SOUND AS SCORE:

LIVE GENERATED AUDIO SCORE AND AUDIO SCORE BASED ON ACOUSTIC MEMORY

Elisabeth Schimana

Vienna
elise@ima.or.at

ABSTRACT

As a composer and musician of electronic music since the 1980s my medium is sound. When I was asked in 2009 to compose a piece for RSO (Radio-Symphonieorchester) Vienna I had to think about how to communicate with this sound body. I opted for what I do best - sound and listening. Since that year I have developed two different methods of communication with musicians - the live generated audio score, where the performers have to imitate the live generated electronic sounds they hear through a loudspeaker, and the audio score based on acoustic memory, where the musicians are given a set of sound samples for interpretation on their instruments and then in the performance this interpretation has to be played from memory. This paper examines the method, scoring, practice and rehearsal, as well as the artistic results using examples from *The Virus series* and the music theater piece *Pricked and Away*.

1. INTRODUCTION

1.1 Psychoacoustic impact on composition

In twentieth- and twenty-first century contemporary music, acoustic and psychoacoustic research has a great impact on the composition practice of composers. Both in instrumental and electronic music, composers deal with phenomena like critical bands (James Tenney, *Critical Band*, 1988), the hearing threshold level (Alvin Lucier, *Elegy for Albert Anastasia* for electromagnetic tape using very low sounds most of which are below human audibility, 1962–1965), or their focus is on listening itself (Maryanne Amacher, *ways of hearing* since 1980). In this way compositions are becoming an experimental test set up.

With continuing technological progress, the possibilities for generating electronic sound have become manifold. This allows electronic music composers to use the medium sound as opposed to writing, as a process-oriented score for acoustic instrument players. But if sound is to be interpreted by musicians, we need to ask questions about the properties of sound and the perception of sound by the listeners. Psychoacoustic studies like ASA (auditory scene analysis) by A. Bregman [1] as well as empirical phenomenological research such as that
conducted by Daniel Schmicking [2] provide insight into these subjects.

1.2 Aesthetics of perception

In studies about the perception of hearing, one distinguishes between universals, in other words innate, culturally independent attributes, and attributes which go along with conscious hearing and are connected with personal experiences and cultural backgrounds. My compositions primarily deal with conscious hearing and address a very specific target group: the professional musician.

If sound is the score's medium, this establishes a wide field for research on the subject of interpretation and the aesthetics of perception. Helga de la Motte-Haber [3] asks whether an aesthetics of perception in musicology really exists because in addition to the analysis of the compositions it would also have to focus on the listeners.

1.3 In the open field, the composition as an experimental test set up

Usually acoustic and psychoacoustic research takes place in the specific situation of a laboratory. My compositions, however, are conducted in an open field. No environmental influences are blocked out, no exceptional circumstances are generated; the situation corresponds with common practices of musicians and composers. The task is, as usual, to interpret a score, and although the setting may be unconventional to many of the musicians, the basic approach is still a familiar one. And the creative aspect exists, the participant is called upon to actively contribute in an artistic way within the framework of the specific conceptual formulation. Therefore, my compositions are an experimental test set up in the open field.

Sandeep Bhagwati describes his approach - the Elaborate Audio Score (EAS) [4] as follows: "...this term denotes a type of score that uses headphones as its

interface to the musician and conveys musical information primarily via acoustical messages."

Headphones are a forbidden planet in my open field approach. All disturbances are welcome and part of the set up.

2. METHODS

2.1 Live generated audio score

I developed this method for the *Virus series,* starting in 2011 with *Virus #1.0*[1] for string quintet. In the beginning there were several major questions: How should a live generated sound score be designed? How should the set up be organized? Who hears what, and why does somebody choose a specific interpretation? Where are my own listening limits? And how is it possible to merge the digital, live generated score with the interpretation of the acoustic instruments?

2.1.1 Basic considerations

The electronic resonating sound body[2] is generated live during the performance and is the audio score for the acoustic instruments. It corresponds to the image of a host cell. The acoustic body corresponds to the image of a virus, because the musicians have to attach and adapt to the electronic sound body, they penetrate into it and a synthesis between the two resonating bodies results.

The *Virus series* is an expedition into acoustic perception, a sounding of the responses of our brains in the span of milliseconds, a plea for the precise acoustic moment. It deals with the question "And what do you hear?" This question is dedicated to the audience, the musicians and myself. It implies that every self will experience something different.

2.1.2 Set up

The musicians sit or stand spread out in the space each in front of a loudspeaker and try to play what they hear as precisely as possible on their instruments. The electronic sounds – the sound score coming from the loudspeaker - as well as the interpretation by the musicians are audible. The instruments are unplugged, so the speakers project only the sound score. It is important to consider the distances between the musicians, in order to give each participant the possibility to focus on his or her own part within the sound score. A minimum of 3 meters for instruments with middle or high frequencies and a minimum of 5meters for instruments with low frequencies are necessary. The composer generates the score live and is therefore a part of the responding system, and together with the musicians she builds a feedback loop. Like the musicians, the composer listens and reacts to what she hears, making decisions for the further progress of the composition. The audience sits amongst the musicians.

2.1.3 Acoustic instruments and electronics

The digital electronic sound body in the *Virus series* has the job of doing what it does best: the precise execution of an algorithm. The acoustic sound body also has the job of doing what it does best: the imprecise execution of an algorithm.

I will explain this statement in the following simple example: a digital sine-wave oscillator oscillates with a frequency of 440 Hz for 2000 ms - break for 1000 ms - repetition - break for 500 ms - repetition. The program will execute this algorithm precisely. Translated for a musician this algorithm would sound like this: play the note A (440 Hz) for 2 seconds, pause for 1 second - repeat - pause for half a second - repeat. Compared with the machine the musician will execute this algorithm imprecisely and as the number of repetitions increase, this imprecision will also raise.

This fact demonstrates one of the most interesting side effect of this method - emerging fuzziness.

2.2 Audio score based on acoustic memory

I first used this very different approach in 2017 for the piece *Vast Territory. Episode 1 Lily Pond*[3]. This first attempt was for 7 minutes only, for strings and wind instruments. The major question was: How does our acoustic memory work. And for how long is this possible without the addition of a written score? In my online research I could not find any relevant answers - this, of course, might be because of my limited financial and time resources. In 2018, I composed the music theater piece *Pricked and Away*[4] working with this method for the ensemble part of the piece.

2.2.1 Basic considerations

The musicians follow a sound score played by memory and are thus tied to the oral tradition. It is like telling a story from aural memory. The audio score consists of field recordings lasting 15 to 45 seconds and are given to musicians in advance for interpretation and memorization. Working with field recordings in audio scores is quite common, but usually the musicians get them during the performance via headphones for interpretation. The only approach tied to the oral tradition in contemporary music I know is Eliane Radigue's way of communicating her compositional ideas to musicians, and she even asks these musicians to pass on the piece through oral tradition to another musician. This other musician has to reference the musician from whom the information is coming. In this way a line of references is created[5].

1 http://elise.at/project/Virus_1

2 I distinguish between an electronic sound body - electronically generated sounds like sine waves or noise, and an acoustic sound body - sounds generated by acoustic instruments

3 http://elise.at/project/Vast-Territory

4 http://elise.at/project/Pricked-and-Away

5 This information comes from a conversation I had with Eliane in December 2018 at her home in Paris.

Field recordings are a very complex type of sound material. They stimulate the imagination or trigger memories about a specific environment mostly connected with very specific emotions.

At the same time field recordings consist of multilayered sound events and most of the time it is not possible to translate all this acoustic information at once for interpretation on the acoustic instrument. As human beings we filter this information in an environment and concentrate on what seems to be relevant for us at a specific moment. A microphone is stupid and will transmit all acoustic information out there. The musician then has to decide which acoustic information is relevant for interpretation, and from musician to musician this can differ quite a lot!

2.2.2 Set up

Each musician follows his or her very personal interpretation of the sound files in regard to a specific time line score. In a short piece each musician has a stopwatch to help him or her execute the time line. In a long piece the timeline has to be a moving visual score with a cursor to indicate the exact time. The individual timeline scores for each musician have to be synchronized. All sounds - the interpretation of the field recordings - are played by memory, the original audio score - the field recordings - is inaudible.

3. SCORING

What is a score? It is a special form of recording - notation - in a musical context. The design of a score depends on its function, whether it is a notation for the composer as a stored memory, or a performance score, which serves as a tool for communication. In performance scores composers notate musical structures for interpreters. Usually the notation is a visual media and the communication with the interpreter implements a reading process and translation process into sound. If the score is sound, the reading process as well as the translation from one medium to another is skipped.

Are the programmed algorithms, the code - the notation for the machine a score?[6][5]

3.1 Machine notation for the *Virus series*

To communicate with the machine I use the program MAX/MSP and Modalys for physical modeling and the interfaces mouse, keyboard and MIDI controller.

To be able to concentrate on listening during a performance the patch and controler design is of immense importance. A maximum reduction is desirable in order to ensure mobility and flexibility. The main objects are poly~ to create multiple voices and pattrstorage to store and transform parameters. During the performance I mainly control the volume of each oscillator[7] and some very specific parameters, depending on the musical needs of the piece.

3.2 The sound material for the *Virus series*

The digitally generated electronic sounds are either very basic electronic materials like sine waves, triangles, filtered saw tooth with a specific ADSR, pitch and meter or physical models of tubes, strings or membranes.

The main objective is to create a “different” similarity to the sound properties of the instruments - e.g. a high flute tone will sound very similar to a sine wave, but still different. This corresponds with the idea that the audio score consists of material which cannot be created on an instrument and which is generally poor in harmonics, thus the instruments, the viruses, add timbre, or color. The sounds created by physical modeling constitute an exception, for they are rich and similar but at the same time totally artificial.

This concept results in a high level of fusion of the electronic and acoustic instrumental sounds.

3.3 Notes for the composer for the *Virus series*

The notation on paper for myself are notes about the ability of each instrument - I noticed that every musician and every instrument differs in possibilities - a table with frequency, meter and ADSR values, and notes about the structure of the piece.

f	H2 30.87 HZ
m	15000
ADSR	A1500, D1000, S0.9, St3000, R600

Table 1**.** Example of notated parameters of one oscillator

The only information passed to the musician is the pitch information - e.g if an instrument has 7 oscillators only these seven pitches will appear in the audio score. But there is no information as to when and in which combinations this is to occur. That is created during the performance.

6 In a book sprint I collaborated on notation we came to the following conclusion: Program == Score? Let us take this opportunity to raise another difficult question: Is the code or the patch the score? In much computer music, the composer (who may also be the performer) creates a piece of software as a patch or as code. It can be argued that this code is the score. However it is important, if not vital that the symbols in a score should have the potential to be executed by any, or at least other, software/program with any hardware, and/or any human being able to connect to the context. Chosen symbols for a score should go beyond a specific software or hardware, creating a metalanguage for interpretation. Otherwise it is not, in some sense, a score, rather it is an encoding of a specific piece and performance of music. It is a notation of it, perhaps too specific to be a score. (Booksprint 2012)

7 Each instrument has 5 to 10 or more well defined oscillators, e.g. a sine wave with definite pitch and meter, which can be played simultanously for pattern creation.

3.4 Sample and timeline score for *Pricked and Away*

The audio score consists of 13 sound samples for each of the 4 musicians, all different, but with similar sound properties in one category - e.g. sound sample 1 for flute has properties similar than sound sample 1 for harp. This creates similarities but at the same time differences, because an interpretation on the harp is quite different from that on the flute. Each sound sample has a duration of anywhere between 15 to 60 seconds at intervals of 5 seconds. I consider this to be quite important in creating a clear feeling of timing, which manifests itself after a while.

The musicians receive the sound samples quite a long time before the actual performance. This gives them ample time to listen to them repeatedly and get more and more acquainted with the microstructure of the sound file.

After this process, I create a timeline with a structure that determines which sound file is to be played at which time during the piece. For this part I had to use a visual score, since it is not possible to remember a duration of 30 min. During the performance each musician will see only his or her part, like in a usual written score. I opted for synchronized tablets on which the score is a video file with a cursor, which indicates the current time. This method has been borrowed from electroacoustic music practice, which is used when a piece is created with multiple layers of field recordings.

As mentioned in 2.2.2 the original sound files are inaudible and the musicians perform the sounds from their acoustic memory.

4. PRACTICE AND REHEARSAL

4.1 Creation and rehearsal process

In 2011, when I started with my first *Virus* for string quintet, I arrived in Kiev to work with the New Music Ensemble Ricochet with a more or less finished programmed patch, and the whole ensemble was ready to rehearse. I quickly realized that this was not the way to do it! I understood that I had to work more individually or with specific instrumental groups to hold the musicians' attention and keep them from losing patience.

After seven years of experience, I have developed a very economical and meaningful way of creating and rehearsing a *Virus.*

a) I start by meeting with each musician for about half an hour to collect information about the instrument, limits in performance techniques, pitch and speed. During this process musicians usually offer me a lot and we already try to push limits. Because I work with the highest and deepest frequencies at the very limits of the instrument, this is a very important half an hour. At this point musicians would probably say: I could even play one tone lower if I practiced a bit. No technical equipment is needed, just the acoustic instrument.

b) I create the pitch/meter system based on the collected information and think about the structure.

c) One more individual meeting of an hour to verify what I have programmed and for the musician to get familiar with the listening and interpretation process.

d) Based on the results of c) I reprogram the patch, create the interface design and rehearse.

e) First rehearsal with the ensemble in the space where the performance will take place. This usually occurs a day before the concert. The amount of audio equipment depends on the number of musicians and is a lot in most cases. Remember, each musician has his or her own speaker, so with 20 musicians you need 20 speakers plus the subwoofers for low frequency instruments. I call it a living acousmonium.

f) Main rehearsal and concert.

We rehearse parts, possible emerging patterns, transitions and a lot of time is needed to tune the system to the needs of the musicians. All in all, this usually amounts to 3 hours of rehearsal time, and in this way, we manage to fit the rehearsal concept into the ridiculously tight schedule allocated for concert preparation.

I am part of the system, my presence is needed.

In *Pricked and Away* the process is similar and different at the same time.

a) I select and prepare the sound material and pass it on to the musicians. At this stage it is test material, not the final audio score.

b) Individual meetings with the musicians, who offer possible interpretations on their instrument, discussions and a joint search for possibilities.

c) I edit the sound files for the final version of the audio score and prepare the timeline structure.

d) Two ensemble rehearsals, during which musicians are allowed to use the notes they took for their interpretation. Continuous fine-tuning of the timeline structure and microstructure of the interpretations.

e) Main rehearsal and concert at the concert space

Written notes for interpretation of the sound files are no longer allowed.

I am not part of the system my presence is not needed.

4.2 Practice

Whereas Sandeep Bhagwati [4] mentions that “the first approach to an audio score is very similar to that needed for a conventional new music score that uses many non-standard symbols” I wish to focus on the differences.

a) An audio score allows us to create extremely complex patterns with very simple commands. The main command is to play what you hear as precisely as possible in terms of all parameters including pitch, rhythm, timbre, etc. Aware that a perfect copy/imitation is not possible, a creative translation process is triggered in the musician. But - and this is very important in my work - it is not about improvisation, the target has to be a perfect copy/imitation. This directed focus gives rise to very interesting results, especially in microstructures. The precondition is to listen intensely and carefully.

With a live generated audio score like in the *Virus series* it is possible to create e.g. timeshifted pulse

oscillations (each musician has a different meter) without complicated written scores/code or click tracks via headphones.

b) Musicians do not need to decode a visual medium, e.g. a new music score that uses many non-standard symbols. As musicians told me this decoding process usually demands a lot of time and very often in the end the acoustic result is not satisfactory. One of my favorite musicians, I composed a solo violin *Virus* for him, told me that this was the reason he stopped playing in a contemporary music ensemble. An audio score works from the other end: the acoustic result is the starting point.

c) Like in oral tradition, the collaboration between composer and musician is an intimate one. This first individual rehearsal time, see 4.1, is of great importance. It creates a personal connection and deeper understanding of each other. In aural communication it is easy to adapt to the personal abilities of a musician and at the same time push the limits a bit. With written scores, this process is eliminated, usually composers deliver the score and that is it.

d) A specific characteristic of the *Virus series* is, that I am part of the system, and together the musicians and I build a recursive feedback loop. I listen and react, just like the musicians, and decide the further progression of the piece. We are talking about decisions made in milliseconds, and that is only possible because our auditory system is so fast! In order for this feedback loop to work at optimum capacity intense concentration is needed. I think it comes close to a state of trance. There is no time to think, just time to act!

e) In my experimental test set ups - the audio scores – I have gathered a lot of information about how my target group, the professional musicians and also myself, perceive sound and sounding structures. Most of the observations I have made confirm psychoacoustic research results. But - and this is most interesting - professional musicians can go beyond this for example: the auditory stream theory by Tougas and Bregman states: "The principle of grouping tones by their frequency proximity was found to dominate over the principle of grouping tones that follow a smooth trajectory." [6] I confirm this, but musicians start to create patterns beyond that.[8] This is a very beautiful moment for me.

5. ARTISTIC RESULTS

So far my *Viruses* increasing and spreading over the globe, which is exactly what viruses should do. The series includes #1[9] – for one group of instruments, e.g. strings, or solos - #2[10] for two groups of instruments, e.g. strings and percussion – and #3[11] for mixed ensemble.

Audio scores based on acoustic memory were used in *Vast Territory. Episode 1 Lily Pond* [12] and *Pricked and Away*[13] only. A specific aspect of this last work was the combination with a text-speaking performer which caused specific needs I still have to work on.

6. CONCLUSIONS

Sound as score has an innovational potential. Its impact in terms of aesthetics and performance practice is still relatively unexplored terrain. Also, the focus on the listeners in the field of reception aesthetics is a marginal one. In particular the live generated electronic score, so-called electronic music, interpreted by acoustic instruments is virgin soil. From the perspective of an electronic music composer the two methods I describe here are a pleasurable and artistically satisfying way to communicate with musicians.

Acknowledgments

Compositions leading to this paper were supported by bundeskanzleramt:kunst, SKE austro mechana and all ensembles and festival organizers who commissioned a piece. Special thanks to Christian Scheib who commissioned a piece for RSO Vienna – this was the starting point.

7. REFERENCES

[1] Albert S., Bregman, *Auditory Scene Analyses*, Massachusetts Institute of Technology, 1990

[2] Daniel Schmicking, *Hören und Klang,* Könighausen & Neumann, 2003

[3] Helga de la Motte-Haber, Reinhard Kopiez [Ed.], *Der Hörer als Interpret*, Peter Lang GmbH, 1995

[4] Sandeep Bhagwati, *Elaborate Audio Scores: Concepts, Affordances and Tools*, Proceedings of the International Conference on Technologies for Music Notation and Representation – TENOR'18

[5] The Contributors, Booksprint 2012 *On Turtles and Dragons and the Dangerous Quest for a Media Art Notation System*, Hrg. Time's Up, Linz, 2012

[6] Yves Tougas and Albert S. Bregman, Crossing of Auditory Streams, Journal of Experimental Psychology: Human Perception and Performance, 1985

8 When I play pulses in the highest frequency range of the instrument and at the same time in the lowest frequency range most of the musicians will follow either the high or the low pulses. A few of them will start to create patterns jumping from one frequency range to the other.

9 http://elise.at/project/Virus_1

10 http://elise.at/project/Virus_2

11 http://elise.at/project/Virus_3

12 http://elise.at/project/Vast-Territory

13 http://elise.at/project/Pricked-and-Away