

THE ACOUSTICAL COMFORT IN THE PIT OF THE GRAND THEATRE OF BORDEAUX

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ABSTRACT The goal of this paper is to complete the knowledge of the acoustical behaviour of the Opera House of Bordeaux for the musicians by an evaluation of the listening comfort in the pit. In order to well estimate the agreement of the measurements' results with the opinions of the users, a comparing study, between the objective survey and a subjective survey conducted with the musicians of the Orchestra of Bordeaux, is presented allowing to finish this exploration.

INTRODUCTION

An early paper [1] deals with acoustical measurements provided on the stage of the Opera House of Bordeaux (GTB). In order to have a completed knowledge of the listening comfort for the musicians some acoustical measurements have been conducted in the pit. As is the case with a lot of other historical opera houses, the pit dimensions don't allow a big sized orchestra [2]. Upon the renovation of the Grand Theatre of Bordeaux the pit has been extended to the stage below (see figure 1) [3].

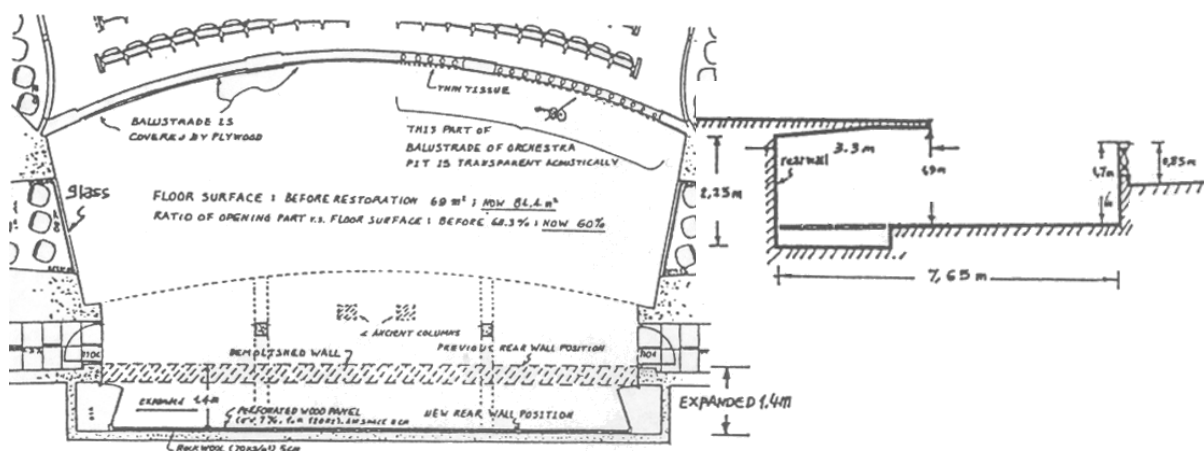


Figure 1 Plan and cross section of the extension of the pit after the renovation in [3]

In spite of this change, limited by the presence of the metal curtain retaining wall, the about 80 m² area doesn't allow groups of more than 65 till 69 musicians. Besides, the patrimonial nature of this theatre forbids any enlargement towards the pit in the direction of the auditorium seats, as it has to be kept in it's original state. So the artistic orchestra management has an Italianlike theatre at it's disposal with a flytower that by the presence of real groundfloor stages and flies permits numerous staging effects, but is only able to plan large scale operas by reducing the number of musicians a stand.

ACOUSTICAL SURVEY

Measurements

In order to evaluate the listening comfort for the musicians in the pit, some acoustical measurements were conducted and the results were compared with the optimum values. The objective criteria measured by a MLS system are the Reverberation Time RT60, Clarity C80 and 'Ease for Ensemble' ST1 defined by A.C. Gade [4] as:

$$ST1 = 10 \log \frac{\int_{20\text{ms}}^{100\text{ms}} p^2(t) dt}{\int_0^{10\text{ms}} p^2(t) dt} \quad (\text{dB})$$

which optimum value is $-12 \text{ dB} \pm 1 \text{ dB}$.

The positions of the selected sound source point (SSP) correspond to the usual position of strings (Violin 1) (S1), cello (S2), wood winds (S3) and percussion instruments (S4). The receiver points are sometimes a SSP (V1 = S1, C1 = S2, B1 = S3, P1 = S4) or representing other groups of players: Violin 2 (V2), double-basses (Cb1 and Cb2), alto (A1), conductor's position (E1), singer on the stage (Sc1). All the points are drawn on Figure 2. During the measurements the pit was only occupied with chairs and music stands. In order to have reference data, measurements are carried out on two points in the audience area at the ground floor (M2) and at the gods (A14) [5].

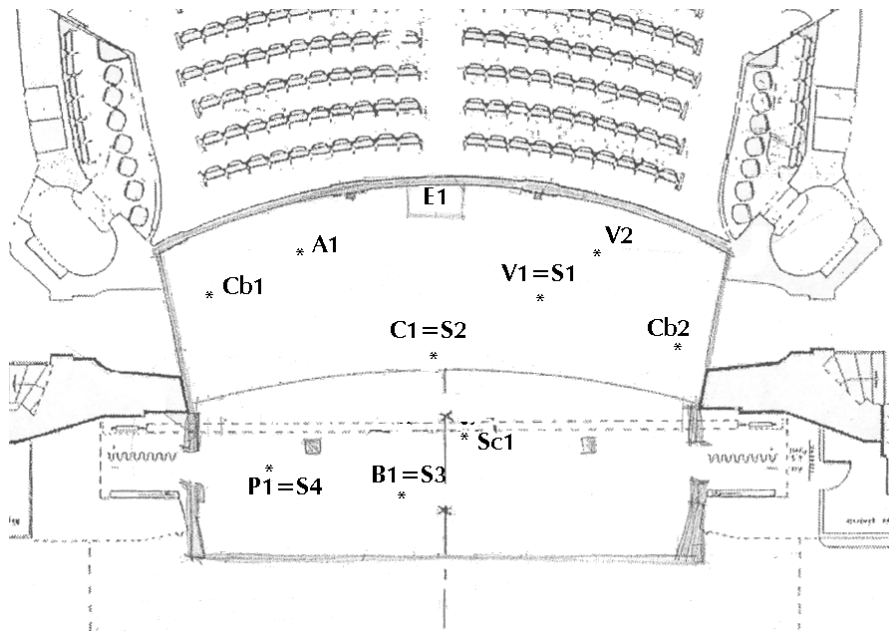


Figure 2 Positions of the source points and the receiver points

Analysis of the Results

In equal conditions (open pit and open stage), we measured on the two reference points (M2 and A14) in the auditorium the same values of reverberation as before [4]. As we can notice in the following graphs (figure 3) the RT60 in the pit presents relatively weak values due to the presence of the tissue covering and the masking perforated plate of mineral wool at the underside of the proscenium and the back wall. If we compare the measure of RT60 between a point in the pit and a point on the stage we put in evidence the difference in acoustic quality between the auditorium and the pit (figure 4).

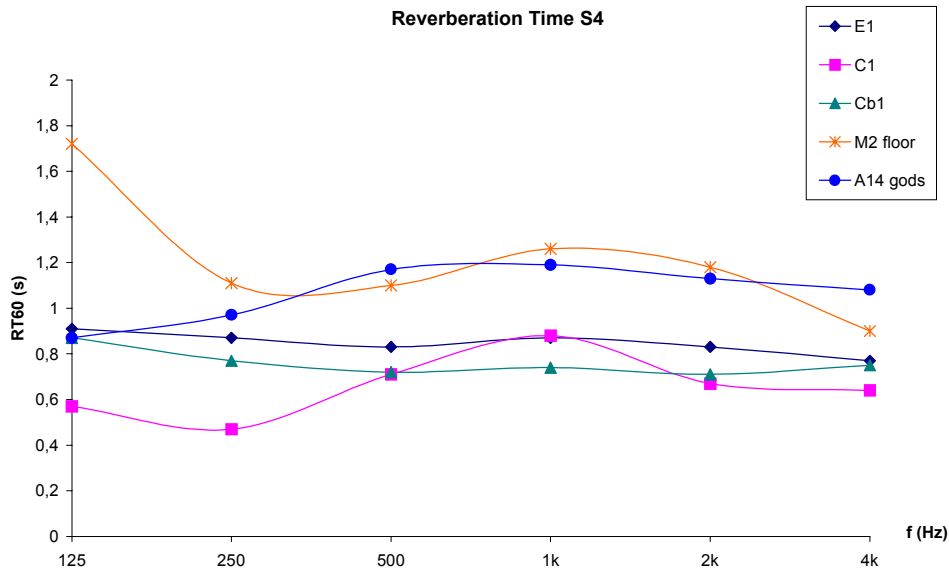


Figure 3 TR60 curves with the source on the S4 position

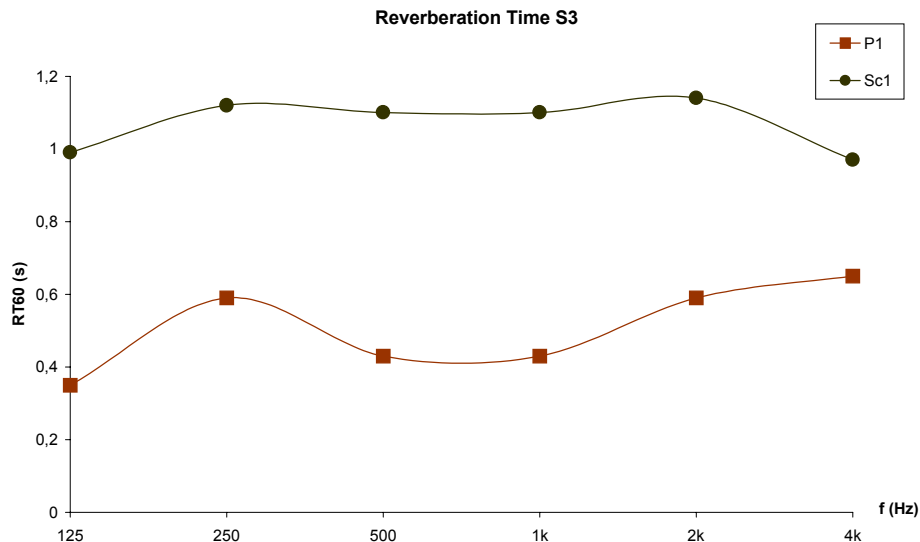


Figure 4 Comparison of RT60 curves with receiver points in the pit (P1) and on the stage (Sc1)

The measure of the ST1 allows to evaluate the listening conditions of the musicians ; in order to be satisfying they oughtn't be superior to 11dB. The following curves show to which point the listening conditions are dissatisfying, no matter the position of the source (figures 5,6,7).

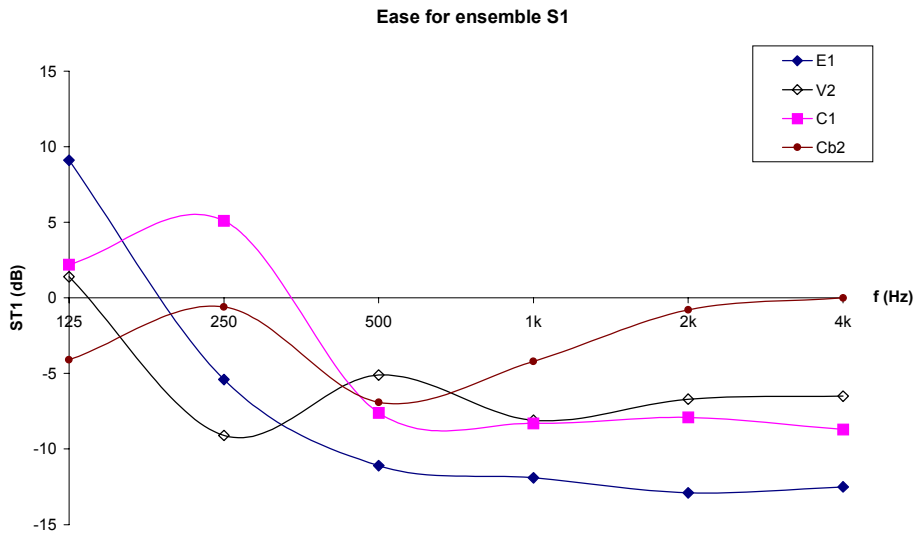


Figure 5 ST1 values for sound source position S1

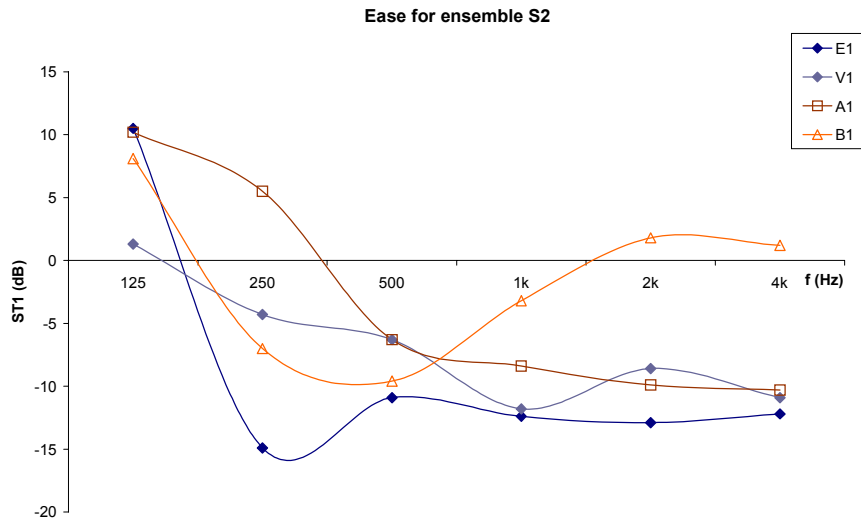


Figure 6 ST1 values for sound source position S2

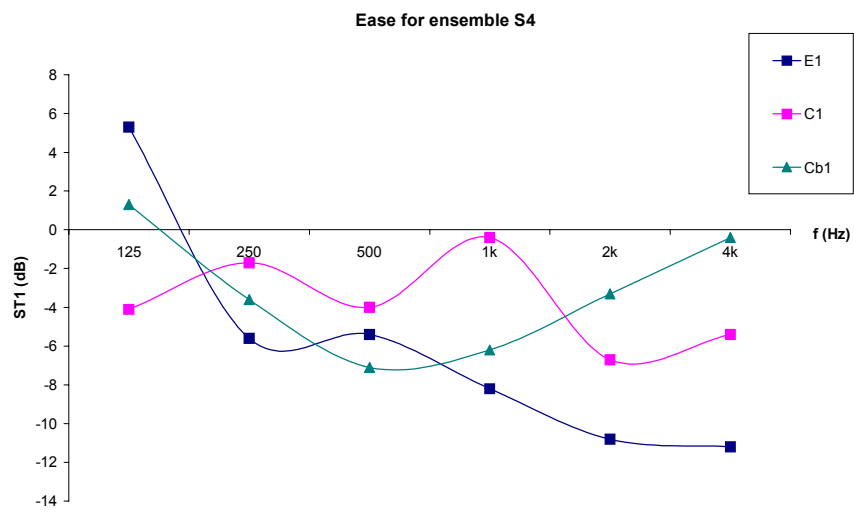


Figure 7 ST1 values for sound source position S4

The values of Clarity 80 (figure 8) are in accordance to the RT60' ones. That confirms the relatively dry acoustics of the GTB which is a hall well adapted to opera performances.

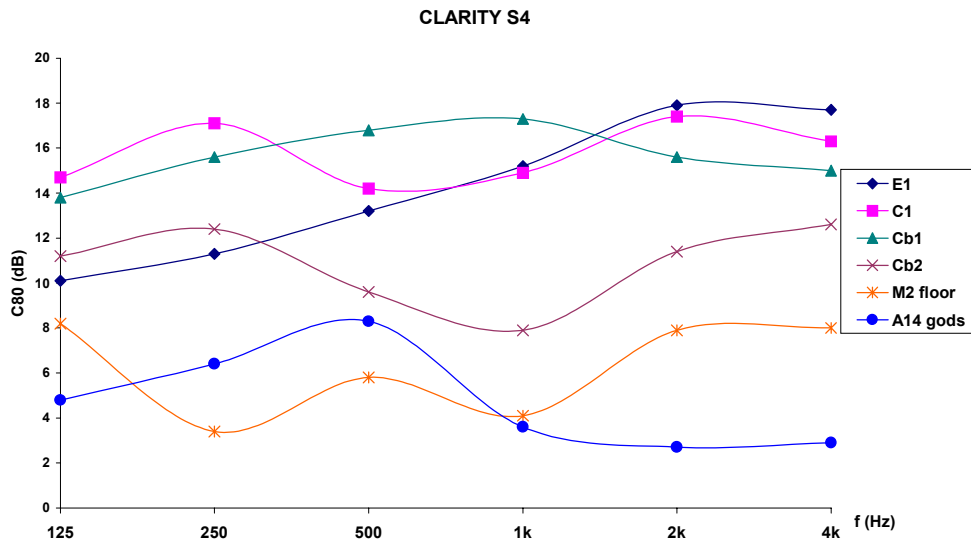


Figure 8 C80 values for the source position on S4

INTERVIEWS WITH THE MUSICIANS

Questionnaire

Like in other studies [6], [7] we were curious to know the opinion of the musicians of the ONBA (Orchestra National Bordeaux Aquitaine) on their playing conditions in the GTB pit. It particularly interested us to know whether :

- the performers can hear themselves,
- they can hear each other,
- they can hear the singers on the stage
- they have the impression that the audience listening/sound quality is good,
- the frequency balance is respected,
- they are not disturbed by the sound level of the other musicians.

Based on these questions we made a questionnaire which we distributed among the musicians during the performance of Richard Wagner's « Phantom ship ». All the stands and the whole pit were occupied. They could make a choice between 4 answers : not at all, a little, quite good, entirely.

Analysis of the Answers

All musicians, but the string stands in particular, are generally disturbed by the wind instruments (brass and wood) and the percussion, notably when they play fortissimo. All were equally disturbed by their own sound.

They all agree that the sound attack seems pure (60% quite good and 40% entirely). On the whole they are not disturbed by other noises (equipment like ventilation, technicians, audience, outdoor noises) during the performance.

It appears that the mutual listening conditions of the musicians and of the singers on the stage are strongly depending on their position in the pit in accordance with the performances.

We notice that the results of this little survey leads to the same conclusions as in [8] together with complaints concerning the lack of space, the excessive noise level, the difficulty to hear the other orchestra members, in particular when the individual average available space in the pit is less than 1,5 m², which is the case in the GTB.

CONCLUSION

The subjective survey results confirm those of the acoustical measurements. Like in a lot of pits, and in particular in the old theatres, the acoustical comfort conditions and other global comfort aspects, are not satisfying. The reasons are mostly related to the obligation to plan operas which demand too much musicians according the available space.

ACKNOWLEDGMENTS

The author wish to acknowledge the staff of the Grand Theatre of Bordeaux, the musicians of the Orchestre National Bordeaux Aquitaine, E. Merida and T. Toulemonde for their cooperation and support for these study.

REFERENCES

- [1] Semidor C. Stage acoustics for an Opera House orchestra, in *Proceedings of the 17th ICA*, Roma, 2001, pp 14-15
- [2] Holden M. Orchestra pit acoustics – From Bayreuth to Broadway, in *Proceedings of the 16th ICA*, Seattle, 1998, pp 331-332
- [3] Xu A.Y. Invisible acoustics in the restoration of the Grand Theatre de Bordeaux, in *Proceedings of IOA*, vol 14, part 2, 137-145 (1992)
- [4] Gade A.C. *Acustica* **69**, 193-203, 249-262 (1989)
- [5] Semidor C., Barlet A., *Journal of Sound and Vibration* **232(1)**, 251-261 (2000)
- [6] Gade A.C. Compromises in orchestra pit design; a ten year trench war in The Royal Theatre, Copenhagen, in *Proceedings of the 16th ICA*, Seattle, 1998, pp 343-344
- [7] Graffy K. et al. Some recent experiences with the acoustical design of orchestra pit, in *Proceedings of the 16th ICA*, Seattle, 1998, pp 667-668
- [8] Gade A.C. et al., Acoustical problems in orchestra pits ; causes and possible solutions, in *Proceedings of the 17th ICA*, Roma, 2001, pp 10-11