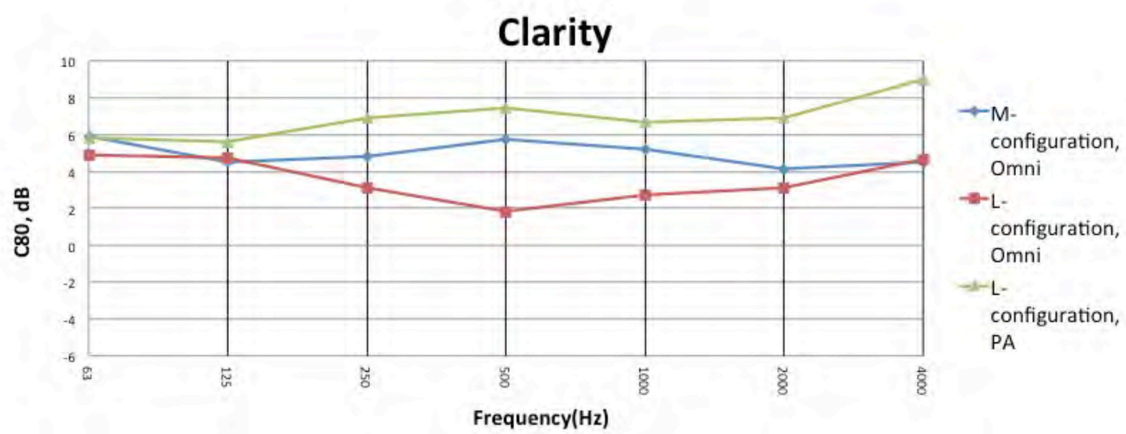

Figure 9. **Clarity in the unoccupied hall in L and M configurations. Clarity was measured with an omni source as well as with the PA system in L-configuration**

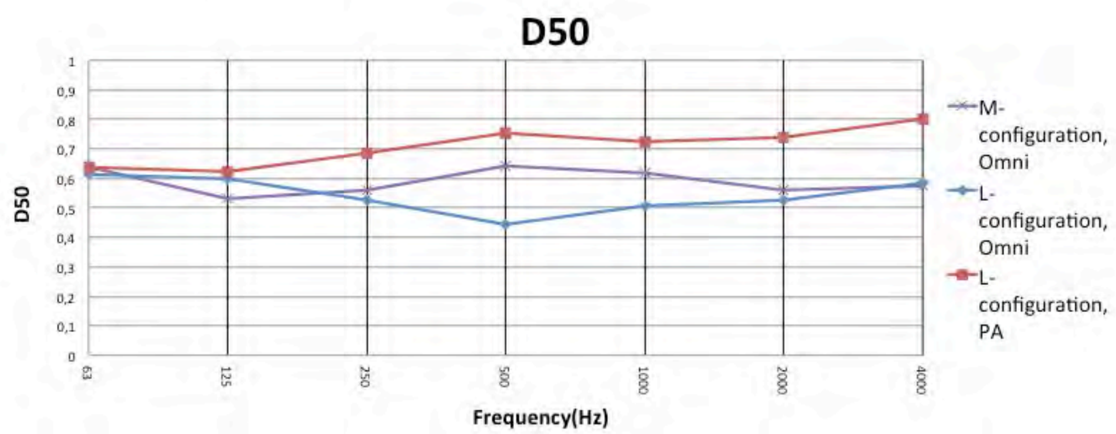

Figure 10. **Definition D50 in the unoccupied hall in L and M configurations. D50 was measured with an omni source as well as with the PA system in L-configuration**

6 Constellation

As the natural reverberation time of the hall is between 0,9-1,3 seconds, the Constellation system is able to create an artificial reverberation field, where the acoustic properties can be modified electronically. For users the pre-programmed system is “error proof”, as the iPad-based interface is rather simple and the only modifiable acoustic parameters for the user are the reverberation time (1,0-2,5 sec), strength and warmth, albeit the scales are quite coarse.

Figure 11. **Constellation interface on iPad**

7 Summary

In general the reception of the hall has been very positive. Rock and pop sound engineers have been surprised with the definition of the hall, and the musicians have commended the sound on the stage. Music critics have given good ratings for classical concerts where the Constellation system has been in use.

8 Acknowledgement

We would like to thank John Pellowe and his colleagues from Mayer Sound for productive co-operation as well as people from Logomo for fruitful teamwork as well as keeping high standards in acoustics.

References

[1] Niels Werner Adelman-Larsen, Eric R. Thompson, Anders C. Gade, “Suitable reverberation times for halls for rock and pop music” *J. Acoust. Soc Am.* **127** (1) January 2010.

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