PLATFORM ACOUSTICS FOR THE JAZZ ENSEMBLE*

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ABSTRACT

The objective of this work has been to investigate the acoustical conditions and preferences of a jazz musician. Five objective parameters that explain some of the characteristics of a platform are chosen and explained. In the experiments, described in this work, these parameters are measured and compared in three halls. Recordings of two jazz tunes are made in these halls and from these recordings a few subjective impressions are judged by the author and some test persons. The result is that it seems to be possible to find desired values for four of the objective parameters. Improvements of a poor platform to make it easier to perform on are possible. It is difficult to judge any specific subjective parameter and to correlate this to any objective measurement.

INTRODUCTION

Normally, at almost all music concerts microphones and amplifiers are used. Very often this is destructive to the music. An orchestra spends much time rehearsing balance and dynamics but in the end there is a sound engineer who decides how strong a part or an instrument should be. It would be preferable to use the room's natural acoustics to amplify the music and it ought to be possible to use reflectors, absorbents and some knowledge about room acoustics to make the platform easy to play on for the musicians. In this way the orchestra's natural sound should be preserved.

In this work some experiments are made to see if the acoustical conditions of a jazz musician can be improved by using only reflectors and absorbents.

EXPERIMENTS

Most of the theory on which these experiments are based is from the works of Anders Christian Gade (1981, 1982). Both the sets of objective and the subjective parameters are from his work. The jazz orchestra "Bomullstussarna", in which the author is one of the members, was used for the experiments.

Objective Parameters

The parameters I have chosen to use are the Reverberation Time, Early Decay Time, Clarity, Early Ensemble Level, and Support.

The reverberation time is the time it takes for an interrupted sound to decrease 60 dB. Recent work shows that the initial decay is more closely correlated to our perception of reverberation. Therefore the parameter Early Decay Time (EDT), is used more frequently. The EDT is the delay time for the first 10 dB, recalculated to reverberation time, i.e. six times the delay time for the first 10 dB. Gade (1982) uses a definition of clarity (C), which was first introduced by Reichardt and his co-workers (1975).

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\[ C = 10 \cdot \log \frac{E(0 - 80\text{ms})}{E(80\text{ms} - \infty)} \]

where \( E(0 - 80\text{ms}) \) is the energy between 0 and 80 ms.

One of the two most important characteristics of a concert hall platform is the acoustic support it supplies to the musician. Support (ST), is defined by Gade as

\[ ST = 10 \cdot \log \frac{E(20 - 200\text{ms})}{E(0 - 20\text{ms})} \]

Gade (1982) tries to describe the conditions of the ensemble with a measurement of the Early Ensemble Level (EEL). Early ensemble level is the energy rate between an emitter and a receiver, 8.5 meters apart.

\[ EEL = 10 \cdot \log \frac{E_r(0 - 80\text{ms})}{E_r(dir)} \]

\( E_r \) is the total energy at the receiver spot, both direct and reflected sound. \( E_r(dir) \) is the energy of the direct sound from the source at the emitter.

All of these five parameters, except EEL, are derived from the impulse response of the platform. The Reverberation Time and Early Decay Time were measured using Schroeder’s method of reversed integration (1965).

**Subjective Parameters**

The subjective parameters I chose to use are:

- **REVERBERANCE** The experienced reverberation.
- **SUPPORT** The experienced acoustical support the hall provides. In contrast to reverberation this does affect the tone while the tone is being played, not only after.
- **TIMBRE** Change of timbre in different halls or different frequency ranges.
- **DYNAMICS** The room’s ability to obey to dynamic intentions.
- **HEAR-EACH-OTHER** The ability to hear all other members of the orchestra.
- **TIME DELAY** The experienced problems when the distance between musicians gets too long.

These were judged by each member of the band in a small questionnaire. In order to find out if there are any differences at the same platform, all of the parameters mentioned above was also judged by one person but as experienced by different musicians at different seats. Four members of the band were equipped with a set of small microphones that were placed in the ears of the person. This was an attempt to record what the different musicians actually hear in the orchestra, and the acoustics can then be judged by one person at different locations.
As a pilot experiment all the objective measurements were made in a very poor concert hall (AV) and again after some improvements were made (IAV). After this three series of measurements and recordings were done. The first one on a platform that is considered good (STG). The second one is on a platform with a poor reputation (STP) and the third on the same platform with some attempts to improve the characteristics (ISTP). The results are shown in Table 1.

Table 1. The objective measures in the five different halls.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>AV</th>
<th>IAV</th>
<th>STP</th>
<th>ISTP</th>
<th>STG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverberation Time, T (s)</td>
<td>1.53</td>
<td>1.40</td>
<td>1.01</td>
<td>0.83</td>
<td>0.50</td>
</tr>
<tr>
<td>Early Decay Time, EDT (s)</td>
<td>1.3</td>
<td>0.82</td>
<td>0.89</td>
<td>0.77</td>
<td>0.49</td>
</tr>
<tr>
<td>Clarity, C (dB)</td>
<td>-0.74</td>
<td>5.55</td>
<td>4.57</td>
<td>5.37</td>
<td>9.11</td>
</tr>
<tr>
<td>Support, ST (dB)</td>
<td>10.5</td>
<td>-1.61</td>
<td>2.25</td>
<td>2.21</td>
<td>2.28</td>
</tr>
<tr>
<td>Early Ensemble Level, EEL (dB)</td>
<td>-3.00</td>
<td>-18</td>
<td>4.06</td>
<td>5.68</td>
<td>-4.47</td>
</tr>
</tbody>
</table>

It is hard to draw any conclusions from the parameters of the good hall. These values are from a good hall but that does not mean they are optimal. It does seem as the reverberation time is to be short for comfortable jazz playing and the early decay time likewise. The high value of Clarity is probably desired. It is hard to say anything about the support as this measure did not change in the different halls. Close to 2-3 dB does, however, not seem to be wrong.

![Fig. 1. The seating of the orchestra. The musicians with microphones are marked with a cross. The reflectors and absorbents (cushions) are shown relative the orchestra.](image-url)
The poor room that was used for the experiments has a reverberation time that is experienced as too long. It is also experienced as noisy. The improvement made were cushions in the corners and some in front of the orchestra to absorb some high frequency sound. Two reflectors were added to reflect some of the sound from the front musicians to the ones in the back. Two reflectors were also added behind the orchestra. The seating of the orchestra and the position of the reflectors and absorbents are shown in Fig. 1. In Fig. 2 the initial 0.2 seconds of the impulse response of the poor and the improved halls are shown. The effects of the absorbents are obvious. The reflected sound is much damped. The energy does also arrive a little earlier from the front reflectors. This is why the clarity is increased by almost 1 dB.

Apart from the early ensemble level all four objective parameters are improved or unchanged in the improved hall. The objective parameters place this improved hall in between the good and the poor hall. Thus the improvements seem to be successful. The results from the measurements of the Early Ensemble Level are not used in these results due to inaccurate measurements, see below.

RESULTS
In my opinion the overall performance recorded in the good hall are much better than the other ones, as expected. The intonation is much better and the timing, which is so important in jazz, likewise. The good hall gives a feeling of closeness or intimacy. The poor hall makes some instruments sound very shrill and noisy, especially the trumpet. The improved hall is, as expected, somewhere in between. More improvements are needed to make the hall feel really comfortable. The ensemble playing is not good but better than in the poor hall. The shrill sound of the trumpet is damped by the absorbents. The orchestra has a warmer sound. The improvements are definitely noticeable and the orchestra did perform better in it.

In order not to be unconsciously misled by my knowledge of how the results ought to be, a small listening test was made. Ten short examples were played to the seven test
persons. Each example consisted of two versions of the exact same sequence, recorded at the same ensemble position, but in different rooms. The test person was instructed to tell which recording he or she preferred. If we discard the persons who gave different opinions about identical sequences, only four persons are left. Of these forty answers only three were wrong. One of the test persons was a very experienced jazz player. Without hesitation he picked out the good hall in ten out of the ten cases. The test shows that there are such things as a good and a poor hall. To some extent it is a matter of opinions but mostly not, and my impressions of the recordings seem to be shared by others.

The expert also introduced a new aspect that he felt was very important, the separation of instruments in a room. A new subjective parameter, SEPARATION, might be called for. Unfortunately, time did not allow me to look further down this alley.

When analysing the results of my objective measures I decided to discard all measurements of the early ensemble level (EEL). Firstly, it turned out it required two high quality microphones, which I did not have access to at that time. Secondly, the rooms are too small. If the microphones are 8.5 meters apart both microphones and the source will be very close to a wall or a corner. To get accurate recordings it should be at least a reverberation radius to all reflecting surfaces.

The small questionnaire turned out to be difficult to use. The orchestra members are not experienced enough for these types of judgements. An overall judgement was made and then the questionnaire was filled out to match these impressions. Instead I chose to just have an informal discussion about the different rooms after the recordings were made. Thus, the subjective parameters suggested in this work are not relevant to the results and no attempts are made to correlate these six parameters to any objective measurements.

The subjective impressions are of course my own. To some extent they will always be affected by my prior knowledge of the rooms. The listening test does, however, show that these opinions are shared by other persons.

CONCLUSIONS

It does seem that there are such a thing as a good and a poor platform. Different persons do have different taste, but some unanimity exists. If a musician encounters a platform that he is not happy with, changes can rather easily be made to make it better. There are a few objective measurements that can be made that reveal some of the characteristics of a platform. Reverberation time and early decay time are perhaps the most useful. Mainly because the effect of a long or short reverberation time is well understood. Clarity seems to give some information on how the details of the music are preserved. The acoustic support the hall gives to a musician is important. There is an objective parameter, Support, that measure this ability.

It is difficult to tell from these experiments how these objective parameters correlate to our subjective impressions of the platforms. However, it does seem as the overall judgement follows the values of all four parameters mentioned above. It is difficult for inexperienced test persons to distinguish between the different subjective parameters.
REFERENCES


