Variability and Adaptability of the Acoustics in the new Conservatory of Amsterdam

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Introduction

Last summer the newly built conservatory for music of Amsterdam was delivered. The conservatory has 5 larger halls. The primary use of these halls is rehearsal and exams. They are also used for musical performances. The halls are quite different in order to learn the students to cope with different acoustics. They range from a hall suitable for rehearsal of an symphonic orchestra to a recital hall, a hall for jazz and pop and a hall for opera and musical. The acoustics of three halls can, to a certain extend, be adapted to the use of the halls. The acoustics aimed and achieved and the variation possibilities are subject of this paper. Furthermore the conservatory has more then 100 education rooms and about 70 study rooms. The acoustics of these rooms can, by means of ”cushions”, be adapted to the lessons scheduled. The needed adaptability was predicted by means of experiments together with students and teachers in a mock-up of ”new rooms” in the former conservatory building. They had to express their preference and give their evaluation of different subjective parameters. The adaptability and the evaluation of it will be shown.

Acoustics of the Halls

The „Conservatorium van Amsterdam“ is a teaching institute as well as a concert hall. The building houses 5 halls located at the lower floors: a classical concert hall, a jazz and pop hall, a recital hall, a theater and an ensemble space. Each hall has its own specific acoustic features and in 3 of the halls the acoustics can be modified to a degree.

Bernard Haitinkzaal

The Bernard Haitinkzaal is a classical shoe box with 2 balconies. These balconies provide the necessary lateral reflections. The technical balcony, which is required for the lighting and sound control, also provides (out of sight) sound absorption. The walls and the ceiling of the hall have a zigzag shape for diffusion. To make sure that the presence of an audience has a negligible influence on the acoustics, the necessary high sound absorption of the 450 chairs has been verified in our Laboratory for Acoustics.

The initial use of the Haitinkzaal was for classical, symphonic music with an orchestra of maximal 80 musicians, chamber music, jazz, modern music and opera and for rehearsals, master classes and exams as well as for performances. So the reverberation time needs to be variable.

This variability is achieved with curtains. These curtains are located at the back walls of the two balconies and in front of the windows. Without any curtains a reverberation time is achieved of 2.0 s and with all curtains in use of 1.4 s.

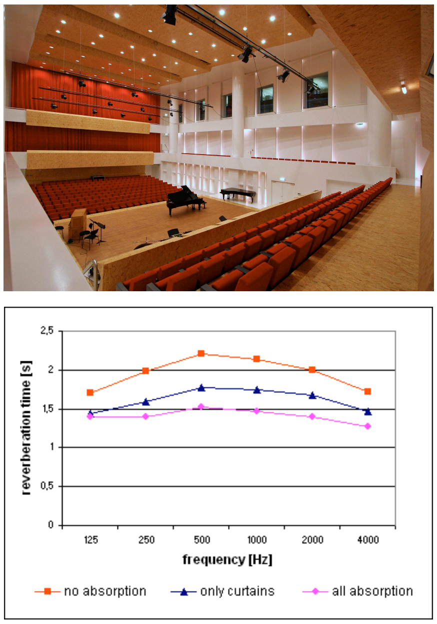

Figure 1: Bernard Haitinkzaal

The volume of about 6,000 m^3 (about 26x19x12 m) is substantial smaller than for example the Concertgebouw, but still suitable for a classical symphonic orchestra. The sound pressure levels can be sufficiently reduced with the curtains.

Now that the building has been in use for almost a year the preferred use of the different halls has become clear. The Haitinkzaal is being used for classical music only, solo recitals as well as orchestra performances. The possibility to adjust the reverberation has not been used frequently so far. The musicians seem to like a predictable acoustic situation that doesn’t change. Most of the time the curtains at the back walls are in use and the curtains at the windows are not. The reverberation time in this preferred situation is about 1.6 s.

Blue Note

The Blue Note has a volume of about 2,100 m^3 (about 17x14x9 m) and seats approximately 200 people. The ceiling is rather high to make the room also suitable for contemporary and electronic music. Above the stage a steel reflector is situated. The stage is on 3 sides surrounded by the audience at the ground floor as well as on the balcony.

It is with succes being used for jazz and pop music and has a corresponding short reverberation time of about 0.9 s. This reverberation time is achieved by dispersed broadband sound absorption at the walls and ceiling, which also provides the diffusion.

Figure 2: Blue Note

Sweelinckzaal

The Sweelinckzaal is meant for small ensembles and chamber music. The hall has a shoe box shape with a volume of about 1,000 m^3 (about 16x9x7 m) and approximately 130 people can be seated. One wall contains windows with a spectacular view of Amsterdam. With these windows and with fake windows in the opposite interior wall the required diffusion is realised. In the ceiling and an end wall the diffusion is realised with lighting elements.

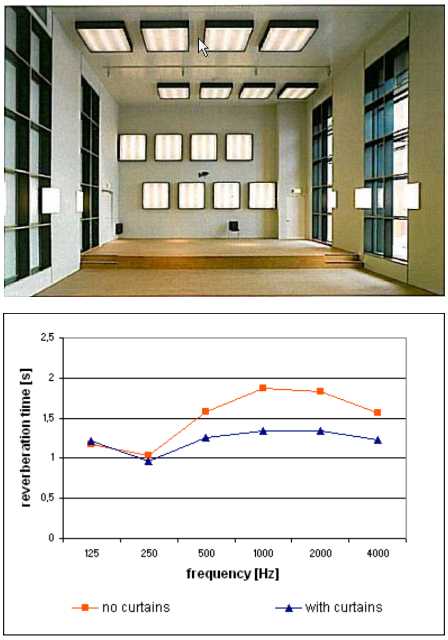

Figure 3: Sweelinckzaal

Cloth upholstered chairs and low frequency absorption in the ceiling form the basic sound absorption. The variation in the reverberation time is accomplished by a retractable curtain at the other end wall. With the curtain in use the reverberation time is 1.2 s and without the curtain 1.5 s. In general the Sweelinckzaal is being used with the curtain in use.

Theatre

The theatre is a black box with retractable curtains in front of all the walls. The variation in reverberation time is therefore ample, ranging from 0.8 to 1.6 s. At the walls permanent sound absorbing and diffusing elements are applied. The volume of the hall is about 1,500 m^3 (about 16x14x7 m). A maximum of about 50 seats can be placed.

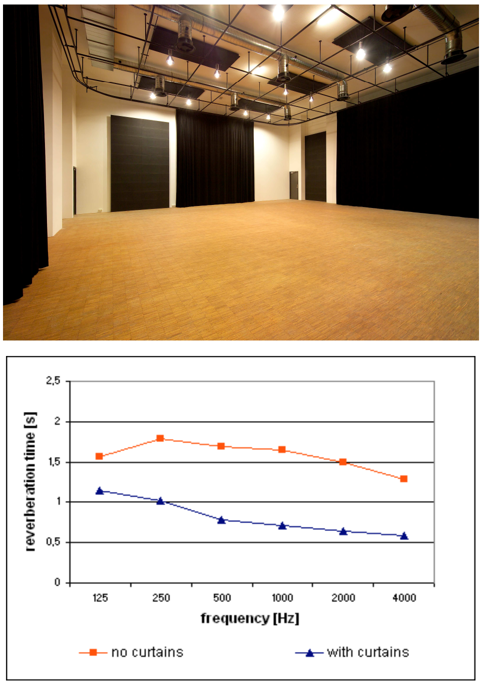

Figure 4: Theatre

This is the only hall with an adaptable acoustics, where the adaptability is frequently being used. The users are very content with the acoustics and would like to have more similar rooms. The use is varying from musical theatre to violin exams.

Ensemble

The ensemble room is located next to the theaterzaal. The volume is about 700 m^3 (about 13x9x6 m). The sound absoptive elements used in this room are similar to those being used in all the education and study rooms. These elements have been especially designed for the Conservatory after an intensive study of the desired room acoustics of the different rooms for the different instrument groups.

Figure 5: Ensemble

Acoustics of lesson and study rooms

In the conservatory there are two room types: lesson rooms for music teaching and study rooms for individual studying. The volume of the lesson rooms is of the order of 100 m^3. The size of study rooms is only about 30 m^3, which means that the loudness may be very high and might be even more important than the reverberation that is often chosen as the first characteristic for optimal acoustics.

Figure 6: Study room

When the building design process was halfway, it was decided to build test rooms with the specially designed acoustical cushions. The investigation gave the opportunity to determine differences in the demands on the acoustics for different musical instruments. Furthermore it was possible to link objective measurements up with subjective opinions of musicians. Also the implementation of adaptable acoustics for lesson and study rooms was investigated.

Test rooms

The test rooms were specially built within the old conservatory building. The walls were made from gypsum board. Floor plans are given in figure 7. Volumes are 106 and 28 m^3; enveloping surfaces are 139 and 56 m^2.

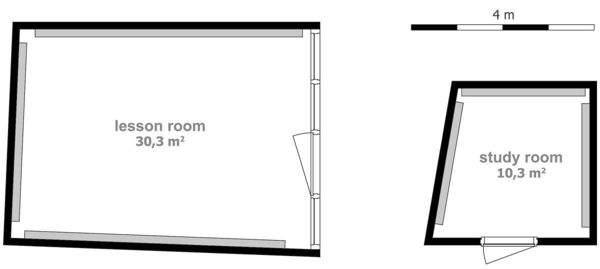

Figure 7: Floor plans of the two test rooms

The room acoustics could be changed by varying the amount and placing of the cushions in the test rooms. By adding cushions in the rooms the reverberation time will shorten and the loudness will decrease. The reverberation time in the lesson room could be varied from 0.25 s to 1.7 s and in the study room from 0.20 s to 1.1 s. The $G_{strenght}$ (loudness) [1] was variable between 16.1 – 26.0 dB for the lesson room and between 21.0 dB – 30.7 dB for the study room.

Tests in the study room were done by students, who had to judge three acoustical variants. A questionnaire was filled in by the students for linking the subjective findings to measurement results of the room. In the lesson room the teachers of the conservatory gave lessons in four different acoustical environments during four weeks. Furthermore an evaluation conversation was done with the teachers. For some instruments additional tests took place to determine the desired acoustics.

Broadband absorber

The absorbing cushions were specially developed for music, which means that special attention should be paid to an even absorption in all frequency bands. The cushions are built up by different layers of mineral wool with a plastic foil between them to achieve also low frequency absorption. The cushions are covered with an acoustic transparent textile. The final sizes are 0.9×0.9 m2 and the total thickness is about 15 cm.

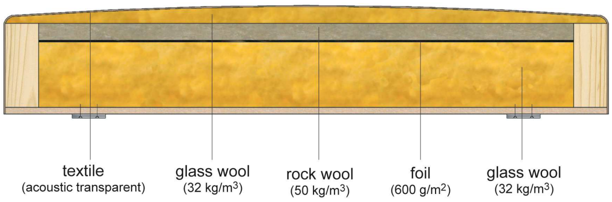

Figure 8: Section of broadband absorber like applied in the Conservatorium van Amsterdam

The effectiveness of the cushions in different settings is shown in figure 9. As could be expected also from its thickness, the edge effects of the panels had some influence, so absorption coefficients above 1.0 were found.

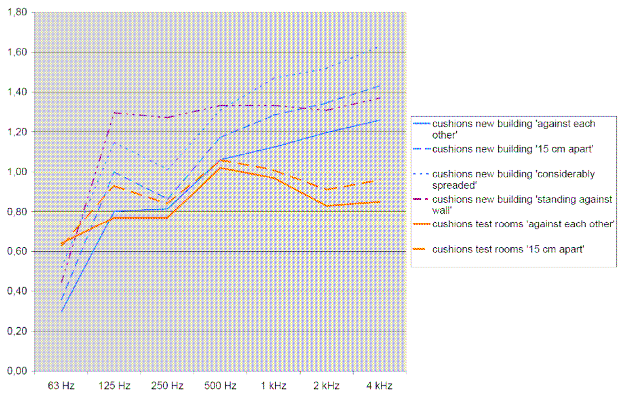

Figure 9: Sound absorption per m^2 element of broadband absorber applied in the Conservatorium van Amsterdam

The manufactured cushions for the new building differed from the cushions that were used for the testing. The higher effectiveness of the final cushions is attributed to a better transparency of the textile.

Differentiation instrument groups

The desired acoustics for 19 different instrument groups are defined on base of data from the investigation. In figure 10 a selection of instrument groups is shown. On the horizontal axis the volume of a room is placed and on the vertical axis the desired acoustics value is expressed by means of the reverberation time. More investigation is needed tot give a completely scientific definition of the curves. However it is clear that the louder instruments need more absorption and a shorter reverberation time is preferred.

Another finding of the investigation is the preference for good basic acoustics over adaptable acoustics for the lesson rooms. Enough differentiation between lesson rooms and a good scheduling are necessary in that case.

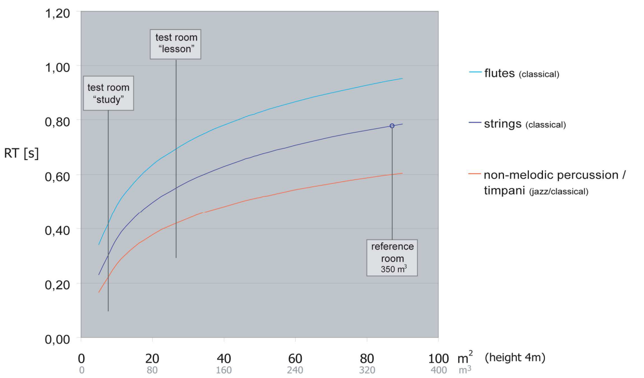

Figure 10: Preferred RT as a function of the volume for different instruments

Desired Acoustics

Through investigation it appeared that the definition of desired acoustics for small music rooms differs from the acoustics for music halls. Desired acoustics can be defined into G-RT-diagrams that give not only the reverberation time but loudness as well. [1]

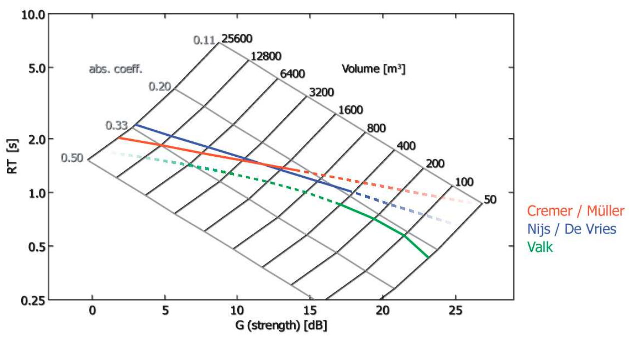

Figure 11: Average of desired acoustics for practice rooms and for performing halls

The smaller the volume of a room is, the more the curve for desired acoustics of this investigation bends to a smaller reverberation time. This can be declared by effect of the loudness, that plays a more important role if the volume decreases. It is apparently unpleasant to play an instrument in a room where the sound level is too high. To obtain desired loudness more sound energy has to be absorbed. The reverberation time will become relatively short. Besides this, the preferred acoustics for practicing is more dry than acoustics for performing. [2]

Evaluation

The teachers of the conservatory are very satisfied with the room acoustics of the new lesson rooms. The average mark (out of ten) is 7,6. 60% of the teachers judge the acoustics of the new lesson rooms as “much better” than the former ones.

Almost all teachers experience a pleasant amount of loudness. The amount of reverb appears on average to be judged as a little on the dry side.

This can be declared by the fact that the final cushions appeared to be more effective than the ones used for the investigation. It was also concluded that the loudness can play a more important role than the amount of reverb in case of small music rooms.

The principle of cushions appears to be an effective method to create adaptable acoustics for the lesson and study room of the conservatory.

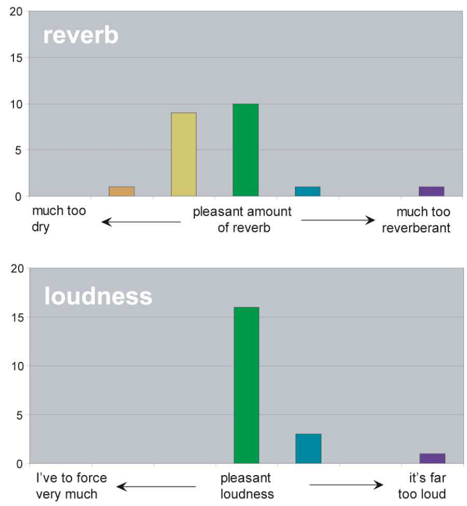

Figure 12: Brief evaluation of the acoutics of the lesson rooms

References

[1] L. Nijs and D. de Vries, “The young architects guide to room acoustics”, Acoustical Science & Technology, 26 (2), 229-232 (2005).

[2] M.E. Valk, P.H. Heringa, L. Nijs, “Het optimaliseren van de ruimteakoestiek voor de les- en oefenruimtes van het Conservatorium van Amsterdam”, (in Dutch), NAG Journaal, nr. 178 (maart 2006)