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The renovation of the Great hall of the Moscow P. I. Tchaikovsky Conservatory

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Abstract

The Moscow P. I. Tchaikovsky Conservatory is situated in a 19th century building located in the center of Moscow. The Great Hall (Bolshoi Sal) of the Conservatory is probably the most loved concert hall in Russia by both musicians and audience, both for its visual appearance but not least for its acoustic conditions.

The paper itself presents the continuation of the paper presented by Henrik Möller on Proceedings of 20th International Congress on Acoustics, ICA 2010 in Sydney „Acoustic description of the Great hall of the Moscow P. I. Tchaikovsky Conservatory“. The presentation describes shortly the acoustical condition of the hall before the renovation, the renovation process (renovated surfaces, used materials and problems during the renovation) and the results of acoustical measurements made after the renovation of the Great hall was completed.

1 General description of the hall

The Bolshoi hall is basically a shoe-box form, with one, very deep rear balcony and side balconies extending to about 3 m from the stage front. The stage is a semi-proscenium stage, with about half of the stage being behind the proscenium and half on a stage extension in front of the proscenium opening [1].

The overall dimensions of the Bolshoi hall are: overall length (from behind organ to back wall) is 56 m, from the edge of the stage to back wall 45 m. The overall width of the hall is 21,8 m and the width between the balconies is 17 m. The height in the auditorium itself is 17,7 m.

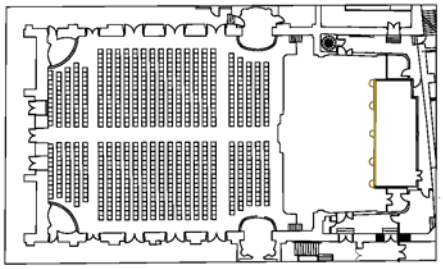

Figure 1: Parterre plan of the Bolshoi Hall

The height of the stage is 1,2 m. The depth of the stage is 10,7 m, measured from the edge of the stage to the front of the organ. The width of the stage-house is 17.4 m and the height in the stage house is 11 m. The seat count for the Bolshoi Hall is 1737 seats.

The surfaces of the hall are highly ornamented, both the side walls and the balcony fronts. The seats on the parterre and on the side balconies have a very light upholstering on the seat but hard backrests. The seats on the rear balcony are very hard, essentially just wooden benches.

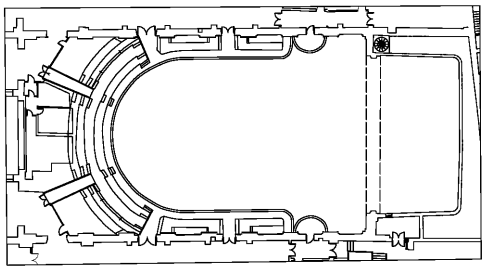

Figure 2: Lower rear balcony plan

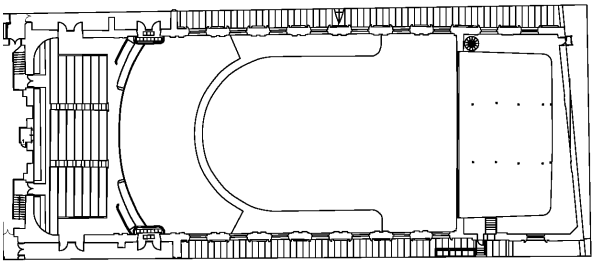

Figure 3: Upper rear balcony plan

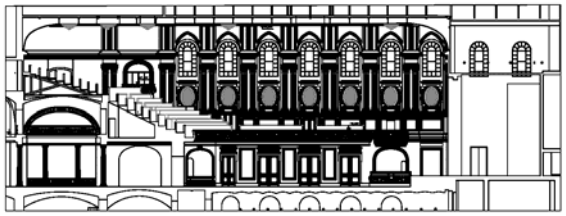

Figure 4: Long section of the Bolshoi Hall

The hall can be seen in the concert-DVD "Horowitz in Moscow" which is recorded in the hall.

When comparing the Bolshoi to other great shoebox halls in the world, two distinct features stand out:

- The rear balcony of the Bolshoi Hall extends further from the stage than in any other similar hall
- The proscenium of the Bolshoi hall is more pronounced than in other halls

The main purpose of the acoustic design for the renovation of the hall is to preserve the acoustic conditions of the Bolshoi Hall. For this reason no major changes has been proposed.

2 Preliminary tests and acoustic measurements

Before the renovation of the hall, subjective testing and acoustic measurements of the hall and also in the scale model have been performed to evaluate its current condition and to check if it's necessary to change any constructions in the hall to improve its acoustics.

The subjective acoustic quality of the Bolshoi hall was investigated by questionnaires to both an audience listening panel as well as to members of the orchestra during one concert and one rehearsal.

The results showed quite clearly that the acoustic conditions in the Bolshoi Hall are evaluated as good, both from the audience as well as from the musicians' point of view. Obviously the listening test was done with a limited number of listeners, but also in previous discussions with musicians and con-cert goers, the evaluation has been almost unanimously positive.

The measurements in the hall have been done in two rounds: before the design project started the reverberation time of the hall was measured and during the design process a full set a acoustic measurements in accordance with ISO 3382 was done. The ISO 3382 measurements were done using WINMLS and the analysis were done using the Matlab based package called IRMA (documented in [2]).

In addition, the acoustics in the Bolshoi Hall have been investigated by a computer simulation, (ODEON Version 9.2).

The measurements and investigations presented in the paper basically show that the Bolshoi Hall of the P.I. Tchaikovsky Conservatory in Moscow has very good acoustics and is quite comparable to the other great halls of the 19th century.

When studying the layout, the hall has however some very distinct differences from the "typical" shoe box halls: a very deep rear balcony and a pronounced proscenium. Both these features could be considered acoustic defects, in particular when taking the sight lines from the rear part of the rear balcony into account.

However, both the measurements and the listening experience in the hall have confirmed that the acoustic conditions in the hall are generally very good and acceptable even on the rear part of the rear balcony.

Also surprisingly neither listening tests nor measurements indicated any major problems with sound projection from the rear stage or balance problems between the rear and the front stage.

3 The renovation process

The ceiling of the Great hall made from planks fixed to the wooden beams was still in a quite good condition. Only some planks have been changed during the renovation, but most part of them was kept. The painted fabric, fixed to the ceiling construction, was fully changed with an equivalent fabric, plastered and painted with water-based paint. Thus, the design of the ceiling remained very close to its original characteristics. The fabric on the curved surfaces between the ceiling and the walls was also changed.

The walls of the Great hall and the ornaments on the walls were only renovated. No replacements of the finishing materials were made.

Bearing concrete construction of the balcony had an emergency condition and was fully replaced. New bearing beams were made from the laminated wooden beams. The new floor of the balcony was made from the thick plywood laid on the wooden joists and oak parquet glued to the plywood.

Wooden beams of the floor construction in parterre were covered with a 50mm thick planks and oak parquet glued to the planks through the linen grid. Instead of the old air supply holes drilled through the floor construction under the seats, single hole with a 150mm diameter was made under every seat and mounted special air diffusers in it.

The new chairs for the parterre and benches for the amphitheater were made strictly in accordance with the original ones. The soft parts of the chairs (seats and backs) were selected in such a way that their sound absorption coefficient was close to the absorption coefficient of the original seats and backs. For this purpose, a series of comparative measurements of several samples of different seats was made in a special reverberation chamber and defined the sample closest to the original.

Some minor changes were made on the stage area. The organ and its position on the stage was the same, but the height of the wooden panels on the back and side walls of the stage has been reduced to 2,8m from the level of the stage. The area above the panels has been plastered and painted.

The fabric and design of the new harlequin and curtains in the lodges have been chosen equally to the originals. The same applies to the carpets in the parterre.

During the whole process of renovation all ongoing works have been performed under the supervision of the special team from the architects and acousticians as well as all used buildings materials have been checked before use.

4 Acoustic measurements results before and after the renovation

The Great hall of the Moscow Conservatory was measured after the renovation of the hall was completed, in order to confirm that the acoustic conditions in the hall were as excellent as before the renovation. Some graphs with the measured acoustic parameters before and after the renovation of the Great hall are shown in Figure 5.

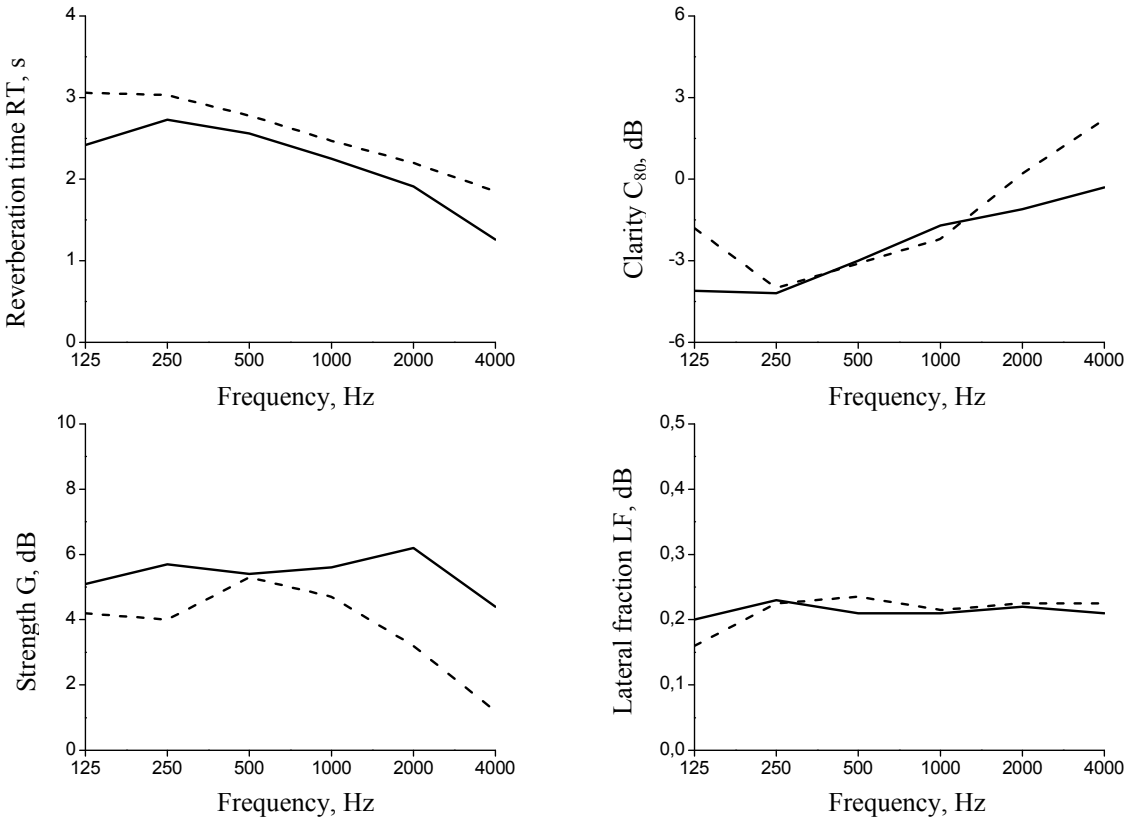

Figure 5: Measured acoustic parameters before and after the renovation [3]

The measured reverberation time RT20 values became higher than before the renovation along the whole range of frequencies. At low frequencies (125Hz) it has been increased for ~ 25%, at high frequencies (4000Hz) ~ 40% and in the range of 250-200Hz the increase was approximately 10%. The low frequencies balance, determined by the value $BR = (RT_{125} + RT_{250})/(RT_{500} + RT_{1000})$ has a value of 1.6, while before the renovation of the hall it was 1.07. It should be also stated, that received reverberation time values measured after the renovation of the hall became closer to its original values, measured for about 20 years before the renovation [4]**.** The balance of low frequencies with the full audience is 1.18.

The measured values for the C80 parameter didn't change at the range of 250-100Hz, but at low and high frequencies it can be seen the difference for about -2 dB, what correlates with the increased reverberation time at the same frequencies.

The difference of sound strength G before and after the renovation in the range of frequencies 125 – 1000Hz doesn't exceed 1,5 dB. Taking into account, that the values of this parameter may vary within 1-1,5 dB depending on the method of the measurement [5], we can conclude that a significant change in it at these frequencies has not happened. At high frequencies (2000-4000 Hz), the volume has increased by approximately 3 dB, which is already a noticeable change. However, the frequency dependence of the parameter G became more balanced.

Lateral fraction energy LF measured before and after the renovation corresponds quite well. The slight decrease of this parameter at low frequencies may be associated with an increase of stiffness of the floor construction after the renovation and, consequently, an increase of sound energy reflected from the ceiling.

In general the measurements indicate that the reverberation time is a bit longer in particular at low frequencies, compared to the situation before the renovation. This is most likely due to the changes in the parterre and stage floor construction. For all other parameters, there are good correlation between the situation before the renovation and the situation after the renovation. Also user comments about the acoustic conditions in the hall after the renovation has all been favourable. So it is clear that overall, the acoustical properties of the Bolshoi Hall are well-preserved in the renovation.

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