ROOM ACOUSTIC MEASUREMENTS IN HALLS WITH ELECTRO-ACOUSTIC ENHANCEMENT SYSTEMS

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1 INTRODUCTION

Electro acoustic enhancement systems are becoming more and more acceptable in particular for multipurpose halls. Throughout the last years, several systems have been implemented, both InLine-, Feedback- as well as combination-systems.
As part of the PhD studies of the authors, several halls with electro acoustic enhancement systems will be measured, using a scaled down version of the Virtual Orchestra, described by Pätynen et all. The halls measured will represents all 3 types of systems and are all found in norther/eastern Europe. The object of the measurements is to get data for listening tests, however the measurement data has also been analyzed to examine the traditional room acoustic parameters.
In the paper we will present the preliminary measurement results for the halls measured and present an outline for the further work.

2 BACKGROUND

So far 3 halls have been measured. The halls measured are:

- 500-seat multipurpose hall
- 500-seat opera hall
- 1800 seat multipurpose hall

It is the intention to measure at least on hall for each of the currently available systems (within some geographical limitations). Furthermore, at least 2 halls are known to have proprietary system, essentially a modified MCR system based on a standard sound system processor.

3 MEASUREMENT SETUP

The measurements are done with the reduced Virtual orchestra, described in [1].

A swept-sine method is used and recorded in the hall using an A-format microphone and an omnidirectional microphone on top of it. The recorded spatial impulse responses are analyzed with Spatial Decomposition Method (SDM) [5] and visualized using mainly the spatiotemporal and time-frequency visualizations [4]. Traditional, acoustic parameters are calculated from the omni response.

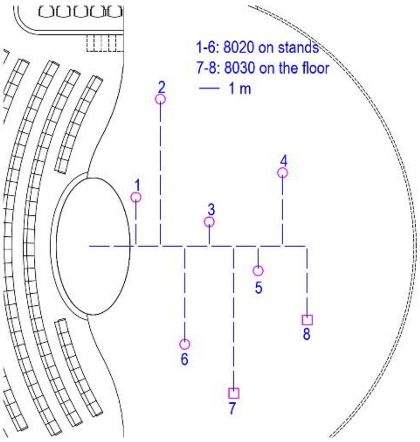


Figure 1: Loudspeaker setup

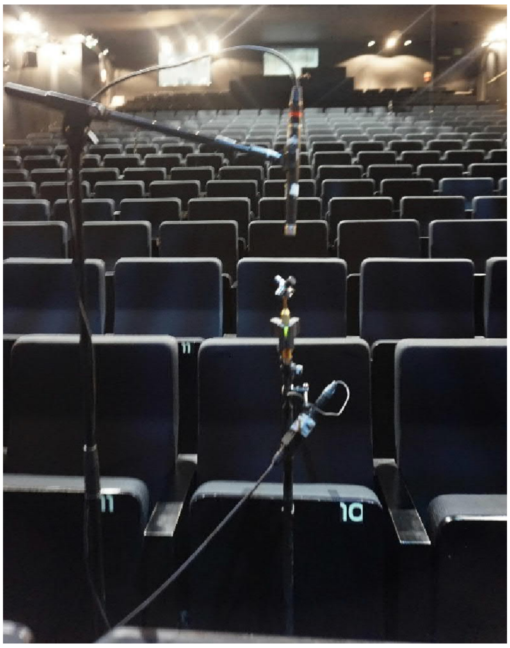


Figure 2: Microphone setup

As most of the acoustic enhancement systems are time-variant, it is clear that the measured

impulse response is a “time-slice” and as the measurements are done with 8 separate sweeps, the impulse response will change between the different sweeps. However, this is same as the situation for the audience in the hall and therefore the method is considered to be appropriate. From purely technical perspective, an average of several repeated measurements could counteract the time-variant character of the electro-acoustic system, but with the expense of other time-variant natural properties.
In all halls, the receiver positions are chosen in accordance with ISO3382-1, and all audience areas of the hall is sampled.

4 MEASUREMENT RESULTS

The measured reverberation time for the halls for the different settings are shown in figures 4 -5.

In all cases, the change in both reverberation and clarity, are by far larger than what would be achievable with traditional variable acoustic means.

When looking at the different settings in the halls, it seems that the setups reflect a certain preference, not necessarily what would be expected from an acoustic design point of view. For instance, the Opera setting in the opera hall, has a significantly longer reverberation and lower clarity than the Concert setting. Also in this hall, the differences between the different setting are not as large as in the multipurpose halls.

In both multipurpose halls, all settings produced a quite significant bass boost, however, as can be seen figure 6, the change in clarity is not as pronounced.

One issue could be that in all the halls, the natural reverberation time at bass frequencies is higher than at mid frequencies.

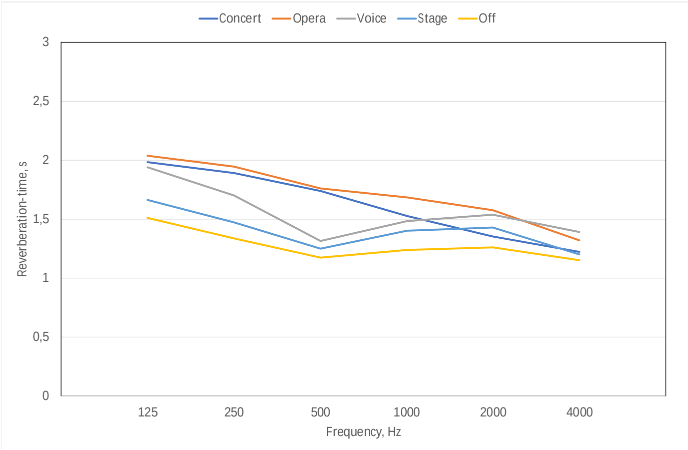


Figure 3: 500 seat opera hall

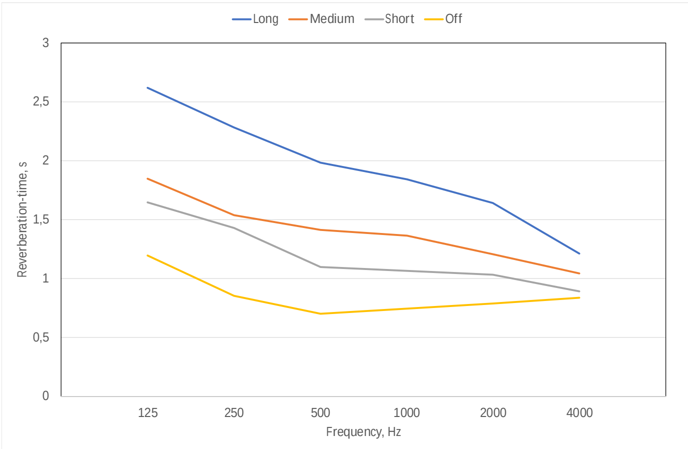


Figure 4: 500 seat multipurpose hall

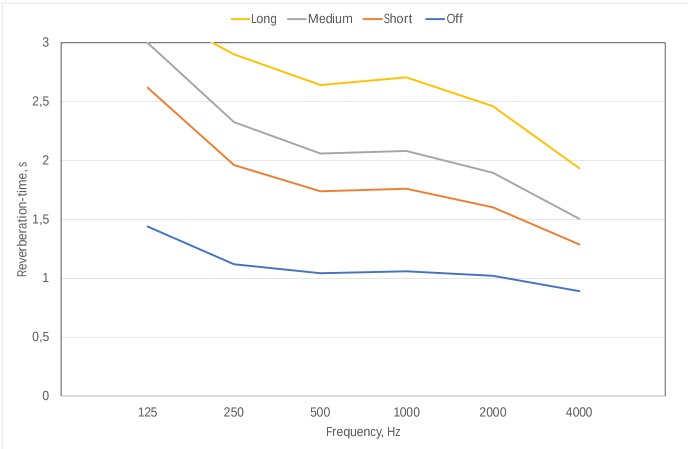


Figure 5: 1800 seat multipurpose hall

The rise of the reverberation time at low frequencies (125 Hz and 250 Hz), could be regarded as somewhat illogic design decision if the hall was designed for an electro acoustic enhancement system, however all the halls in this investigation are renovated which might explain the natural acoustics.

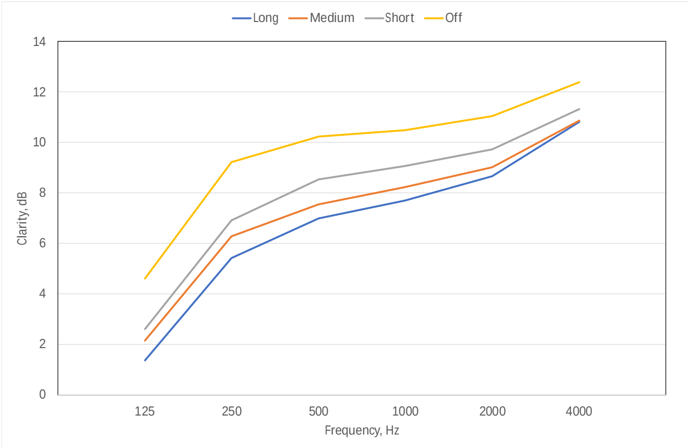


Figure 6: Clarity in the 500 seat multipurpose hall

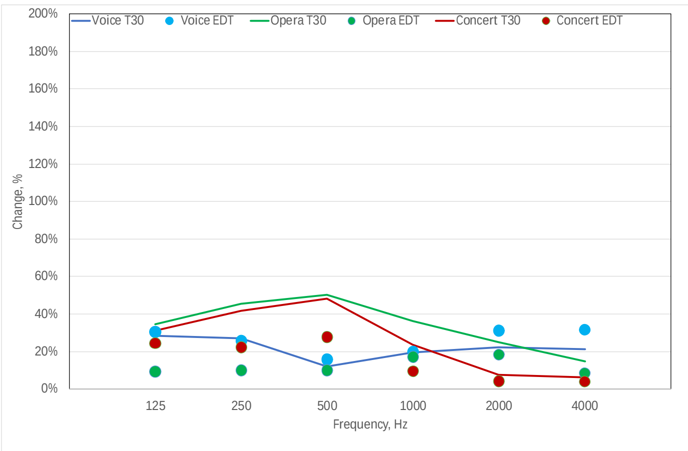


Figure 7: Relative percentage change of reverberation time and EDT in the opera hall

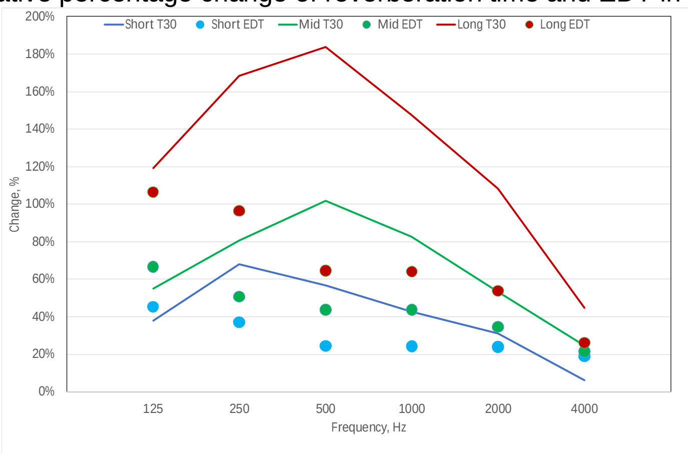
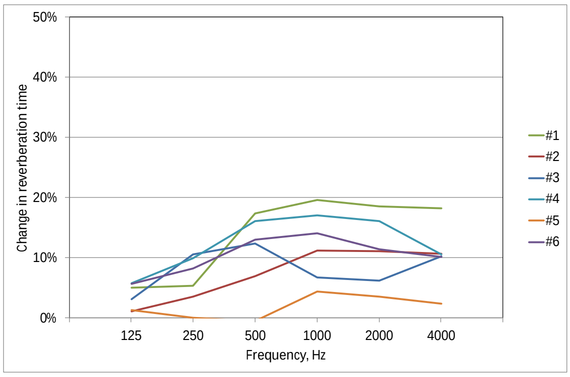


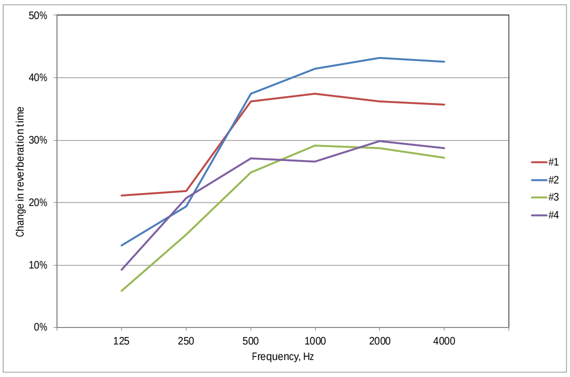
Figure 8: Relative percentage change of reverberation time and EDT in the 500 seat multipurpose hall

When comparing the variability in the to 500 seat halls measured for the investigation the variability of Finnish multipurpose halls presented in [8], some clear differences can be noticed. First of all, the overall dynamics are much larger with electronic enhancement systems. But what is perhaps more interesting is that is possible to achieve very large variability at bass frequencies with electronic enhancement systems and that, to some extent, the different acoustic characteristics can be independently adjusted for the different settings. With variable acoustic surfaces, this only possible to a limited extent, with variability to control some distinct areas of reflections.

As Cees Mulder states in [9], every mic-amp-loudspeaker channel, can produce a 2% percent naturally sounding increase in the reverberation time. It would seem that this may be part of the reason for the large difference of the performance of the systems in the halls, the amount of change implemented corresponds to the since of the size of the system, or at least the number of channels in the feedback part of the system.



Just surfaces in the auditorium



Auditorium surfaces and stage curtains

Figure 9: Variability of reverberation time in multipurpose halls with variable acoustic surfaces

5 DISCUSSION AND FUTURE WORK

As stated earlier, the project is stilling on going and it is intended to measure more halls. The main limitation of the data presented in this paper is that the data is only from 3 halls, representing 2 of the currently available systems. It is clear that currently there are at least 4-5 commercially available systems with similar functionality and furthermore there some installations with proprietary systems based on standard audio processors. It is the intention to gather a comprehensive database for all these systems.

The main issue, of course which have not been discussed in this paper, is how do these systems sound or rather do they sound natural. One argument or question, should they sound natural ? The sound in a cinema hall is far from “natural” and still enjoyable. It is clear that un-natural sound becomes a problem if in interferes with musicians’ ability to play on stage. Playing should like playing in natural acoustics, not playing with sound reinforcement monitors. But again: it is problem if it doesn’t sound natural if it sounds good?

In the next phase of the work, first of all more halls will be measured and spatial analysis will be performed on the data to present better metrics for the acoustic performance of the halls.

Finally, a listening test based on both the measurements in halls with electro acoustic enhancement systems as well as halls with traditional acoustic solutions will be made.

6 CONCLUSIONS

Electro acoustic enhancement system has become a feasible tool to increase the acoustic variability of halls, in particular multipurpose halls. Judging by the measurement done so far, the actual settings implemented, are more a result of user preferences, than strict acoustic theory.

However, it is the clear impression of the authors that electro-acoustic enhancement system will be one of the primary tools for creating multipurpose halls in the future.

7 REFERENCES

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