Universität für Musik und darstellende Kunst Graz

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Bachelor thesis for Computermusik (V 033 104)

„The Dialogue “

The communication between electronics and instrumental music

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May 2022

Table of contents

1. Introduction

Our discussion here is mostly about an approach to compose electroacoustic music and specifically about creating a fluent communication between electronics and instrumental sounds.

Technology respectively electronics in the beginning were used to augment the human capability as a simple continuation of the physical body. Through the time in the history people came to this idea to make electronics and technology an integral part of their lives as a powerful medium for information retrieval, communication with other people, and medical usage.

In the present age, our lives and in relation to our discussion about contemporary art disciplines, technology and electronics can be perceived a bit differently which means that the technology can act now and then as an active entity having an active communication and interaction with its surrounding environment and human agents.

The question here would be how to build a bridge and choose between these two extremes of mere augmentation and active communication within a spectrum in the electroacoustic medium, which in this case is about the level of interaction between electronic and instrumental sounds.

The motivation to write this thesis is an aspect that grasps my attention lately. Our lifestyle tends to get more dehumanized, automatized, and abstracted in recent years and I assume it is essential to pay attention to human quality of things, with which we interact daily and concerning our theme, to observe and create the connection between the tangible instrument and non-tangible electronics, in other words, to connect the past and the future.

In the upcoming chapter the discussion will be about the concepts behind this approach and examples from the music history, in which new aesthetics with the development of technology got created and the third chapter is about my compositions and technical aspects behind the pieces. In the last chapter there will be a conclusion based on the assumptions and general observation of the ideas.

2. The Concepts

2.1. The Inception

We are confronted with one word and one sentence in the title of this thesis, the dialogue and the communication between electronics and instrumental music. Both of these terms reflect the nature of a specific genre in new music, which we will try to elucidate here below and that is the live-electronic music.

There are couple of iterations in the history of music, in which a person used or invented an electronic instrument for a composition, but John Cage was one of the first persons, who coined the term live-electronics and used the combination of instruments and electronics in a creative way. *Imaginary Landscape No. 1* (1939) is a piece he composed for four performers to play records with constant and variable frequency, large Chinese cymbal, and string piano. The first two players use turntables to play tones that have been pre-recorded at specific frequencies.[1] "Cage asked the performers to manipulate the pitch and rhythm of the tones by changing turntable speed, spinning the platter by hand, and dropping and lifting the needle." [2] (Figure 1)

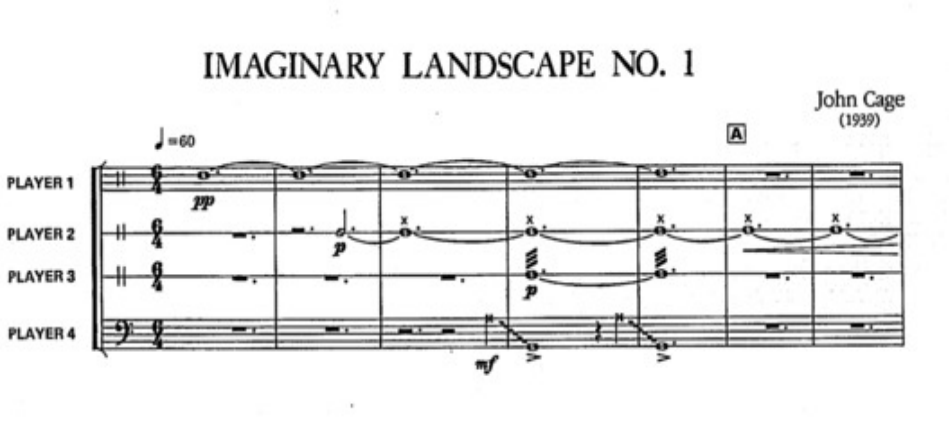

Figure 1 Imaginary landscape no. 1 by John Cage

[1] John Cage, *Imaginary Landscape no. 1* (New York: Edition Peters, 1939).
[2] Nicolas Collins, "Live Electronic Music", in *The Cambridge companion to Electronic Music,* eds. Nick Collins and Julio d'Escriván (Cambridge: Cambridge university press, 2017), 41.

In 1960, Cage composed *Cartridge Music* (Figure 2), for which the desired number of performers can use any type of object to produce sounds through cartridges based on the non-traditional score with drawn shapes and the instructions in the manual. He subsequently stated his motivations behind it: "The first was to render performance indeterminate, and the second was 'to make electronic music live'." [3]

"Given that playing a phonograph cartridge requires no traditional musical skill, interpreting the score presupposes no musical literacy, thus matching a radically new instrument to a correspondingly innovative approach to scoring." [4]

In the performance notes, he encouraged the distribution of the loudspeakers around the audience and mentioned that all normally undesirable events such as "feedback, humming, and howling" are accepted. [5]

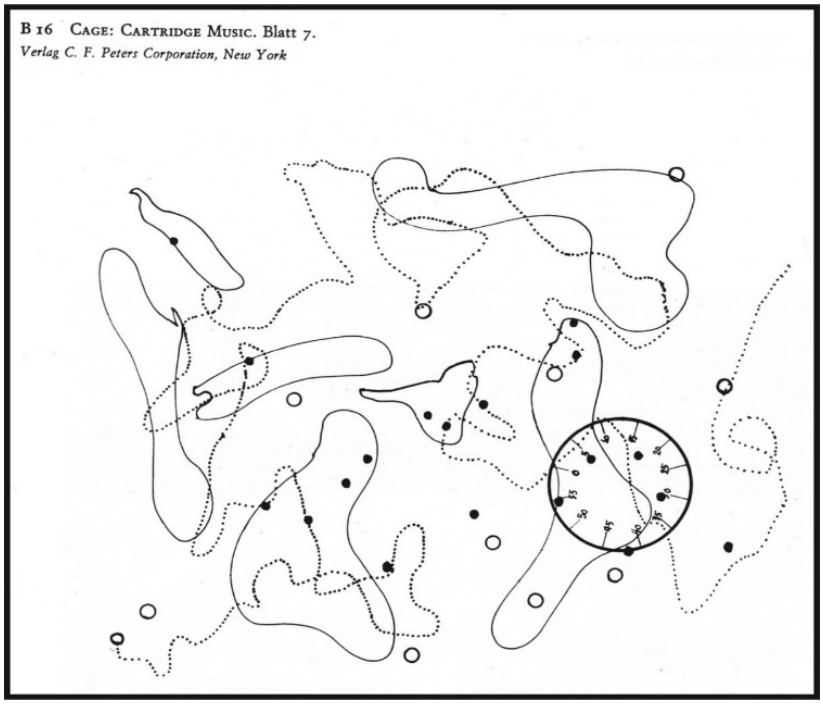

Figure 2 from the Cartridge music by John Cage

[3] Friedemann Sallis et al., eds., *Live-electronic Music: Composition, Performance, Study* (New York: Routledge, 2018), 1.
[4] Collins, "Live Electronic Music," 41.
[5] John Cage, *Cartridge Music* (New York: Edition Peters, 1960).

Besides Cage's innovations, the history can be summarized by referring to other compositions such as Daphne Oram's *Still Point* (1948– 50) for orchestra, recorded sound, and live electronics, premiered in 2016, Pierre Schaeffer and Pierre Henry's *Orphée 51* (1951) for voices and tape, and Bruno Maderna's *Musica su due dimensioni* (1952) for flute, cymbal and magnetic.[6]

Quoting from Monty Adkins,

> Until the advent of real-time computing, work on pieces using electronics was often difficult and time consuming. Boulez's *Poesie pour pouvoir* (1958) was withdrawn because the composer was not happy with the electronic part. Varèse's *Déserts* (1954) overcame issues of synchrony by having three electronic interpolations between larger sections for ensemble. It was not until Luciano Berio's *Différences* (1959), Karlheinz Stockhausen's *Kontakte* …, Luigi Nono's *La fabbrica illuminata* (1964) for soprano and tape, and further works for orchestra and electronics such as Roberto Gerhard's *Symphony no. 3 'Collages'* (1960), Roger Reynolds' *A Portrait of Vanzetti* (1962– 3), Luc Ferrari's *Composé Composite* (1962– 3), Arne Nordheim's *Epitaffio* (1963), Iannis Xenakis' *Kraanerg* (1968) and Stockhausen's *Trans* (1971), that instruments and electronics were successfully combined on a large scale.[7]

Karlheinz Stockhausen was a major figure among all, who searched for a way to link instruments and electronics in music and concluded that,

> Composing electronic music means describing that which sounds in mechanical and electro-acoustical dimensions and thinking only in terms of machines, electrical apparatuses and circuit diagrams, reckoning with one single production and unlimited repeatability of the composition. Writing instrumental music means inducing the performer's action by means of optical symbols and appealing directly to the living organism of the musician, to his creative, ever-variable capacity for reaction, enabling multifarious production and unrepeatability from performance to performance. Then electronic and instrumental music would mutually complement one another, distance themselves ever further and faster from each other—only to awaken the hope of meeting occasionally in one work. The first works in which electronic and instrumental music are combined were premiered in 1958. The idea is to find beyond contrast, which represents the most rudimentary kind of form; the higher, inherent laws of a bond.[8]

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[6] Monty Adkins, "Extending the Instrumental Sound World Using Electronics", in *The Cambridge companion to Electronic Music,* eds. Nick Collins and Julio d'Escriván (Cambridge: Cambridge university press, 2017), 259.
[7] Monty Adkins, "Extending the Instrumental Sound," 259.
[8] Karlheinz Stockhausen, "Electronic and Instrumental Music", in *Audio Culture: Readings in Modern Music*, eds. Christoph Cox and Daniel Warner, rev. ed. (New York: Bloomsbury, 2017), 536.

In Figure 3, we can see the first page of the score from the piece *Kontakte* (1958-60), one of first live-electronics compositions by Stockhausen for piano, percussion, and tape.[9] The title of the work "refers both to contacts between instrumental and electronic sound groups and to contacts between self-sufficient, strongly characterized moments." [10]

Stockhausen introduced *Kontakte* in May 2001 at the Royal College of Music in Stockholm as contact between different "families of sounds" and "forms of space".[11]

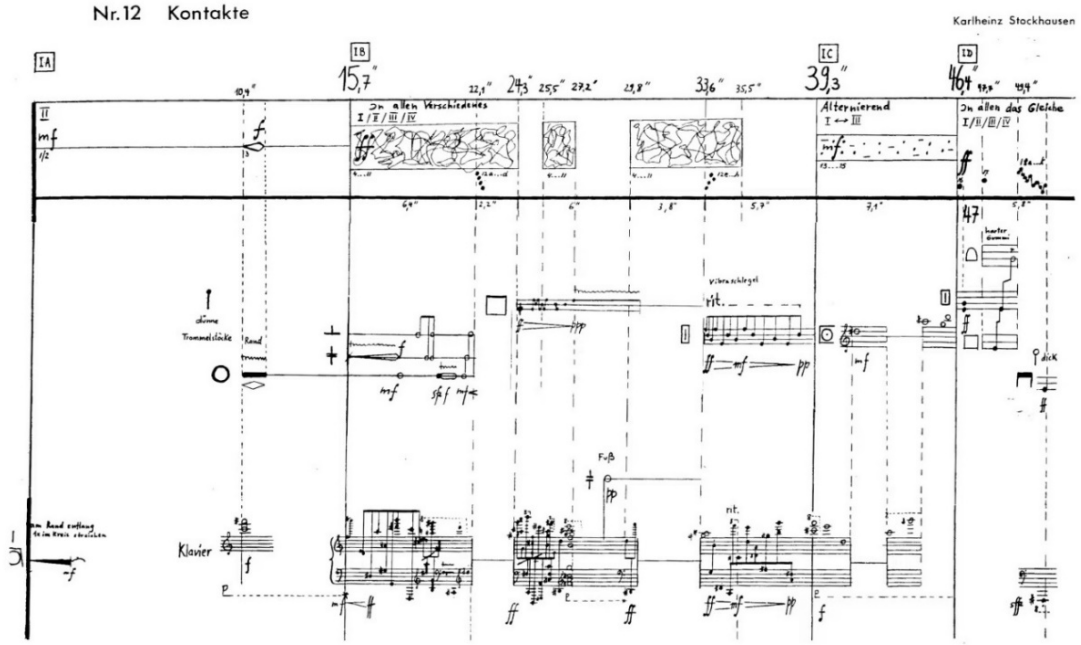

Figure 3 Kontakte (1960) by Stockhausen for piano, percussion, and tape

[9] Ed Chang, "KONTAKTE - Planning & Design,", accessed March 11, 2022, http://stockhausenspace.blogspot.com/2015/11/kontakte-planning-design.html.
[10] "Kontakte," Wikipedia, accessed March 11, 2022, https://en.wikipedia.org/wiki/Kontakte.
[11] "Stockhausen introducing Kontakte," accessed April 17, 2022, https://www.sonoloco.com/rev/stockhausen/kontakteintro.html.

2.2. The Definitions

Different definitions can be found for the live-electronics. According to Sallis, Bertolani, Burle and Zattra,

> On the one hand, it is an umbrella term under which we find a wide range of musical practices, styles, techniques, and technologies that stage the dichotomy embedded in it: live (= human) vs. electronic (= sound generated by some sort of electrically powered device). In this sense, live electronic music was and continues to be used as a broad oppositional category to acousmatic music: i.e., music prepared in a studio and fixed on some medium in advance of being 'played back', normally without 'performers' in the traditional sense of the term. On the other hand, 'live electronic music' can be used more narrowly to underscore the fact that the electronic sound production is taking place on the stage in real time. Currently, when used in the narrower sense, live electronic music usually refers to works involving the digital management or manipulation of sound, placing it firmly in the era of personal computing that emerged in the last decades of the twentieth century. [12]

Other than the broad definition of the live-electronic music, we may take a look at the definitions of the dialogue and communication, since they are an integral part of the concepts.

According to Britannica, "communication is the exchange of meanings between individuals through a common system of symbols." [13] Or by Merriam Webster, is "the act or process of using words, sounds, signs, or behaviors to express or exchange information or to express your ideas, thoughts, feelings, etc., to someone else." [14]

Dialogue, however, by Britannica means, "as a literary form, a carefully organized exposition, by means of invented conversation, of contrasting philosophical or

[12] Sallis et al., *Live-electronic Music*, 2.
[13] "Communication," Britannica Encyclopedia, accessed February 04, 2022, https://www.britannica.com/topic/communication
[14] "Communication," Merriam Webster, accessed February 04, 2022, https://www.merriam-webster.com/dictionary/communication

intellectual attitudes." [15] According to Merriam Webster, "dialogue is a discussion between representatives of parties to a conflict that is aimed at resolution" [16], which we might consider as the most useful definition regarding our discussion about the works of art and the formal process in the traditional or even contemporary sense.

2.3. The Spectrum of Process

To study the aforementioned spectrum in the introduction, we should dive explicitly into two processes of mere augmentation and active communication and what may come in between. "Augmentation is a process, in which the size, value, or quality of something is increased." [17] As in our case, used for the analysis of a piece to retrieve more information or amplify the instrumental sound through specific effects such as delay or simple filters to reflect the sound in a new perspective but still refer to the source; in other words, to create a self-reflecting communication like an interaction with coloured mirror. Here the electronics act as a minor or additional part to the primary flow of sounds and the relation between the source and produced material is comprehensible.

On the other hand, an active process or interaction concentrates more on two-way communication and exchange of ideas between different autonomous sound sources - agents- which are produced and developed either by a human or a machine. The principal factor would be the agency and liveliness of sounds and interaction between different acoustic qualities rather than speculation or an investigation to find out if sounds are created by artificial intelligence and the programmed machine itself or through a controlled process by a human actor.

[15] "Dialogue," Britannica Encyclopedia, accessed February 04, 2022, https://www.britannica.com/art/dialogue.
[16] "Dialogue," Merriam Webster, accessed February 04, 2022, https://www.merriam-webster.com/dictionary/dialogue.
[17] "Augmentation," Cambridge Dictionary, accessed February 05, 2022, https://dictionary.cambridge.org/dictionary/english/augmentation.

We would need to dive deeper into the concepts of interactions to define a criterion. Sheizaf Rafaeli wrote an extensive essay about interactivity and communication, in which different forms of interaction and their distinction are discussed. As stated by Rafaeli, Interactivity is a feedback system "that relates both to previous messages and to the way previous messages related to those preceding them." [18]

Humberto Maturana and Francisco Varela explain in their treatise about biology of cognition and properties of living systems that 'every living system' is based on interactions with its environment. "From a purely biological point of view, they cannot be understood independently of that part of the ambience with which they interact." [19] Agostino di Scipio paraphrased and summarized this notion explained in the book:

> A living system is 'autonomous' only through permanent exposure to the noise of heteronomous forces and agencies in the environment. It can only work out its autonomy and its systemic closure via a permanent structural coupling with the environment, and actually elaborating the coupling itself as something not pre-established and fixed but dynamically negotiated and, ultimately, construed or built.[20]

Thus, we may also conclude that it is essential to have such a system consisting of autonomous sound sources in dialogue, though independent but having an influence on each other in a live performance setting, in order to have an authentic active communication. However, activeness may be possible to a certain degree, as our systems are possibly programmed and controlled beforehand most of the times.

In order to understand these concepts better concerning the art of music, we may name an example from the tangible instrumental music world. The improvisational setting within a boundary of rules, in which different agents -musicians- are listening and reacting to each other lively. Although, they are autonomous, they influence each other actively.

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[18] Sheizaf Rafaeli, "Interactivity: From New Media to Communication", in *Advancing Communication Science: Merging Mass and Interpersonal Processes*, eds. Robert P. Hawkins, John M. Wiemann and Suzanne Pingree (California: Sage Publication,1988), 110.

[19] Humberto R. Maturana and Francisco J. Varela, *Autopoiesis and Cognition: The Realization of the Living,* (Dordrecht: D. Reidel Publishing Company, 1980), 9.

[20] Agostino di Scipio, "Dwelling in a field of sonic relationships", in *Live-electronic Music: Composition, Performance,* eds. Friedemann Sallis et al. (New York: Routledge, 2018), 25.

Between the two mentioned poles, we may define a median category, in which electronic sounds depend on the instrumental source in a one-way relation and instrumental performers do not react to the electronic sources actively as in the second category. The electronic sounds are generated from or triggered either by the instrumental section or other known sources, but the relation is blurred, deformed and the sounds are not completely referring to their source, which resembles a sort of interaction with other self. Additionally, in another respect, the formal structure of a piece can be made of different sections and each section with a different type of character, ranging from passive to active form of interaction in a mixed process.

Furthermore, the presentation setting of sources and the physical presence of the loudspeakers on stage close to human performers as a means of corporealizing respectively embodiment of another active performer may well be the further aspect of this mediation, which causes the audience to perceive the performance and the relation between its actors differently.

2.4. Examples from the Music Repertoire

In the last section, we examined three categories of possible interactions in a live-electronic setting. Now, it would be necessary to have an overview on a couple of examples from music repertoire.

2.4.1. I am sitting in a room

The first piece would be *I am sitting in a room* by Alvin Lucier composed 1969. We can take a look at the score as a text written by Lucier:

> *Necessary Equipment: one microphone, two tape recorders, amplifier and one loudspeaker.*
>
> *Choose a room the musical qualities of which you would like to evoke. Attach the microphone to the input of tape recorder #1. To the output of tape recorder #2 attach the amplifier and loudspeaker. Use the following text or any other text of any length:*
>
> *"I am sitting in a room different from the one you are in now.*
>
> *I am recording the sound of my speaking voice and I am going to play it back into the room again and again until the resonant frequencies of the room reinforce themselves so that any semblance of my speech, with perhaps the exception of rhythm, is destroyed.*
>
> *What you will hear, then, are the natural resonant frequencies of the room articulated by speech.*
>
> *I regard this activity not so much as a demonstration of a physical fact, but more as a way to smooth out any irregularities my speech might have."*

Instructions then follow on how to record and play, re-record and again playing it back via microphone and tapes, to achieve the desired effect also lively, eventually the words get blurred, and the resonant frequencies of the room emphasized.

Lucier in an interview Douglas Simon explained his concept and idea about how the space influences the frequencies of a musical sound:

> If the dimensions of a room are in a simple relationship to a sound that is played in it, that sound will he reinforced, that is, it will be amplified by the reflections from the walls. If, however, the sound doesn't "fit" the room, so to speak, it will be reflected out of phase with itself and tend to filter itself out. So, by playing sounds into a room over and over again, you reinforce some of them more and more each time and eliminate others. It's a form of amplification by repetition. [21]

We may assume in this case; the electronics are augmenting respectively reflecting the sounds in the process of composition (our first category). Despite the fact that the electronics act as a tool and mediator between the room, the person, and reflections; the person stays inactive and out of the active dialogue or interaction through the main process. Additionally, it can be also deduced even though the speech in the end is unrecognizable, but the relation between the sound objects is clear throughout the performance, and we are confronted with an exploration of a compelling idea rather than an active type of communication with regards to our categorization.

[21] Gisela Gronemeyer and Reinhard Oehlschlägel, eds., *Alvin Lucier: Reflections, Interview, Scores, Writings*, (Cologne: Farbo Druck, 1995), 96.

2.4.2. Roomtone variations

This piece is composed by Nicolas Collins in years 2013-14 for any combination of instruments and live computer score, in which resonant frequencies of a concert room is mapped by electronics through acoustic feedback and then projected as notation for performers to improvise. Once the musicians start to improvise on the notes they are gradually stepping through a site-specific "architectural tone row".

Nicolas Collins explains:

> Every iteration of Roomtone manifests itself in two forms: the initial live performance that moves through the opening section of sonic analysis and into an unrehearsed exploration of the resulting pitch material within the room that produced it; and subsequently, readings done from the notation that arose in that first performance, which becomes a document for study, practice and improvisation – a portable portrait of a place. The program determines the room's resonant frequencies by slowly increasing system gain to the point of feedback, measuring the pitch of that feedback, then nulling out that pitch with a narrow notch filter; this pitch is then displayed as the corresponding note on a musical staff. The gain continues to be raised until the 24 strongest frequencies have blossomed into feedback, been suppressed by the filters, and notated on the staves. This typically takes less than two minutes. [22] (Figure 4)

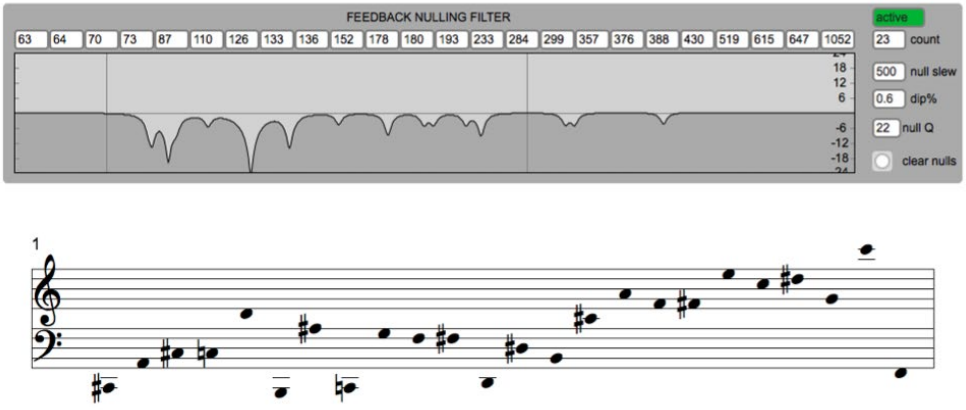

Figure 4 a snippet from the process of Roomtone variation

Based on the text score musicians can improvise and react in different ways by means of chords and melodies through different dynamics. (Figure 5)

[22] Nicolas Collins, "Roomtone variations," accessed March 14, 2022, https://www.nicolascollins.com/texts/RoomtoneScore2017.pdf.

Performance Instructions

Red notes = play only these pitches (actual measured room resonances).
Blue notes = play these notes (actual resonances) and all possible octaves on the same side of middle C.
(Software has option for displaying permitted octaves as well as root pitches.)

Play as many permutations of available notes as possible, in parallel (chords) or sequence (melodies).
Generally play mf and slow, with occasional group crescendos/decrescendos.
Occasional glissandos and de-tunings.

Emphasize the "chord change" when the highlighted block shifts forward, whether there is significant harmonic movement or not.
Play legato over changes -- don't cut off notes prematurely/disruptively.
Don't be tentative.

Figure 5 Instructions for human performers

According to our definitions, we can examine a sort of real-time active communication (our second category) in this piece, as the electronics are the primary agent in every first iteration of a performance by producing the feedback in a specific room with specific setting. The pitch structure of the feedback system itself is hard to control in a live setting and in every iteration, it has a different quality, but the system is interacting with its specific environment just as 'every living system'. The musicians also do experience a lack of control by listening and reacting actively through an improvisation. Here comparing to the Alvin Lucier's *"I am sitting in a room"*, a type of dialogue can be found between different streams and agents, which consists of the electronics, the musicians, and the room itself though within constraints, which are necessary to construct a certain flow and form.

2.4.3. Mixtur

Mixtur is a live-electronic piece made by Karlheinz Stockhausen, which is composed initially at 1964 (recomposed 1967 and 2003 for different settings) for 4 Ring Modulators, 4 Sine-wave generators and Orchestral Groups.

In the score the instrumental ensemble is divided in total into six groups together with another group of technicians for modulators and sound generators. In figure 6, the performance setting can be seen, in which different sections and devices are arranged in a certain manner to create a spread spatialization. Besides the instrumental sounds and sine waves, the signal from each instrumental section is projected via microphones through ring modulators then play backed live. Stockhausen suggests that "the unmodulated and modulated orchestra sounds should be equally loud; the sound of the modulated orchestra should even be slightly louder. Especially the low ring modulation – which should be heard as rhythm– must be as strong as possible."[23]

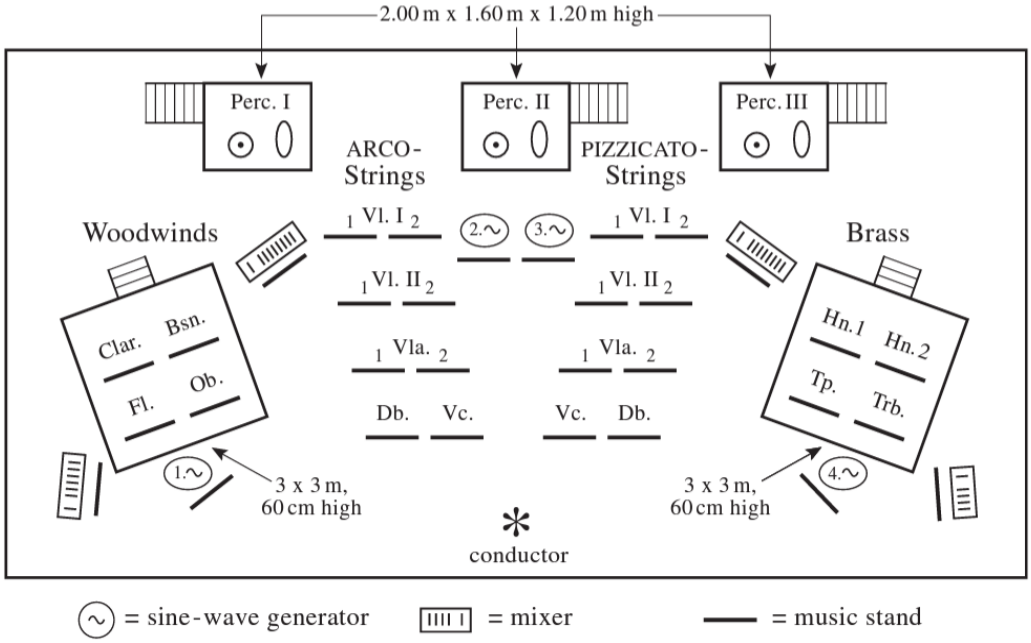

Figure 6 performance setting in Mixtur

[23] Karlheinz Stockhausen, "Mixtur_2003," accessed March 28, 2022, http://www.karlheinzstockhausen.org/pdf/mixtur_2003_english.pdf, 1.

Another layer that was part of the early versions and gives the piece a character of liveliness is the aleatoric elements throughout the score. In figure 7, as an example it can be seen, that players can choose between ten notes out of 34 and perform them. However, Stockhausen changed many of these in the very last version and wrote them in the traditional way.

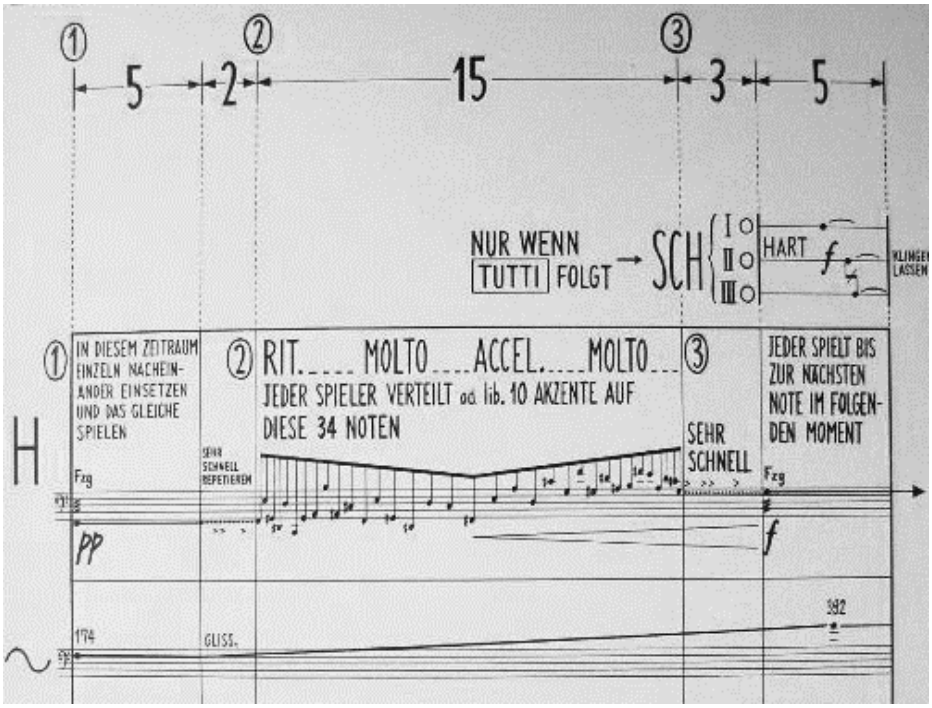

Figure 7 aleatoric elements in Stockhausen's Mixtur

Stockhausen also explains his intention behind this piece about the transformation of familiar orchestral sound to something different and new.

> It is an unbelievable experience, for example, to see and hear string players bowing a sustained tone and to simultaneously perceive how this tone slowly moves away from itself in a glissando, the pulse accelerates, and a wonderful timbre spectrum emerges. The interesting aspect of ring modulators is to produce all shades of the transitions from tone to noise, noise to chord, from timbre to rhythm and rhythm to pitch; finest micro-intervals, extreme glissandi and register changes, percussive attacks resulting from normally smooth entrances, complex harmonies (also above single instrumental tones), and many other unheard-of sound events result from this modulation technique and from the variable structuring.[24]

[24] Stockhausen, "Mixtur_2003," 4.

Mixtur is one of the examples, for which the third category can be considered. Although the tangible instrumental sound is clearly heard and by a deeper listening can be recognized as the source for electronic sounds, but the relation is blurred and manipulated. In other words, the electronics are dependent but deformed which produces new varieties of sounds.

Simply put, one may hear a sort of dialogue between different elements of the piece, though not in an active way, since the human performers are not interacting live with the electronics as their part is written and prepared beforehand. Moreover, the main electronic elements are generated by modulations based on the instrumental sound source and without the initial instrumental sound there would be no modulated deformation.

3. The Compositions

In this chapter we are going to review my compositions and approach to the concepts discussed in last chapters.

3.1. Meh

Meh is a piece composed for saxophone quartet consisting of soprano sax, alto sax, tenor sax and a baritone one plus electronic sounds, which are generated live in the Supercollider coding environment. (Figure 8)

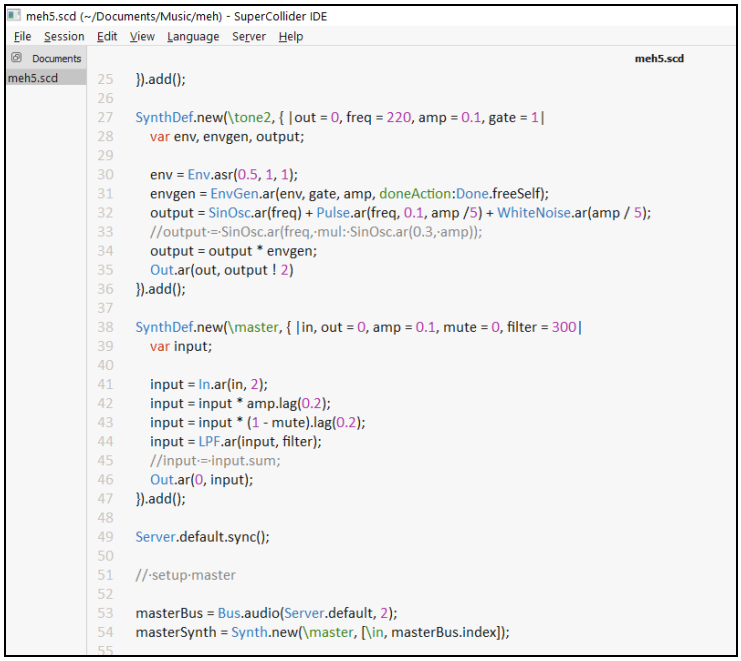

Figure 8 short excerpt of the code written in supercollider

What electronic does in this piece is underlying the instrumental sound and augment the textural elements with altered aggregated chords and moving bass figures. The pitch structures are based on specific modal lines with microtonal alterations and eastern influences, explained in the performance notes for the performers. The main formal elements and structures are created upon imitative and canonic lines for each instrument except the electronics.

The form can be divided into three macro structural sections, in which the middle part is contrasted and ornamented by trills and tremolos and strong dynamic accents while the other two have subtle dynamic and harmonic changes. A part of score can be viewed in figure 9.

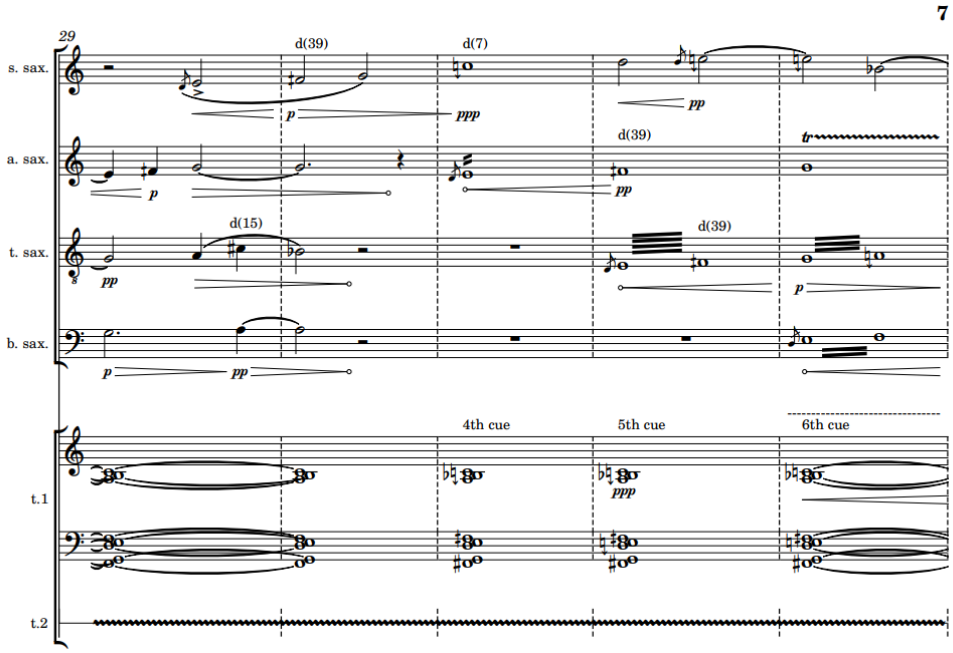

Figure 9 sample from the score of Meh

Although the electronics are acting as a mere tone generator -like in the first category- moderated by a person during the live performance, but the performance setting (Figure 10) incorporates the loudspeaker in the middle, around which the instrumentalists play. The loudspeaker becomes a sort of corporeal figure and another type of identity in the piece.

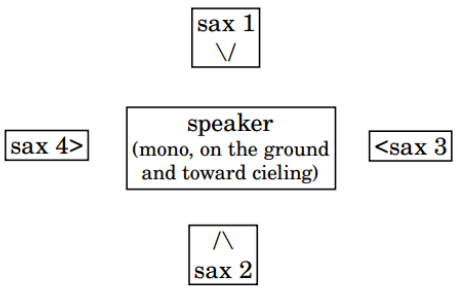

Figure 10 performance setting of Meh

The written patch in Supercollider produces a graphical user interface (Figure 11) can be seen down below. There are several parameters to control during the performance:

- The cues for each section with different harmonic alterations regulated by next or previous buttons.
- The volume and the color control, which can make the sound either softer and more subdued or add more harmonics to make the sound sharper and richer.

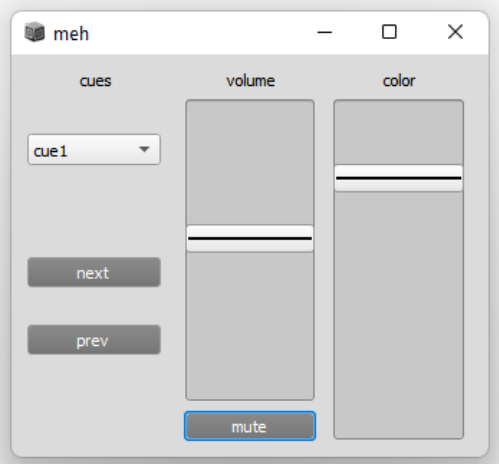

Figure 11 patch with a GUI in supercollider

3.2. Tamaas

Tamaas means contact in Persian language. The piece includes an accordion player and two loudspeakers as instruments. The electronic sounds are either triggered by the accordion player with a foot pedal with MIDI function during the performance or played back as a tape. All the electronic textures are made of feedback tones, which are processed, transposed, or glued from different parts after the initial recording.

The feedback tones are implemented in two ways:

- In a simulated room based on the CUBE, a studio with ambisonic sound system at the institute of electronic music (IEM) at the University of music and performing arts Graz.
- Tones generated between the loudspeaker and microphone of my laptop.

The material of instrumental sound consists of diatonic tempered tones from a central tone of D and breathing by the air key on the accordion. In contrast the electronics contain microtonal and processed sustained tones or melodic lines. In figure 12 and 13, the main compositional elements can be observed.

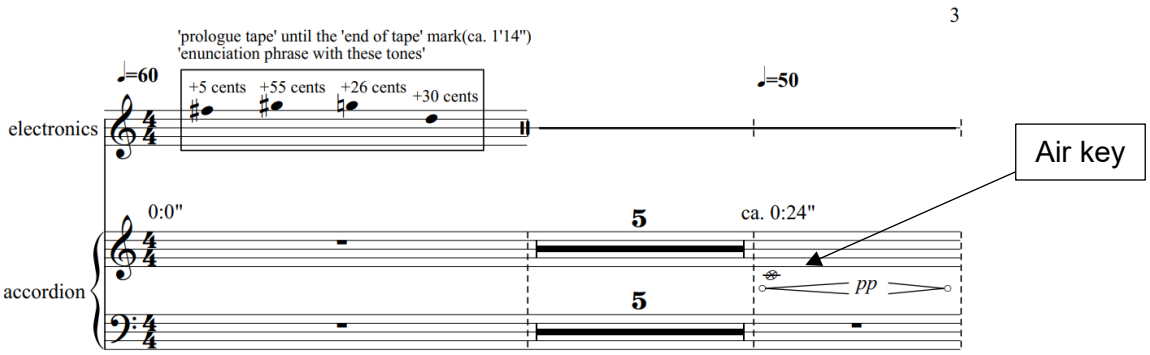

Figure 12 main compositional elements of Tamaas

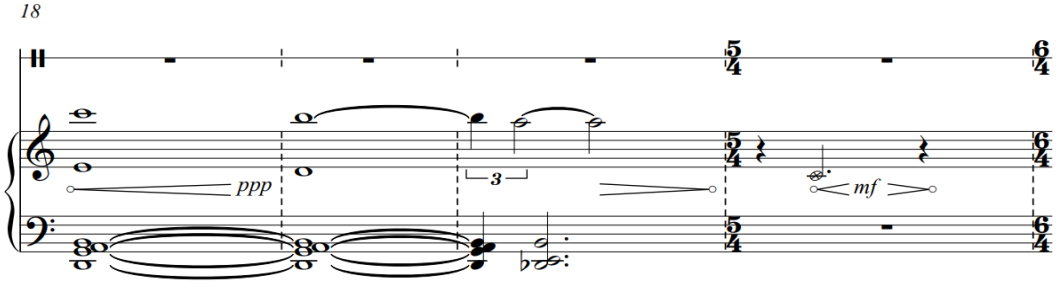

Figure 13 main compositional elements of Tamaas

The electronic tracks are processed and combined in a session of digital audio workstation named Cockos Reaper, which can be seen in Figure 14.

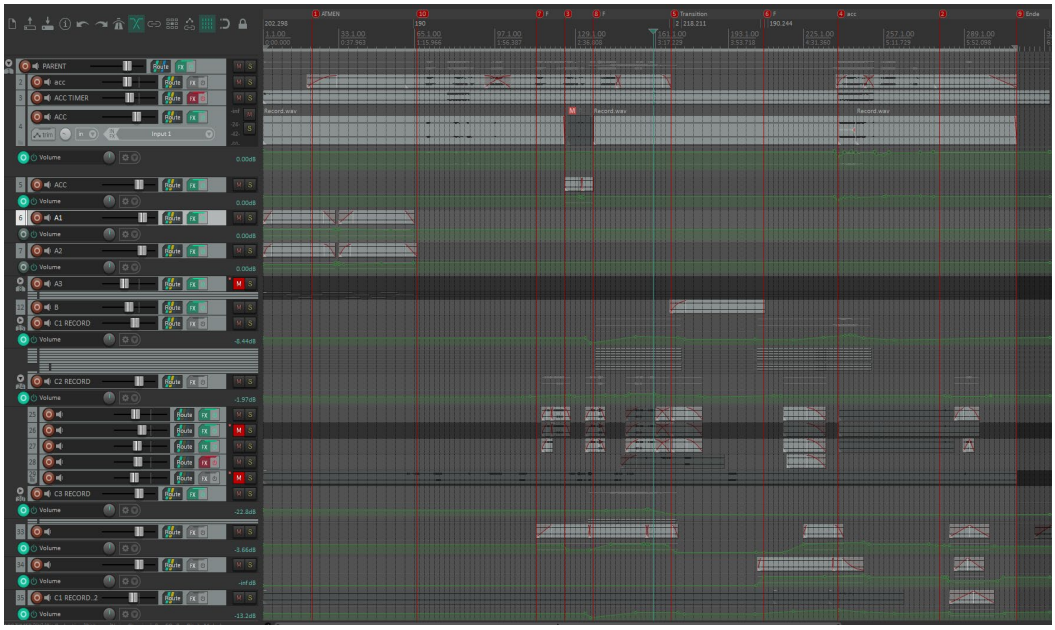

Figure 14 Cockos Reaper session for Tamaas

As the name of the piece suggests, there is an ongoing dialogue -call and response- between two sides until they reach circa the minute 4:48, at which they dissolve into each other and afterwards they become independent once more till the end. However, the electronics have no live and active interaction with the environment.

The performance setting (figure 15) also suggests a specific format for staging, which gives the loudspeakers a different kind of corporeality. They are seated on a chair up on each other pointing slightly to different directions for the better stereo imaging just like the instrument of the human performer, the accordion, propagating sounds in a stereo image. The loudspeakers can be seen in this way at the same height as the human performer, ‘dueling’ throughout the performance.

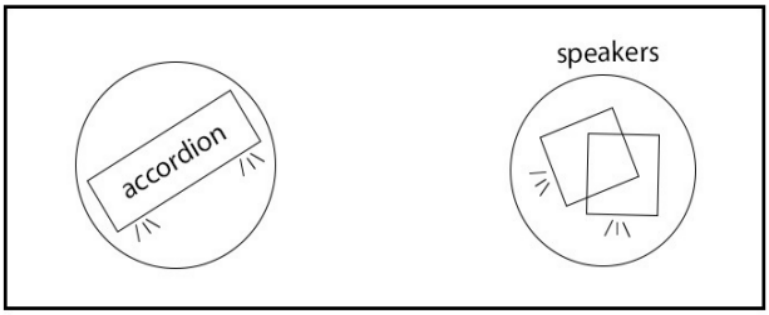

Figure 15 performance settings of Tamaas

Based on our categorization, this piece should be included in the third category, since it incorporates some specific elements of an active communication explained above but within a one-way interaction, which is mainly controlled by the human performer without the influences from the electronics and the environment.

3.3. Dam

The instrumentation of *Dam* includes a viola, a cello, and a prepared grand piano for electronic sounds. There is an exciter fixed under the piano, parallel with the bass bridge inside since it produces more resonances in piano. The sustain pedal is pushed all the way down by a small wooden box during the whole piece.

The electronic textures generated from instrumental sounds are projected inside the piano, so that the piano works as a loudspeaker and a resonator. The amplification of these textures through piano gives them a sort of instrumental quality and coloring.

The written patch in Supercollider coding environment should be used live with a MIDI controller to regulate the master volume, the level of instruments projected inside the piano without any filters, the level of electronic synths and number of overtones used. There is one main synth which controls all the electronic sounds. (Figure 17)

The sounds of first and third section consist of an amplitude modulated pink noise based on a recorded human breath sound (Figure 16) and drones, which are produced at the intersection of the instrumental pitch constellations and a filter bank used in Supercollider to resonate the overtones of C note with a given fundamental frequency of 130.8.

"*DynKlank* is a bank of frequency resonators which can be used to simulate the resonant modes of an object". It contains series of band pass filters with several parameters such as filter frequencies, amplitudes and ring times with frequency and decay scale factors.[25]

```
//·breath

breath = PlayBuf.ar(2, breathBufnum, loop:1);
breathEnv = breath.abs().lag2(1);
breathEnv = breathEnv * 10;
breath = DelayN.ar(breath, 1, 0.2);
breath = breath + PinkNoise.ar(breathEnv);
breath = breath * -40.dbamp();
breath = DynKlank.ar(`[freqs, amps, times / 100], breath, freqscale, 0, decayscale);
breath = breath * breathAmp.lag(1);
```

Figure 16 Breath sounds implementation

[25] "DynKlank," Supercollider, accessed April 16, 2022, https://doc.sccode.org/Classes/DynKlank.html.

The instrumental sounds are also projected in the filter bank and whenever an overtone gets picked out, it will sound as a drone with a subtle bending alteration by a noise generator. *LFDNoise3* is a function, which produces interpolated random values at a specified frequency rate within a given range.[26] (Figure 17)

```
SynthDef.new(\dam, { |out = 0, amp = 0.1, bus, freqscale, decayscale, breathBufnum, droneAmp = 0.0001,
  breathAmp = 0.0001, dropsAmp = 0.0001, inputAmp=0.0001|

  var input, output, instrument, drone, breath, breathEnv, drops, freqs, amps, times;

  freqs = \freqs.kr(Array.series(32, 100, 100));
  amps = \amps.kr(Array.geom(freqs.size(), 1, 0.95));
  times = \times.kr(Array.geom(freqs.size(), 1, 1.2));

  freqs = freqs.collect({ |freq|
    LFDNoise3.kr(0.1).range(0.9, 1.1) * freq;
  });

  amps = amps.lag(3);

  input = In.ar(bus, 2);
  input = Compander.ar(input, input, -20.dbamp(), 1, 0.1);
  instrument = input * inputAmp;

  //·drones

  input = input * -40.dbamp();
  freqs = freqs / 2;
  drone = DynKlank.ar(`[freqs, amps, times / 10], input, freqscale, 0, decayscale);
  drone = drone * droneAmp.lag(1);
```

Figure 17 the drones sound and main synth of Dam

The form is divided into three parts and the pitch material of instrumental part is made upon the intersection between harmonic series and Persian melodic qualities and also influenced by the long bourdon-tones (pedal tone) concept of eastern music. The just intonations of harmonic series are used to alter the intonations and make contrasts between smaller sections. Another formal element is constant alteration of second tone of the chosen mode, here C major scale in the first and third section, as a pivot for a fluid intonation, which is the prime concept of contrast in this composition.

[26] "LFDNoise3," Supercollider, accessed April 16, 2022, https://doc.sccode.org/Classes/LFDNoise3.html.

The piece begins with fundamental partials such as octave and fifth (figure 18) from the harmonic point of view but then progresses to the higher partials such as third, seven and eleven, which deviate from the equal tempered tuning. These overtones are not used always in their original register but transposed to lower or higher octaves to be more audible and to color the chords.

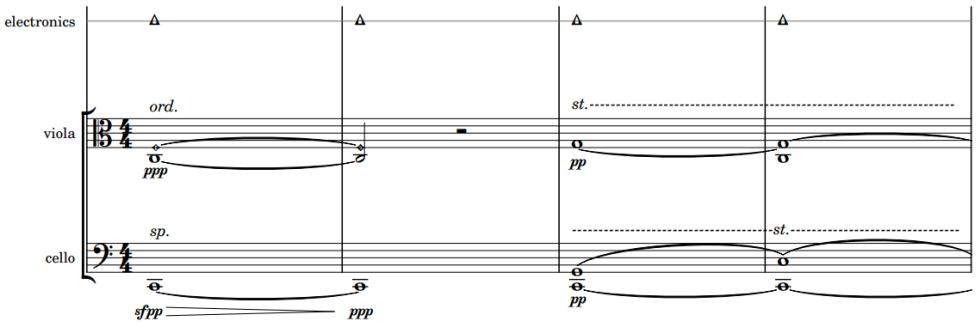

Figure 18 the beginning of Dam

In the middle section, the instrumental pitch material is made of descending artificial harmonic lines influenced by a specific Persian maqam, named *'Chahārgāh'*, while the electronic sounds of drops are generated through sweeps with limited random parameters for the duration, amplitude, and length of the sweep. The sweep synth produces basically exponential glissandos from a lower boundary frequency to a higher one. The boundary frequencies are chosen based on the maqam though in a random order as opposed to the sequential lines played by the performers. (Figure 19)

```
SynthDef.new(\sweep, { |out = 0, amp, low, high, length|
   var freq, sweep, env;

   env = EnvGen.ar(Env.sine(length), 1, amp, doneAction:Done.freeSelf);
   freq = XLine.ar(low, high, length, 1, 0, 2);
   sweep = SinOsc.ar(freq);
   sweep = sweep * env;
   Out.ar(out, sweep);
}).add();
```

Figure 19 the sweep synth for the sound of drops

The transition between the first and middle section can be seen in figure 20.

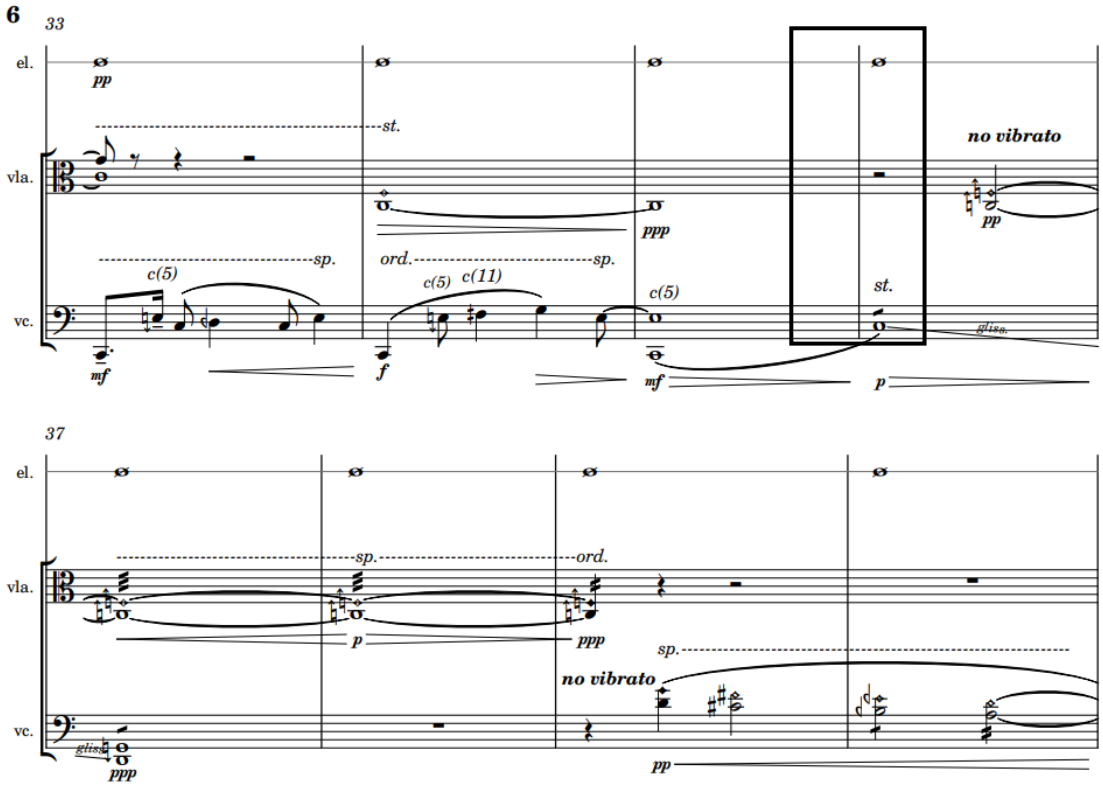

Figure 20 sample from the score of Dam

The electronics in this piece act differently in each section, although they depend on the instrumental sounds and have no separate stream of interaction, the relation is blurred and deformed to run the dialogue between different entities as in our third categorization in the last chapter. In the middle section, the electronic sounds are produced from the patch independently but have no influence on their ambient surrounding. Likewise, the musicians are not reacting actively to the electronics as they are playing their written parts, which are composed previously.

3.4. Etude for tam-tam and electronics

The piece consists of a tam-tam with the size of 110 cm and a transducer and a hard drumstick as prime elements but also for the implementation of feedback chain between the exciter and tam-tam, we would need to have a mixer with a built-in equalizer, a cardioid microphone, a compressor, and an amplifier.

The nature of this composition is more or less experimental, and it can be only conveyed through improvisation, since everything is happening live, and the feedback tones cannot be controlled completely. The compressor is used to sustain the feedback and prevent outbursts of sound and the equalizer can be used to add or remove a certain frequency range in the chain, but it is not possible to produce a specific frequency in each iteration at different rooms in the similar way.

The necessary setup diagram can be seen in figure 21. The exciter should touch the tam-tam by the human performer to let the tone resonate on the instrument and the drumstick is used to disturb the feedback chain and bring variety into the process of performance.

The composition is divided into different sections to explore different possible sound qualities of created system and as it is written in the score, the timing can be managed a bit freely but there is minimum duration for each section. In figure 22, the first section of performance score can be seen.

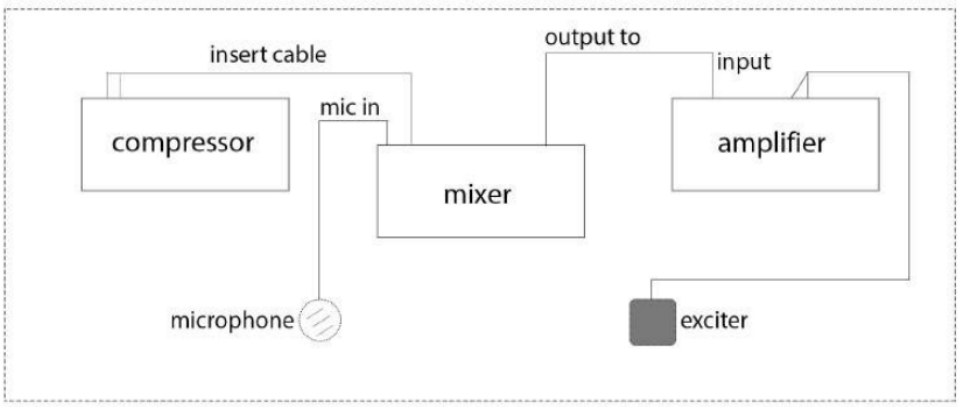

Figure 21 setup diagram

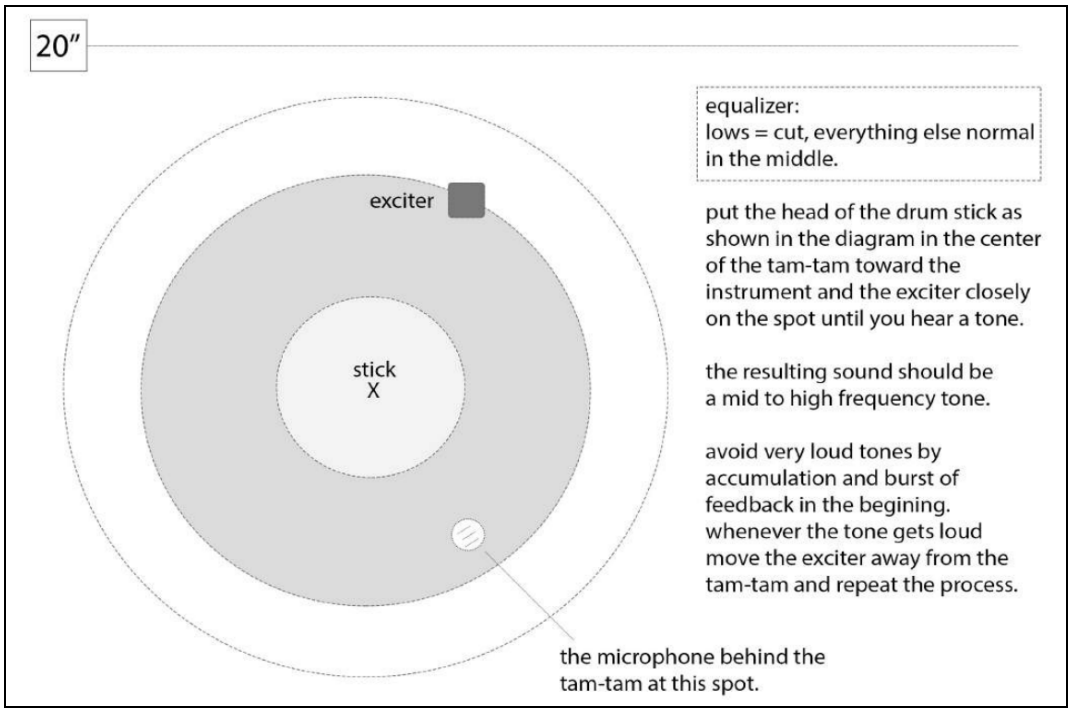

Figure 22 first section of score

The interesting fact that makes aggregated non-tempered feedback tones with special beating on the tam-tam is the type of this instrument. Tam-tam is a metal idiophone with an indefinite pitch, which comprises a low fundamental frequency and other high overtones with complex inharmonic relations [27] which implies they are not integer multiples of a fundamental frequency.[28]

Based on the aforementioned facts, we might conclude that the improvisatory nature of this piece and the interaction between the human performer and the electronic system result in active communication.

Both ends of this system are agents that should listen to each other actively, be exposed to their ambient environment and react in the moment as 'every living' entity -performer- would do to structure the sounds in time and convey a flow and change during a live improvisational performance.

[27] Reginald Smith Brindle, *Contemporary Percussion,* (London: Oxford University Press, 1970), 86.
[28] "Harmonic series", Wikipedia, accessed 11 April 2022, https://en.wikipedia.org/wiki/Harmonic_series_(music).

4. Conclusion

This thesis initiates a discussion about a certain aesthetic in live electronic music from a subjective as well as objective point of view. The communication and its different faces are the main theme of these observations.

After the short introduction in the first chapter, we had dived deeper into the concepts of interactivity and ways of communication by distinguishable means and categories in the second chapter. Afterwards, general analyses concerning our categorizations of different pieces from the musical repertoire of electroacoustic music were reviewed.

In the third chapter, the implementation of the explained concepts was about my approach to composition and how I relate the two entities of electronics and instrumental sounds to each other in specific arrangements.

It can be assumed that every system with more than one entity contains a certain amount of interaction even if not active, through different means and in the case of arts, through forms of presentation.

The lack of control to a certain degree and improvisational nature of the relations between agents in a performance setting usher in a type of active communication. The more we set strict boundaries and prepare the elements beforehand, the less the agents will be able to listen to each other actively and express themselves in the moment. Nevertheless, the condition and the scope of communication depends on the perspective and perception of the listener since it could be quite subjective.

Additionally, following our debate, it can be deduced that thinking about the way of communication and the relationship between the tangible and non-tangible entities create the main compositional elements and influence the significant decisions in creating a work of art. Human quality is a criterion essential to the arts in general, about which we ought to elaborate and contribute more.

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5.3. List of Figures

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