THE SIGNIFICANCE OF EXCELLENT CONCERT HALL ACOUSTICS FOR AUDIO RECORDINGS OF CLASSICAL MUSIC

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1 INTRODUCTION

When you ask musicians or conductors where they would like to record their next CD album, they typically have very clear ideas in which hall they like to record and which venues they dislike.
Recording Engineers nowadays have many digital tools and software (such as Delays, Roomenizer Plug-Ins and Convolution reverb) to design and shape recorded sound. Why do we still book expensive concert halls to record symphonic music?
And what happens when recordings have to be done in acoustically problematic venues or in exotic orchestra setups? During the difficult years of the Covid-19 pandemic, we unintentionally made acoustic experiments all over the world with new orchestra layouts on stage.
This paper describes the importance of hall acoustics for Classical Music recordings, as well as the importance of a compact seating arrangement for orchestras and their effects on music making during a recording of symphonic music.

2 HOW DO MUSICIANS REACT TO DIFFERENT ACOUSTIC ENVIRONMENTS?

2.1 Experiments in an anechoic chamber

In 2017, the tonmeister department of Bavarian Radio Munich made a series of experiments with a few members of Bavarian Radio Symphony Orchestra to find out how musicians react to changes of acoustics: several orchestra members of BRSO (a cellist, a trumpeter, a flutist, a percussionist and a string duo) were asked to play – one by one - short pieces of music, alone in an anechoic chamber in the former Institute for Broadcasting Technology (IRT Munich). The performances were recorded without adding any additional reverb.
First, each musician was asked to play a short piece. Immediately afterwards he played the same melody again, but now wearing headphones. Through the headphones he heard a reverberated version of what he was just playing. Now he perceived himself playing in a beautiful virtual concert hall, with the reverb parameters set to suit the performed piece of music.
Again, this was recorded. The recording itself was done - exactly like the first time – without adding the artificial room response: the reverberation played to the musician's ears was not recorded.
Now the two recordings could be compared with regards to tempo, sound, dynamics and phrasing.
A third recording of the same piece of music was then done in the concert hall (Herkulessaal Munich)

2.1.1 Results of the experiment:

The difference between the three recordings and their musical interpretation made by the cellist under three different listening conditions can be assessed as follows:

1. **Playing without hearing any room response in the anechoic chamber:**
   Very intimate
   Not performed for audience – like rehearsing for himself
   Little dynamics
   Small gestures

2. **Playing in the anechoic chamber while hearing reverb on headphones:**
   Tempo becomes a bit slower, more flexible and lines more legato
   Level louder with more harmonics (more brilliant)
   More dynamics
   More articulation and phrasing
3. **Playing in the concert hall on empty stage:**
   Dynamic gets more delicate and differentiating
   Variety in tone and color gets richer
   Now it is a performance of music !

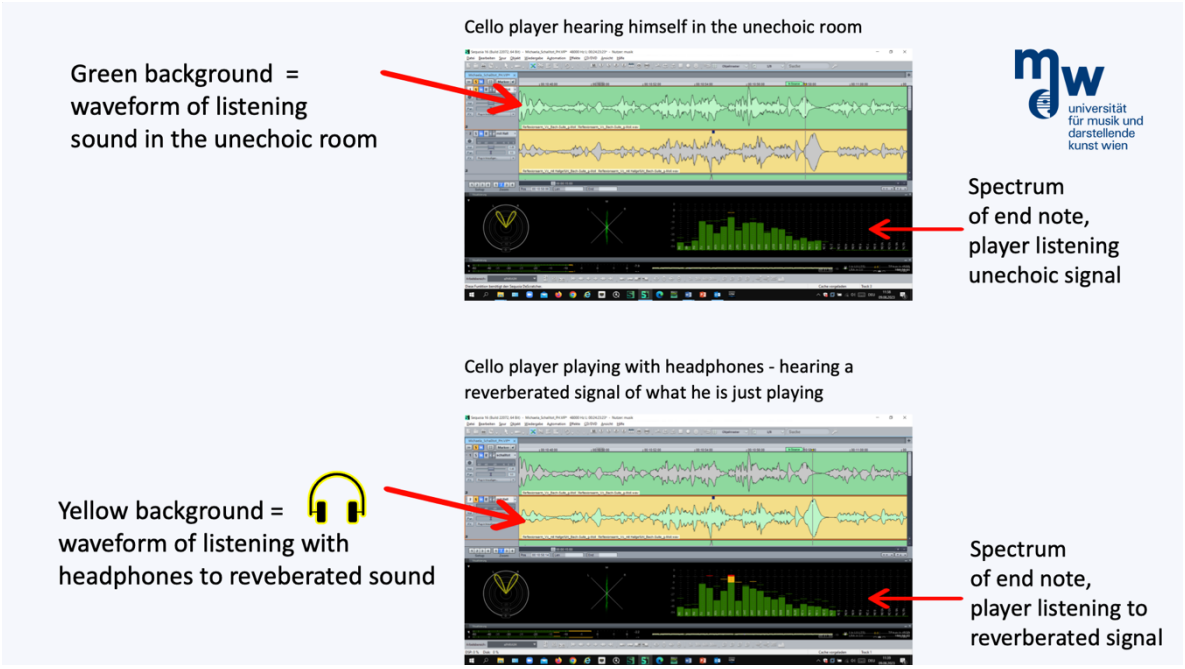

Fig. 1 Comparison of Waveform and Spectrum of Solo Cello

It is interesting to mention that the adaption of playing style to what the player heard happened within milliseconds. The other instrumentalists participating in this experiment (playing flute, trumpet, snare) reacted similarly to the changes of the acoustic environment.

2.2 Recording in acoustically unsuitable halls may result in failure

Very generally, we learn much more about music recording and acoustics when facing difficult situations during recordings. This can be situations when musicians are struggling with the acoustics of a venue. Extreme situations during recordings show the limits of adapting to acoustics. Having been involved as Recording Producer in a few recordings which had to be cancelled or could never be released because the chosen venue was simply not fitting for the repertoire, I am always aware of the importance of acoustics. But also extreme setups on stage, like during the Covid-19-period, brought us new findings.

2.3 Unintentional experiments during Covid-19 throughout the world

In early summer 2020 the Covid-19-restricitions forced orchestras to adapt their seating arrangements according to the regulation of keeping social distance. However, musicians of many orchestras were longing for making music together after many weeks of isolation during lockdowns.

They accepted all official requirements for social distancing and tried to find solutions to play with the administrative order to sit 2-3 meters apart.
Singers and wind players had to sit apart from each other with a minimum of 3 meters, sometimes additionally sheltered by transparent screens or reflectors to avoid the spreading of the virus. Before each rehearsal, the stage manager used to appear on the stage with a ruler to check the correct distances.

However, even the largest stages of concert halls could not offer the musicians enough space for such spatial expansion. In principle, there were three possible workarounds for this dilemma:

1. Reducing the string section to a minimum of necessary players per section
2. Expanding the stage area in all possible directions with an additional forestage and using galleries (e.g. organ gallery or audience galleries and balconies around the stage area)
3. Choosing non-symphonic repertoire – compositions of larger Chamber music, performed with conductor (e.g. Mozart Gran Partita for 13 musicians or Dvorak Serenade for strings)

While the third solution is primarily an artistic decision, the first two points also concern acoustic issues.

For example, by reducing the number of first violins from the usual 14 (or 16) to just 6 (or 8) and adjusting this accordingly for all other string groups (2nd Violins, Violas, Celli and Double Basses), the string section could be halved.
But what did it do to the music, the balance and the intention of a composition, when Symphony Orchestras performed as chamber-sized string sections, whereas the wood wind and brass sections remained in their normal number of players (since every wind player plays a different voice)?
String players were no more sharing their music stands in pairs, as is the standard in normal times: each string player now had his/ her own music stand, to be able to sit further apart from each other.

One of our students at University of Music and Performing Arts Vienna based his diploma thesis on research about how the orchestra setups during Covid-19 affected the results of sound, music making and the artistic outcome of music productions. [1]
We interviewed orchestra musicians of different symphony orchestras and recording producers to find out what in their opinion where the greatest difficulties or limits during Covid-19- recordings:

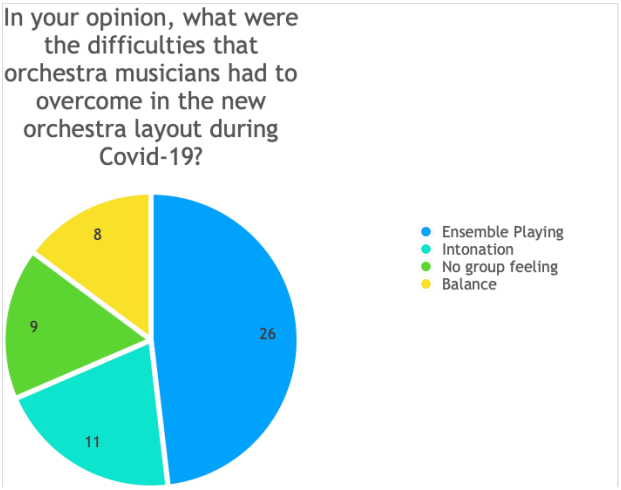

Fig. 2 Survey result on the difficulties of the orchestra musicians in the new distance situation, quoted from T. Dasbach[1]

Most of the musicians commented that it took them several weeks and many rehearsals to adapt to the new setup on stage. They reported frequently that they found it difficult to assess their own playing: "*How does my sound fit into my group of instruments? Do I play too loud or too soft? How does my sound color and vibrato fit into the overall sound? How is my timing?".*

Recording Producers mentioned that many musicians came into the control room to listen to the recording to get some answers to their questions or to get feedback from the Producer.
This proves how important it is for orchestra musicians to hear themselves and their colleagues on stage in a good ratio.

In addition to the questionnaire, a listening comparison was carried out for this diploma thesis:
the group of subjects (all of them recording experts for Classical Music or advanced Tonmeister students) listened to orchestra recordings of the same symphonic composition, recorded once pre-Corona and then compared the identical piece of music recorded in the same concert hall with the identical orchestra in a Covid-19 orchestra layout. The test persons had no information which of the two samples was recorded during Corona. The audio was presented without Video.

The results of the listening comparison confirmed that the Covid 19-recordings had issues with

- Ensemble Playing
- Intonation
- Missing homogeneity in the string sound
- Lack of blending between instruments
- Missing density and compactness of sound
- Audible “Safe-Playing” – There is no covering by the group
- Reduced dynamics, caused by careful playing, taking no risks
- Limited freedom for music making and interpretation

Generally speaking, the interpretations remained somewhat limited and did not reach the quality level of the orchestra’s playing during normal times.

Wind players commented that they had more difficulties in hearing the strings since the string players were sitting further away and were halved in number of players.
In some cases, on-stage monitoring was used to give the percussion and wind players some orientation about what was going on in the strings.

Recording engineers reported that in a Covid-19 orchestra setup, an ideal position for a main microphone to catch a balanced overall orchestra sound could hardly be found. They also had to apply 2-3 times as many spot microphones to cover the expanded stage area the musicians occupied now. Whereas in a normal orchestra it was sufficient to set up one cardioid microphone for two flutes, now one per player was necessary. In normal pre-Corona orchestra setups, there might have been two spot microphones for the 14 first violins. Now with 6 isolated players, we needed a minimum of three spot microphones for 6 players to create expansion and homogeneity in string sound.

The numerous spot microphones also picked up a lot of spatial sound from the instruments sitting far away, which added unintentionally reverb to the mix. In addition, in Covid-19 constellations, a large proportion of the stage floor remained unused (i.e. is not covered by musicians) and therefore acts as a reflecting surface.

This was particularly the case in front of the brass section, whose sound is usually dampened to a certain degree by the woodwind section sitting right in front of the brass. But in a Covid-19 setup, the brass received additional enhancement by reflections from the empty 3 meters of stage floor in front of them.
This again shifted the balance between strings and wind instruments to the detriment of the strings, which were already sounding weaker because they were fewer players.

All this resulted in the recorded sound being more reverberant, especially since microphones were also picking up the sound of the abovementioned on-stage monitors, which further contributed to a less defined and dull sound.

While the imbalances of instruments and levels, as well as the amount of reverb, were relatively easy to correct for the sound engineer, for the musicians the insecurity during their performance remained.

Video Producers were not happy with the increased number of microphone-stands, spoiling the picture.

The year 2020 will be remembered as the year of the so-called “ghost concerts”. These were complete and uninterrupted performances in concert dress with cameras running, but without any audience present. They were often recorded during rehearsal times and not at 8pm in the evening. The psychological motivation for conductors and musicians to rehearse for such a perceived ‘dry-run’ in the same intensity as for a concert performance inevitably was somewhat lower. Very often the video stream was not even broadcasted live, but only recorded. And everybody involved in the performance had the opportunity in mind that eventually musical accidents or errors can be fixed by the tonmeister before broadcasting.
Although artists were working with great professional attitude, most performances given in empty halls, in front of cameras instead of listeners, could not reach the same artistic level compared to a public concert. Missing tension, missing energy (also caused by the careful safe-playing) reduced the level of the overall artistic outcome to quite some degree.
Hence, in many cases, the artistic boards of orchestras did not approve the final result to remain online permanently.

2.4 What did we learn from Covid-19-Orchestra-Setups?

Even in excellent concert halls with ideal stages for symphony orchestras, a “normal” orchestra setup is necessary to perform on highest musical standards.
A compact orchestra-seating defines the orchestra as one “sound body”.
Eye contact between musicians, breathing together and hearing each other without delay caused by travel times of sound waves across too big distances is crucial for musicians and cannot be replaced by putting monitor speakers on the stage floor.
The abilities of musicians to adapt to new circumstances and adjust their playing in the necessary manner have proven truly amazing. When the Covid-19 distances finally were abandoned again to return to normal seating, once more this was a process of re-adapting for the musicians, which lasted across another couple of rehearsals, until they arrived back at standard playing.
Symphonic repertoire, certainly when we are talking about romantic composers, cannot be reduced to small string settings without severely compromising.

2.5 Acoustically unsuitable venues and their consequences for the recording

Performances and recordings of orchestral music may end up with disappointing surprises when the chosen venues are unsuitable for the piece of music, or for the instrumentation, e.g. the acoustics may be too lively, overly reverberant or too dry. Or there might not be enough space for an orchestra to sit.

Such situations can occur when recordings of symphonic music take place in huge cathedrals, where orchestras have to sit tightly squeezed in a narrow sanctuary. Examples are the concerts of Schleswig-Holstein Festival in Lübeck cathedral or the Bruckner cycle with Munich Philharmonic recorded in the Basilica of the Monastery of St. Florian near Linz/ Austria.

However, audio recordings in cathedrals are typically more satisfying for those listening to the recording than for the audience sitting far away in the nave of the cathedral. Close microphones can

significantly support the clarity of the recorded result but it remains extremely difficult for the orchestra musicians to perform.
But even in concert halls, which have an excellent reputation for symphonic music, things can go wrong, e.g. when a semi-staged opera performance is taking place there. Stage designers or opera directors create a stage set and video design on an orchestra's stage of a concert hall. Large stage structures and scenery parts as well as thick fabrics such as curtains for video projection have major implications for the orchestra sound. To make room for the staging and the acting of the singers, the orchestra is moved away from its "standard" position on stage. The orchestra might be seated further at the back of the stage or closer to the audience. The risers for the musicians might be higher or lower than usual. As a consequence the surfaces (stage surrounding walls, ceiling, reflectors above stage or a canopy), which would provide acoustic support to a standard orchestra seating in an ideal manner, are not in the correct position anymore.
The sound of a late romantic opera with a large-scale instrumentation can suddenly become "small", muffled and dull. It loses "impact", for both the audience listening in the hall, and for the outcome of the recording.
This is certainly quite disappointing for the orchestra, which has raised a lot of money and invested much time and effort to make an opera project of this dimension come true.

3 WHAT DEFINES THE "*RESULT*" OF A CLASSICAL MUSIC RECORDING?

3.1 Criteria of recorded sound

Analyzing audio recordings with regard to recording parameters we can evaluate many criteria:

- Balance of instruments
- Localization in width (panorama) and depth
- Precision of localization
- Spatial impression (direct or distant, envelopment…)
- Presence versus spatiality
- Reverb (during music and after music stops)
- Virtual position of the listener (at conductor's place or in a good seat in the stalls)
- Color of sound
- Attack/ Impulse response
- Text Intelligibility
- Clarity/ transparency
- Homogeneity (e.g. of a section of string players)
- Dynamic range
- Acoustic noises & artefacts

Except for dynamics, none of these criteria of recorded sound are measurable with measuring systems, bar graphs or other tools.
Besides, the acoustician might notice that actually all above listed criteria can also be applied when assessing concert hall acoustics.

3.2 Criteria of making music (on a recording)

The impact of music making and interpretation is much more than just the notes, balance of instruments or the correct ratio between clarity and reverb.

- Interpretation
- Inspiration
- Tempo

- Dynamics
- Perfection of ensemble
- Intonation
- Creation of tonal quality and variety of colors
- Homogeneous sound
- Freedom of metric strength (agogics)
- Atmosphere of the moment and taking risks

…. just to name a few.

4 THE ARTISTIC OUTCOME OF A RECORDING CANNOT BE MEASURED BY PARAMETERS OF SCIENCE

The artistic outcome of an audio recording is depending on a perfect coincidence of matching criteria of recorded sound AND criteria of music making.
Many of the music criteria can only be developed to highest artistic perfection, when orchestra members are sitting close together.
When their position on stage is not suitable to hear each other, or the sound delays due to large distances are beyond a critical limit, their performance becomes unsure. Playing gets anxious and careful. This cannot be compensated by any tools of the recording engineer. The recorded overall result will remain artistically disappointing
During Covid-19, we have proven what we had always assumed: “ghost-concerts” (with running cameras on stage but without any audience in the hall) could hardly ever reach the artistic standards of “normal” concerts with audience in a sold-out hall.

Fig. 3 What does influence an audio recording

When recording Classical Music in acoustically inadequate environments, this might not only be unsupportive, but actually even very irritating for the musicians. They become tense, play too careful, avoid risk and perform without inspiration. The recorded result will remain artistically disappointing, although we might be able to adjust balance and reverb with digital tools.

Recording Classical Music during a live performance of a concert is a complex challenge to meet the needs of musicians, audience, concert promoters, sound engineers and video producers. The aim is not only to make a documentary recording but to achieve an artistic recording of long-lasting value:

Fig. 4 Music Production for longer exploitation (CD) during a live recorded Videostreaning

As shown in Fig. 4 many trades and groups of parties are involved in a public event and might inspire but also interfere or impair each other.

5 SUMMARY

Recording is first and foremost about making musicians feeling well on stage. It is of fundamental importance that musicians hear themselves and others sufficiently and get supporting feedback from hall acoustics. This enables them to perform on high artistic level.
Performing music is interaction with other musicians, with hall acoustics and audience. This process happens subconsciously and unavoidably. Ideally, all orchestra musicians will feel and behave like **one** instrument („body of sound“).
If the hall supports their playing in an ideal manner, musicians and conductors will have the freedom to choose their tempo, phrasing, a dynamic and vibrato fitting into the ensemble and adequate to the interpretation of the piece. This plus the presence of audience is the main requirement to maybe catch some magic moments of music making on an audio recording.

6 REFERENCES

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