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Using Low Frequency Audio Content in Order to Use a Given Space as an Instrument

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USING LOW FREQUENCY AUDIO CONTENT

IN ORDER TO USE A GIVEN SPACE AS AN INSTRUMENT

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A THESIS

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By: Berkay Tok

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An Abstract of the Thesis Presented

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Abstract: This thesis by Berkay Tok aims to represent the work that have been created through my MFA degree while sharing details and deeper insights about the underlining idea of these work. My main focus in this thesis is to structure it in a way that it represents the exploration and learning process that I have been going through at my master's degree. Both my work and aim of my creativity significantly changed in the previous years thanks to fruitful lectures that I have had the chance to take through my master's degree. While providing a deeper look at my work this thesis mainly focuses on the explorations I have made through my degree and how I interpreted these findings at the end of my master's degree. Aim for this paper to explore use of low frequency audio content in a different approach by using subwoofers in order to produce binaural beats and use them to extract the natural sounds of a given space such as rumble.

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CHAPTER 1

INTRODUCTION

Throughout the history many composers, instrument makers and instrumentalists experimented with lowest frequency sounds that a specific instrument can produce. Octabass is one of the most prominent examples of those experiments in order to produce low frequency audio to the limits of human auditory capabilities.

> *Ondes martenot, also called Ondes Musicales, (French: "musical waves"), electronic musical instrument demonstrated in 1928 in France by the inventor Maurice Martenot. Oscillating radio tubes produce electric pulses at two supersonic sound-wave frequencies. They in turn produce a lower frequency within audible range that is equal to the difference in their rates of vibration and that is amplified and converted into sound by a loudspeaker. Many timbres, or tone colors, can be created by filtering out upper harmonics, or component tones, of the audible notes.*
>
> *In the earliest version, the player's hand approaching or moving away from a wire varied one of the high frequencies, thus changing the lower frequency and altering the pitch. Later, a wire was stretched across a model keyboard; the player touched the wire to vary the frequency. In another version the frequency changes are controlled from a functioning keyboard. Works for the ondes martenot include those by the French-born Swiss composer Arthur Honegger, the French composer Darius Milhaud, and the American composer Samuel Barber. (1)*

After incorporation of synthesizers to music composition process achieving low frequencies was not an issue for a composer anymore. This led many contemporary composers who composes primarily for traditional instruments incorporated synthesizers into their compositions and arrangements extensively.

CHAPTER 2

METHODOLOGY

2.1 Understanding the Research Methodology

Intermedia combines multiple aspects of art making process in order to offer and seek undiscovered territories of creative process. This interdisciplinary approach can be helpful for the art maker to allow undefined areas of creative approach. As opposed to traditional arts, interdisciplinary arts always redefine its methods in creation, interaction, representation and performance of its material. Even though this allows relatively progressive conceptual outcomes it also presents its own issues both in institutional art spaces and personal art studios as well as through development of related research.

Following predefined research paths that are proven to be effective and yielding productive results may not be applicable for Intermedia which requires tackling these steps by finding never tried before solutions. A cinematographer can easily go back to Dziga Vertov's Kino Eye, Sergei Eisenstein or Andrei Tarkovsky and many other directors in order to understand the process to create a film by observing previous interpretations of similar issues even though cinematography is one of the newest additions to major art disciplines. With the potential financial exploitation of cinematography on the horizon at the time, it didn't take so long for tools that are designed specifically for film production become available. Same is true for a traditional musician; they can refer back to hymns and chorales, research various eras of tonal music history combine that information with the current technology created specifically for tonal music production with

arpeggiators, chord builder and such it's relatively an easier path to figure things out by looking at the reflections of the past and going on from there.

However, it's not possible to observe the same phenomenon when it comes to interdisciplinary art making approaches. Most of the time a new method in art making requires new means of acquiring required materials. Therefore, most art research that take Intermedia as a subject are prone to diverting undefined methods for creation and research of the artistic material and outcome. This leads us to need of a clearly outlined and defined statement for every single specific case in order to define a proper methodology.

2.2 Justification of the Research Methodology

Throughout my research and studies, I have witnessed countless times, limitation of creative choices improves creative process by many different ways. One of these ways is the repetition. Using the same tools and techniques gives art maker the ability to sharpen their skill on being creative on that specific toolset.

In today's digital sound technology, a lot of things are quite easy to achieve compared how they have been achieved in analog era. This abundance of tools and almost unlimited access to various complementary or subsidiary tools, various software and hardware pose an issue where this abundance creating sort of an artistic block where learning and practicing on tools turns into a never-ending time waster and produces no fruitful results.

In this regard, I have come to conclude that defining the limitations and borders before beginning the creative process would lead to a better conceptualization of the work that is intended to be created. As a sonic artist, I began looking for both technical and conceptual limitations for my future compositions and sonic work that is going to exhibited as sound installations, where there might not be a set composition but instead an ongoing sound interaction at the exhibition location.

Most of my work can be categorized as acousmatic music and I will try to explain the reasoning behind this statement through my thesis. As taking sound producing devices and acoustical space as a basis, I have found that my compositions are focusing more and more on the lower part of audible sound spectrum since the sound energy on lower side of the spectrum is relatively easier to observe through acoustical space. Therefore, one of my limitations set itself by using solely low frequency audio content to create my sound work.

As my research combines intermedia, sonic arts, architecture and space my progress through my research have been using a mixture of different methodologies. These techniques and processes are varying from researching previous composers and their publications to studying tonal harmony in order to be able to discern the differences on musical sounds and non-musical sounds better where I use both on my art work extensively.

An artist starts by doing and learns by doing. Art making process can be defined as an exploration process where experimenting where sometimes it can intersect with scientific research. The results are not committed but to be explored during or after the process. The outcome is generated by making progress through the art work. Acousmatic music related research also uses

social constructionist elements by nature by suggesting deconstruction and reconstruction of musical understanding and common practices.

2.3 Statement of Research Methodology

From a sonic arts standpoint, it is easy to feel overwhelmed by the vast amount of options that are applicable from many methodological approaches. Often times sonic arts feeds itself from many different sources that can be both considered as qualitative or quantitive.

In this section I will try to identify the methods and methodologies that are in combination to create a mixed methodological approach. As a sonic artist my main goal is to compose and in order to understand methodology, I am going to use for my research I should explain my process briefly from start to finish for a sonic piece that can be considered as a composition where it presents itself in a specific form.

Foundations of experimental electronic music composition can be traced back to two main school of thoughts. One is in Germany and called tape music and the other is France based concrete music. While German based tape music had quite strong serialist roots and used calculations and other quantitive approaches, France based concrete music took more of a qualitative approach to electronic music composition where many composers considered addition of ability to record and playback sound a new instrument in the spectrum of available sound production methods and instruments. I will be looking at these two main school of thoughts in detail later in my thesis.

As we can observe in the very beginning of experimental electronic history sonic arts always needed to feed itself from many different sound sources. Some composers decided to record naturally occurring sounds and incorporating them into both tonal and non-tonal sonic compositions. Others decided to use older methodological approaches while using newly invented instruments. These practices are still carried in many experimental sound art scenes today.

CHAPTER 3

3. HISTORY AND PREVIOUS RESEARCH

3.1 My Past with Sound and Bass

I have been involved in sound production and music composition in various ways, allowing me to be able to discern the differences in compositional techniques and approaches. During my undergrad years I have been performing as an instrumentalist while working for broadcast facilities to design and mix sound for films and jingle production for commercials.

My interest in music changed drastically as I have evolved from an instrumentalist to music producer who utilizes a set of music production tools in order to replace or redesign instrumentalists' parts in a given musical composition. This is a process with many obstacles in and out. I will try to give a brief explanation about these hurdles before going on to this chapter.

One of the most important things for a music producer to overcome is the necessity to shift paradigms rapidly. An instrumentalist in a band setting can only focus on their part, while just listening to other members of the band in order to perform synchronistical. This allows musician to pay great attention to details in their parts while increasing the variability which introduces a great amount of realism and attention to the musical piece.

As a music producer creating compositions that sound alive is quite complicated process. A music producer should be able to draw a main structure for the composition while thinking like a composer and only after that switch to an instrumentalist point of view to be able to perform and

recording the musical parts needed. Most of the time a music producer uses various tools such as synthesizers, samplers, modelling instruments to create the final product. At this point there are many things that get lost in musical translations. A composer most of the time fails to be able to as creative and as agile as an instrumentalist in their specific instruments. Also, music producers tend to use looping and repetition techniques which introduces a new set of issues compared to a complete musical part recorded by a musician.

As I have been involved in traditional tonal harmony music production by using comparatively contemporary tools, I have started to discover another sonic world that I haven't been paying attention before. A sonic realm where all sounds are approached as usable sounds, where most of the non-musical sounds.

These series of explorations of experimental music scene led me to get admission to my first graduate study at Istanbul Technical University, Center for Advanced Music Studies (MIAM). At MIAM I have had the chance to work with sound engineers and composers such as Pieter Snapper, Reuben de Lautour and Kamran Ince where I have been introduced the intersection between sound engineering and music composition. At that point I have been influenced by composers such as Iannis Xenakis, Edgar Varèse, John Cage, Pierre Boulez, Pierre Schaeffer, François Bayle, Karlheinz Stockhausen and similar others.

While my exploration of experimental music composition was an ongoing process, I have started to become interested in underground bass music scene. I wasn't performing or producing traditional settings of acoustic music anymore and underground bass scene and its genres was a new reality for me to explore as well. Later on, these interests would melt into each other creating

the basis of the work that is explained in this thesis. Exploring compositional and production approaches such as acousmatic music by Bayle, while also performing music that relies heavily on the sound reinforcement had a intercrossing relation that started to shape my creative outcome.

As I have mentioned previously, from Octabass to Dolby systems in theaters there was always a search for use of low frequency domain in order to trigger emotional reactions on the audience.

3.2 Frequency

Frequency is defined by one full cycle of a wave. When a wave starts at zero and reaches its full volume at positive levels it starts to travel to its way to the lowest value it will take. When the signal reaches zero again one full cycle is complete. Frequency determines how many full cycles a signal makes in a second. One of the most common frequency is middle A. It vibrates 440 times in a second. Therefore, we call it a 440 Hz frequency wave.

3.3 Audible Frequencies

Frequency is a broad term by itself. Determination of the type of signal is based on the cognitive mechanism of human brain. If a signal is between 20 Hz and 20000 Hz (20 kHz) we perceive this signal as a sound wave. In this manner, different notes have different frequencies like colors having different frequency of reflectance.

In this thesis main focus is audible frequencies and frequencies that are out of audible range but still in the range of human auditory system.

3.4 Inaudible Frequencies

Any frequency out of human auditory range can be classified as inaudible frequencies. To be more precise we can categorize these frequencies in two main groups;

-Frequencies that are below audible range

-Frequencies that are above the audible range

3.5 High Frequency Range

High frequencies generally consist of waveforms between 1000 Hz to 20000 Hz for humans. Smaller animals generally are able to hear better and higher frequencies. Bats are a good example; they have very limited visual capabilities, but their auditory system is very advanced letting them to navigate both in dark and bright environments.

3.6 Mid Frequency Range

Even though these guidelines change source to source generally we can assume that frequencies between 100 Hz and 1000 Hz can be categorized as mid frequency range. This range is extremely important for humans. This is where fundamental frequencies of human voice belongs therefore almost all our auditory communication happen in this range.

This range is also easiest in terms of reproduction difficulty. Most speakers are able to reproduce mid frequency range while high and especially low frequency range are difficult to reproduce and require more technological challenges to be solved during the design period, increasing the production cost of the units. Laptop speakers, phone speakers, speakers in elevators, Tv speakers, most standard car system speakers are an example for these speaker types.

3.7 Low Frequency Range

Low frequencies generally consist of waveforms between 20 Hz and around 100 Hz for humans. Bigger animals such as whales and elephants are capable of producing and hearing frequencies lower than 20 Hz which allows them to communicate over very long distances due to waveform length getting longer as the signal frequency gets lower.

What we call as bass is a part of low frequency range.

3.8 Bass in Music History

3.8.1 Viol

Composers and luthiers had struggle with production of low frequency capable instruments. First attempts in music history in terms of low register sounds started with the instrument called Viol but the physical limitations limited the attempts severely.

> *Family of bowed stringed instruments, the most important ensemble instruments from the 15th to the 17th cent. The viol's early history is indefinite, but it is recognizable in*

depictions from as early as the 11th cent. During the second half of the 17th cent. it lost its dominant position to the violin family and became practically extinct until the general revival of interest in early music and instruments in the 20th cent. The viol differs from the violin in the manner of playing, in its shape, and in having frets and typically six strings, tuned in fourths with one third, rather than in fifths. Most viols are properly played upright, resting on or between the knees, with the bow held with the palm upward. The viol usually has sloping shoulders, a flat back, and deeper ribs than the violin. It is a chamber instrument with a soft, sweet tone, incapable of the dynamic extremes and brilliance of the violin; this helps to account for its decline. The viol was built in four principal sizes—treble, alto, tenor, and bass—which were used in ensemble, or "consort." The double-bass viol, or violone, survived all the others, becoming, with some modification, the present double bass. The bass viol was the principal solo instrument of the family, possessing a large literature from the 16th to the 18th cent. It later became known as viola da gamba [Ital.,=leg viol]—originally the name of the whole family, to distinguish them from those of the viola da bracchio (arm viol) family, the forerunners of the violin. The viola d'amore, a member of the viol family, originated in the 17th cent. and was especially popular in the 18th cent. It has from five to seven strings, tuned in thirds and fourths, and an equal number of sympathetic strings running through the bridge and under the fingerboard. Unlike most viols, it is held, like the violin, under the chin. It was and is principally a solo instrument, possessing a modest literature from all periods, including the 20th cent. (The Columbia Encyclopedia, 2016)

3.8.2 Contrabass or Double Bass

Contrabass is the next evolution of the bass in musical scene. It is larger than Viol and can produce lower frequency sounds. It has 4 strings which are usually tuned to low E, A, D and G. It’s an important instrument between musical genres. Originated from classical music orchestras, it evolved itself into Jazz music around 1950s.

3.8.3 Octabass

Octabass has no practical use today. It was an experimental instrument and needed to be played by two players. It's able to produce very low frequencies even lower than human audible perception abilities. One of the most famous composers incorporating Octabass in his compositions was Wagner.

3.9 Binaural Beats

It is a known phenomenon that when fed to distinct simple waveform concurrently human auditory system introduces another frequency that is equal to the difference between the two signals being fed. For example, if a sine wave of 1000 Hz and another sine wave with a frequency of 1200 Hz are being heard together, subject audience would report another 200 Hz frequency as well.

This phenomenon takes another level when the different frequencies are directed to each ear separately. If a subject listen to 70 Hz sine on one ear and 78 Hz on another ear that will cause listener to hear another sound source as an 8 Hz beating. As human auditory system doesn't allow us to hear frequencies lower than 20 Hz this phenomenon is being used to send very low frequency waveform to brain in an attempt to adjust its working frequency.

3.10 Isochronic Tones

Isochronic Tones uses the same phenomenon without the need to deliver two distinct signals. Instead of using the frequency difference between two signals, Isochronic tones pulses an audio signal with the frequency of desired effect.

3.11 Human Auditory System and Hearing Range

Even though it is hard to define when a waveform considered an audio waveform, in most applications audio frequency limit is considered somewhere around human hearing range. In some high definition application this limit can be extended.

Human hearing range can recognize sound waves approximately between 20Hz and 20kHz first being the lowest and latter being the highest frequency. These number varies person to person and highly effected by age. As a person gets older, ability to hear high pitched sounds lowers. This is the explanation behind the phenomenon “older sound engineers mix brighter” meaning that the overall frequency balance created by older sound engineers consist more of the higher frequencies since they weren’t able to hear them sufficiently while mixing them.

3.12 Nyquist Theorem, a Brief Introduction for Sonic Artist

Nyquist Theorem is the basis of all digitization of analog material we use today. Sampling is the process of dividing an analog signal into pieces and recreating them digitally in binary format using only 1 and 0. Sound, photographs, video all uses Nyquist theorem for sampling to digital domain.

> *“Nyquist sampling (f) = d/2, where d=the smallest object, or highest frequency, you wish to record.*

The Nyquist Theorem states that in order to adequately reproduce a signal it should be periodically sampled at a rate that is 2X the highest frequency you wish to record. With images, frequency is related to structure size. Small structures are said to have a high frequency. Thus, the imaging sample rate (or pixel) size should be 1/2 the size of the smallest object you wish to record." (4)

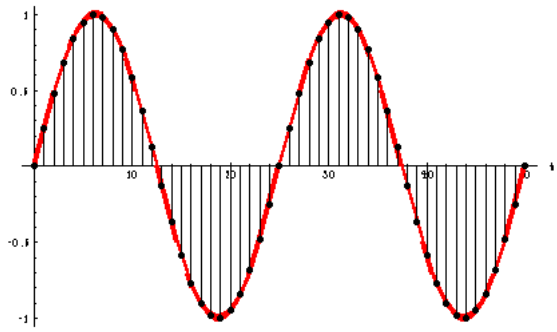

Figure 1: Adequately sampled signal

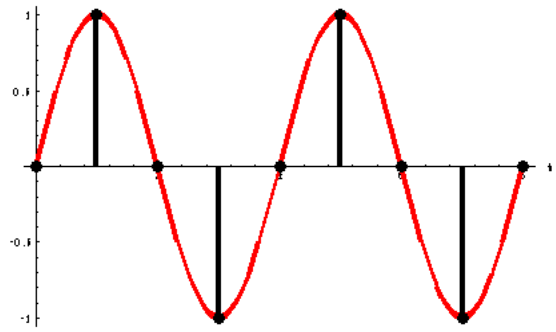

Figure 2: Minimum representation of analog signal in digital

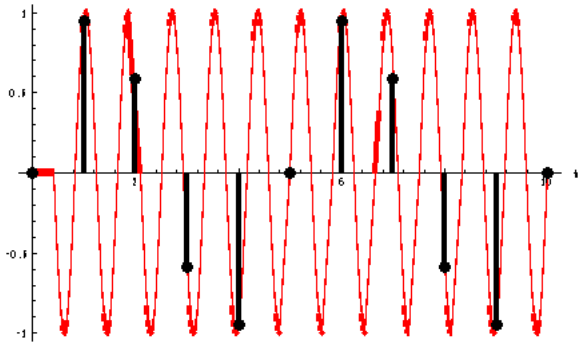

Figure 3: Undersampling will cause a phenomenon called aliasing.

3.13 Subwoofer History

Subwoofer is a loudspeaker special to low frequency sound production. Subwoofers usually work in the range of 20-180Hz, but some subwoofers can produce sub sonic frequencies as well. In THX approved systems, subwoofer cut off frequency is below 80Hz.

First subwoofers belong to 1960s era and they are created in order to support regular loudspeaker's low frequency production. First subwoofer patent belongs to Raymon Dones, of El Cerrito, California and dated back to 1964. Subwoofers are categorized as passive and active subwoofers where active ones have built in amplifiers and passive ones need a separate amplifier in order to be able to produce sound. In addition to that subwoofers are using both traditional loudspeaker systems as well as new experimental techniques that are tailored for low frequency audio production.

First mainstream use of subwoofers took place with the introduction of Sensurround technology. But subwoofer use really shined when the medias carrying the sound information improved in quality and became unbound to a limited frequency response. Obviously common use

of synthesizers allowed musicians and composers to produce low frequency sounds without needing huge instruments such as Octabass which we mentioned in the beginning of this section.

Around 1990s optical medias with surround sound capabilities took subwoofer use in the consumer products and became a widely used electronic gadget in most people's houses. Today subwoofers are so common that most of the live sound reinforcement work uses at least one subwoofer in their rig.

CHAPTER 4

4. HISTORY

4.1 A Quick Look at Western Music History

Western Music can be categorized into these following eras;

Medieval Music (476 A.D. to 1400 A.D.)

Renaissance Music (1400 A.D. to 1600 A.D.)

Baroque Music (1600 A.D. to 1750 A.D.)

Classical Music (1750 A.D. to 1820 A.D.)

Romantic Music (1820 A.D. to 1900 A.D.)

Modern Music (1900 A.D. to 1960 A.D.)

Contemporary Music (1945 A.D. to present)

Medieval music history is considered the beginning of the western music with Gregorian chants. In the beginning there were no notations and chants used to be transferred by memory. After first notation attempts terms pitch and harmony came into play naturally. First non-religious western music can be identified as French poets who arrange music for their poems. Around the 10th century polyphonic music started to emerge by writing various lines for different voices at a mass.

It was a common practice at this point for composers of these chants to apply slowing down techniques to existing chants and create new and extremely slow lines to be sung on top of the

existing chant. These experiments allowed composers to discover new possibilities of polyphonic composition. It should be also noted that these attempts -where introducing new musical elements by altering the speed of the current piece- represent a similarity to the experiment's discoveries made by composers after the invention of recorded sound. This branches another topic to "musical time" of Curtis Roads' "Microsound". Roads' summarizes time subject "musical time" in his work very cleverly. According to Roads, musical time spans on 10 different areas;

> *Taking a comprehensive view, we distinguish nine-time scales of music, starting from the longest:*
> *1.* ***Infinite*** *The ideal time span of mathematical durations such as the in®nite sine waves of classical Fourier analysis.*
> *2.* ***Supra*** *A time scale beyond that of an individual composition and extending into months, years, decades, and centuries.*
> *3.* ***Macro*** *The time scale of overall musical architecture or form, measured in minutes or hours, or in extreme cases, days.*
> *4.* ***Meso*** *Divisions of form. Groupings of sound objects into hierarchies of phrase structures of various sizes, measured in minutes or seconds.*
> *5.* ***Sound object*** *A basic unit of musical structure, generalizing the traditional concept of note to include complex and mutating sound events on a time scale ranging from a fraction of a second to several seconds.*
> *6.* ***Micro*** *Sound particles on a time scale that extends down to the threshold of auditory perception (measured in thousandths of a second or milli- seconds).*
> *7.* ***Sample*** *The atomic level of digital audio systems: individual binary samples or numerical amplitude values, one following another at a fixed time interval. The period between samples is measured in millionths of a second (microseconds).*
> *8.* ***Subsample*** *Fluctuations on a time scale too brief to be properly recorded or perceived, measured in billionths of a second (nanoseconds) or less.*
> *9.* ***Infinitesimal*** *The ideal time span of mathematical durations such as the infinitely brief delta functions. (Roads, 2001)*

These musical time definitions can be observed from earliest periods of music composition and my thesis will try to look deep into these details.

Going back to the subject of western music history brings us to Renaissance era. This is the era where harmonic embellishments become an essential part of compositions and defining factor for the quality of the composer. Composers around Europe gain fame, travel and perform in various places and countries.

4.2 Music Concréte

Music Concréte is mainly a description for music composition experiments and research that has been conducted in France. Most of these experiments done at Groupe de Recherches Musicales.

> *GRM—to give it its full title, Groupe de Recherches Musicales—is hardly a household name. But it deserves to be spoken of in the same breath as other centers of 20th century sonic innovation, from the BBC Radiophonic Workshop to the San Francisco Tape Music Center to Bob Moog's work station. In fact, in terms of sheer outer-limits invention, it might just outstrip them all.*
> *GRM began life as Groupe de Recherche de Musique Concrète, a sonic laboratory founded in 1951 by Pierre Schaeffer. A former telecommunications engineer turned avant-garde composer, Schaeffer had coined the term musique concrète some years earlier to describe his experiments with turntables and tape machines at the studios of the Paris radio station Radiodiffusion Française. In Schaeffer's vision, anything could become music: crashing pots and pans, a chorus of speeding locomotives, familiar sounds made abstract through stereophonic sound or the application of echo and delay. In his hands, the studio itself became the instrument.*

The GRMC's early activities attracted luminaries including Karlheinz Stockhausen, Iannis Xenakis, and Pierre Henry, but it was a tempestuous creative environment, and in 1958, Schaeffer pulled it back under his control, renaming it Groupe de Recherches Musicales. In the years following, GRM became the locus for a new community of young composers—among them, Luc Ferrari, Bernard Parmegiani, Beatriz Ferreyra, and François Bayle. As technology evolved, GRM evolved with it. During the 1970s, a generation of computer musicians like Bénédict Mailliard and Jean-Claude Risset flourished within its walls. 1974 saw the inaugural concert of François Bayle's Acousmonium, an orchestra of 80 speakers that broke new ground in sound diffusion. The following year, GRM was incorporated with Institut National de l'Audiovisuel to form INA-GRM, placing it in a wider context of artistic and cultural research. (Pattison, 2018)

As Pattison briefly summarizes, GRM was one of the two most important places that popularized experimental music studies. Researches, composers, musicians and engineers collaborated in order to explore the effect of the latest technology in music creation process. Today IRCAM in France is somewhat of a continuation of GRM with leading audio and spatialization research including microphone arrays and high order ambisonics research. I had the chance to participate in a IRCAM masterclass at Boston University on high order ambisonics.

4.3 Tape Music

Tape Music refers to the experimental music composition experiments in Germany, especially at WDR Studio. One of the most prominent figures of this scene is Stockhausen. The biggest difference between France's Music Concrete and Germany's Tape music is that German composers relied on recorded sound more than French composers while French composers tend to experiment with synthesizers and other forms of producing sound.

The Electronic Music Studio at Westdeutscher Rundfunk (WDR) in Cologne was founded by the composers Werner Meyer-Eppler, Robert Beyer, and Herbert Eimert (the studios first director) and was based on Meyer-Eppler's ideas outlined in his 1949 book 'Elektronische Klangerzeugung: Elektronische Musik und Synthetische Sprache'. This thesis defined the ongoing theoretical character of the studio as being based around electronically synthesised sound – in sharp contrast to Schaeffer's musique concrète acoustic approach at GRN in Paris. (6 Crab)

4.4 Questioning the Form

Even though there are many musical genres, in terms of the common definition of music consist compositional form developed throughout the musical history. Form can be identified as the roadmap of a musical piece. Events in time domain considered the structure and this structure suggest the form of the piece.

Form is an essential element of a musical composition along with harmony and counterpoint. Especially with the emergence of experimental and avant-garde composers' questioning of form in notation came to question countless times.

"A score may no longer 'represent' sounds by means of the specialized symbols we call notation, symbols which are read by the performer who does his best to 'reproduce' as accurately as possible the sounds the composer initially 'heard' and the stored. Edgar Varèse once drew attention to some of the disadvantages of the mechanics of the traditional notation: with music 'played by a human being much later, the player has to prepare himself in various ways to produce what will - one hopes - emerge as that sound.' 4'33'' os one the first in the line of the compositions by Cage and others in which something other than a 'musical thought' (by which Varèse meant a pattern of sounds) is

imposed through notation. Cornelius Cardew wrote in 1963: 'A composer who hears sounds will try to find a notation for sounds. One who has ideas will find one that express his ideas, leaving their interpretation free, in confidence that his ideas have been accurately and concisely notated.''' (Nyman, 1974)

As Michael Nyman phrases clearly questioning widely accepted compositional forms was an essential part of both experimental and avant garde composition movements. Composers of this era weren't only searching for unexplored domains of sounds timber and pitch they were also looking to reveal undiscovered possibilities of compositional techniques and methods. Extended techniques are commonly used, and musicians are asked to perform these techniques with their instruments, even though most of the time there are no extended techniques training in formal curriculum of conservatories.

As more radical compositional styles emerged in the second half of the twentieth century, many nontraditional notations and techniques were formulated by composers to convey their musical ideas. Composers throughout the world were influenced both by other composers and the advent of computer music. Berio, known for his computer music, wrote quartets in the 1950's and taught composition at Tanglewood during the 1960's. Xennakis was one of the first composers to replace traditional music thinking with radical new concepts of sound composition. Penderecki began using graphic notation in his scores prior to 1960 with his composition of Threnody for the Victims of Hiroshima. He is well known for his avant-garde techniques and string textures. These composers represent a few that had influence on the notational writing of American composers. The new techniques are commonly referred to as extended techniques. An extended technique is devised when a composer creates a new notation in order to convey to the performers of his work his intention regarding a different timbre, special sound, or effect. (Tischhauser, 2002)

Here Tischhauser points out an important aspect of these new radical composers and their approach to musical notation. Xenakis was an influential figure when it comes to creating and designing never tried methods of traditional musical notation.

> *It is well known that Xenakis very often conceived his music with the help of graphic aids, on a Cartesian plan with time in abscissa and pitches in ordinate. Music is represented by points and lines. A point shows the punctual type of an attack; a line, a sustained sound or the relation between two points. By gathering all elements in the same plan, it may be difficult to follow a voice precisely. On the other hand, this kind of representation permits one to visualize the global evolution or transformation over time of masses of sounds. (Gibson, 2006)*

This was a way for Xenakis and similar composers to be able to create the basis for discovering new sonic aspect of musical composition without the need to adhere to traditional musical notation standards. Here explains some issues and limitation with traditional notation;

> *In music notation, many signifiers (notes in particular) are unique only within a specific context. Thus music notation is highly context-dependent. For example, a dot may be interpreted as an augmentation dot, as part of a repeat sign, or as a staccato symbol, depending on context. Music notation contains both pictorially and literally mnemonic signifiers. Tempo and dynamic markings are examples of literally mnemonic signifiers. Pitch and time are represented roughly and pictorially with a two-dimensional coordinate system, where the vertical axis represents pitch and the horizontal axis represents time. Thus, music notation is also structurally isomorphic in respect to time and pitch.*
>
> *Music notation is reversible. A musical score may be created by transcribing a musical performance. However, for trained musicians, music is generally easier to read than to write. Music notation is terse. This can be seen from computer representations of music notation, which show the large amount of information embedded in the individual signifiers of music notation.*

> *Music notation is both cryptic and partly inconsistent. Its signifieds are hard to understand without prior musical education. Among the inconsistencies are ways of representing durations of notes as a combination of several different symbols, which include noteheads, stems, flags, beams, and augmentation dots. Among the benefits of music notation are that it is both extendable and optional. (Lassfolk, 2004)*

These limitations, although probably needed at a time to replicate the sounds of composers in history without causing too much interpretation without composers' existence in every performance of the piece started to look unnecessary for composers who were able to record replicas of their work with their accompanying notation. Usually these notations include everything that a composer wants to underline.

4.5 Sound into Space

Main question this thesis suggests is to question new compositional techniques which will allow sound to be used in a different context and in relation to the space it's going to be exhibited. Limiting audible variables in a composition can be a viable compositional procedure and I have decided to focus my research on lower frequencies of audible frequency spectrum.

Here is an image showing the relation between wavelength/frequency. Even though shown frequencies are not audible, this image is a good presentation of how various wavelengths move in a given space.

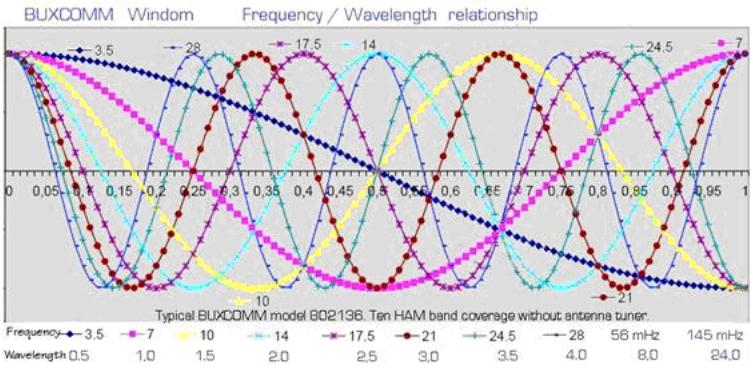

Figure 4: Wavelength/Frequency Relation

A lower frequency wave has a longer wavelength. This means that in order to complete a complete cycle of one unit of the given frequency, that specific wave needs to travel the necessary distance before losing its energy.

This approach was performed in APPE space at University of Maine and results were quite interesting.

In this installation two separate low frequency capable speakers placed facing each other. These speakers are rated capable of producing audio waves as low as 15 Hz and up to 1000 watts root mean square power each. These speakers have built in audio amplifiers in order to accept direct line input in order to produce sound. Audio coming from the oscillators is fed through a digital/analog converter and connected directly to speaker system.

Installation creates a web of audio waveforms in the space, clashing and altering each other at specific spots. Since most of my work use low frequency spectrum with long wavelengths, these nodes of audio waves can be spotted by walking in the space by feel. They are not visible but they are easy to spot just by walking into one of those nodes. They either have a strong amount of bass

frequencies or have almost no low frequency content, allowing participants to listen to other sounds in the space created by the rumbling of the low frequencies without the low frequencies themselves.

The acoustic phenomenon happening there is quite interesting. Human auditory system usually loses its directional perception capabilities below ~200Hz. But using beating of very low frequency audio content we are able to create a different variety of directionality using sound waves.

There are no simple waveforms in nature. Without a laboratory clean environment, it's almost impossible to hear pure waveforms without artifacts created by reflections of the sound source. Even though in this work the oscillators used produce sine waves, as soon as processing of that information starts, harmonic content is added at varying amounts. First step of this processing is digital aliasing occurring before the digital to analog converters. After that sound information hits converters and gets filtered in order to adhere Nyquist standards. According to the quality of the components of these converters, audio information gets altered by mostly unwanted but subtle harmonic content being added. After these steps instead of digital data, signal travels through analog domain. I should add here that there are modern systems that uses digital data until speaker input which eliminates the noise problems through long distances that can be introduced on analog domain. After digital audio converters, audio travels in analog domain and reaches speaker inputs. Once this analog signal reaches the speaker input it is sent to audio amplifier and then to speaker cone in order to be transformed into sonic energy.

4.6 Black and White Composition

In photography use of colors is an artistic choice. A photographer may decide to use full color spectrum, filter some of it or end up not using any resulting in a black and white photograph. Even though removing colors from a photograph results in a black and white photograph, there are a lot of other techniques to create a black and white photograph that looks substantially different than the initial black and white photograph. I will try to demonstrate this using a public domain photograph.

Photograph below is converted to black and white color scheme by various techniques.

Figure 5: Original

First iteration;

Figure 6: First Iteration

Second iteration

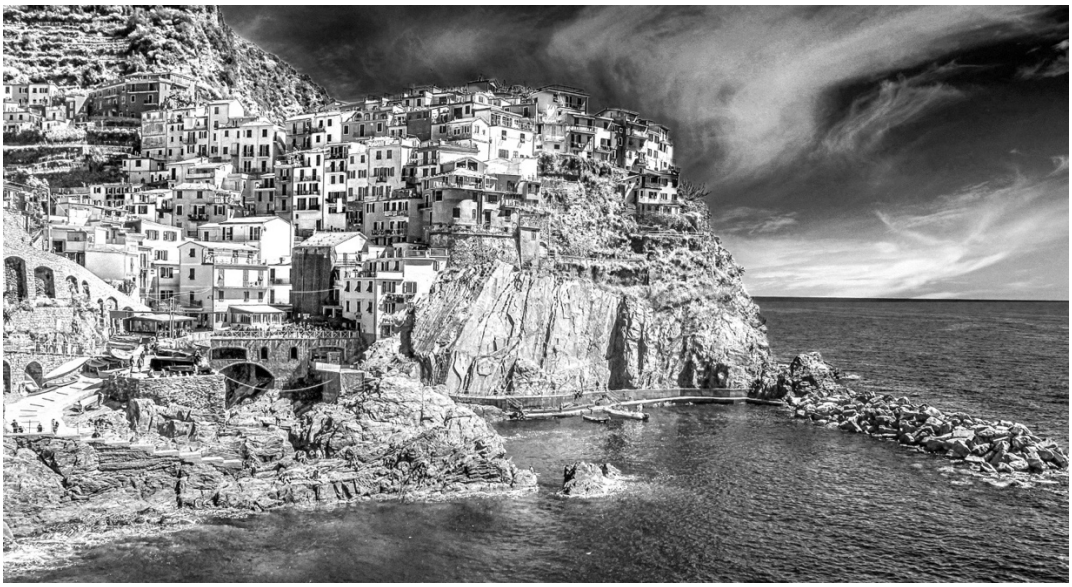

Figure 7: Second Iteration

Third iteration

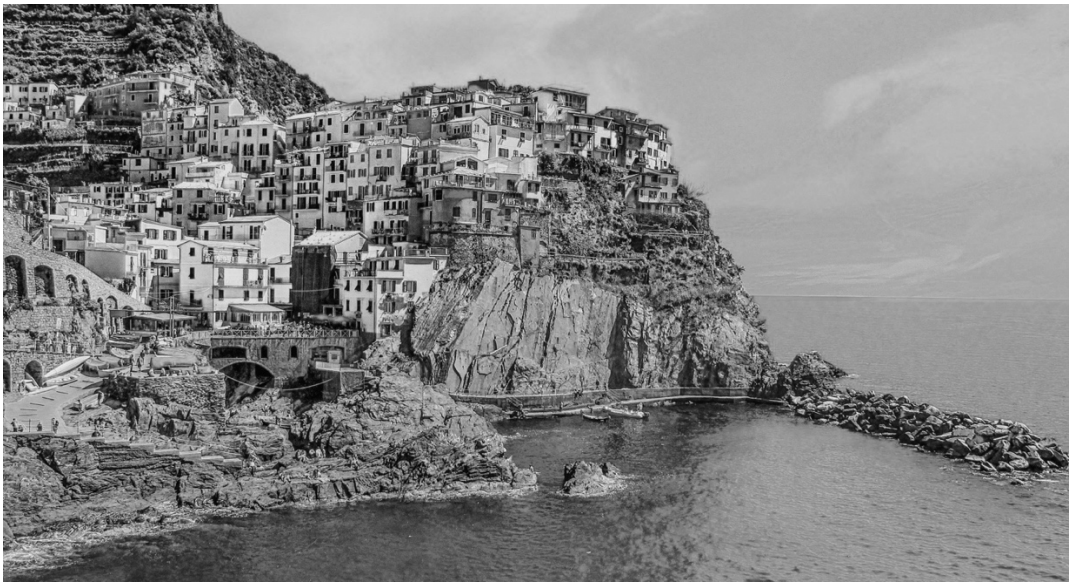

Figure 8: Third Iteration

Fourth iteration

Figure 9: Fourth Iteration

As we can observe above, different techniques, blends and mixtures creates different results when developing a black and white photograph. This is a result of selective filtering of various parts of the visible spectrum.

Photographers are familiar with these techniques in order to create dramatic results from their images. It can be assumed that since photography started with black and white photographs, the notion of black and white photography already existed in cultural perception and as technology improved to offer full color photographs, vintage and nostalgic feeling of the black and white photography needed to be simulated after capturing full color photographs.

Same phenomenon can be partly observed on sound technologies and sonic cognition as well. New technological achievements digital audio allows us to easily record and reproduce frequencies that are above 15 kHz where this part of the spectrum was problematic and challenging to record and reproduce in analog domain correctly. But this improvement did not reflect on the music listeners' expectations. Many preferred the softer more rolled of feeling of old analog technology compared to sharp, harsh and uncontrolled brightness of digital audio. Today there are many processors available to simulate the smoothness of analog hardware and processors into digital domain.

As same phenomenon can be observed on sound technologies it is not true for musical composition. Until modern era in musical history most composers targeted to achieve fully developed composition throughout the audible spectrum. The idea of selective use of frequency spectrum and limitation of sound to a specific range could lead to new explorations between sound and acoustical space relation.

4.7 Space as an Instrument

Use of low frequency spectrum has a purpose in my thesis research. This is the frequency spectrum where most of the acoustical energy exists. By using low frequency waves, it is possible to create rumbles and shakes in an acoustical space. When I was composing my first low frequency compositions, I realized that their tonal structure completely changes according to the space they are played in.

> *It has been said that in the performance of Variations VII Cage gave up more control than in any other composition. Again, it is difficult to tell whether this was a result of accident or intention. The setting was perfect for Cage. The venue for 9 Evenings, the 69th Regiment Armory, was acoustically very live with its six to seven-second reverberation span that ensured the entire space was filled with cathedral-like ambience. This acoustic space presented a nightmare for the technicians—as Robby commented after visiting the building five days before the first performance: "How in Christ's name were we ever going to produce any coherent sounds in an environment like this? Would all of these little black boxes be swallowed up and shrink to insignificance? I swore I could count a seven-second echo constant each time I placed my foot on the floor. (Frances Dyson, Sounding New Media, 70)*

As Frances Dyson tells the ambience at one of Cage's performances, he refers to how an acoustical space affects and challenges a composer to exhibit their work. One of the aspects to this situation is that I believe as experimental and avant-garde composers challenged the preconceived notions of musical composition and tonal harmony, time to time there were attempts to use traditional sound and acoustical engineering techniques to control the tonal outcome of the acoustical space.

With the emergence of acousmatic music, use of space became a part of the experimental music composition and a blend of music skills and sound engineering skills needed to expand on what this new musical approach brings to the arsenal of the composer.

4.8 Speaker as an Actuator

Traditionally an instrument needs an actuator in order to produce sound. A guitar needs a pick or a finger to be able to trigger a string, a piano needs hammers, a flute needs the air.

In Bineuro installation instrument is the space itself and speakers are the actuators that creates shakes and rumbles in the space in order to produce its unique sound. Just like internals of a traditional instrument this instrument also allows composer to alter the subtle nuances of the placement of actuators and internal structure.

This brings us to another question where if composer is the person to author the creation of said instrument can we assume that here composer takes the role of the *luthier* as well.

> *Modern guitar luthiers now improve in making a guitar with such plenitude of lower partials that the tone is deeper, more resonant and well-balanced at the back of large concert halls than before. A new design of strutting system can work in a concert hall, however when played in a small room, the tone can be too thick. Up until today, luthiers still have not solved this dilemma and are experimenting with double soundboards, detachable necks, false backs, sound ports, sound chambers and other innovations. (Desmet, 2014)*

If luthier is the person dealing with the internal placement and sonic issues of an instrument here in this case, Bineuro suggests that composer can take the role of the luthier as well. For example, of the composer desires a dense sonic environment with plenty of sound nodes they can place the sound sources accordingly. Geometrical similarities in placement would result in more beatings and nodes and non-symmetrical placements would decrease these nodes allowing audience to listen to individual sources to some extent.

> *Issues relating to the viable proximity of the listener to musical sound sources in a live performance context were raised in discussing gestural space. In the process of recording music, spectromorphologies performed in one space are captured in such a way that they can be transferred to another space to be listened to acousma- tically.23 In a stereo recording, a significant and necessary transformation is that the musical 'image' must be shrunk to fit the real space between the pair of loudspeakers. But decisions have also to be made about the appropriate presence of gestural and ensemble space as well as the relations between them: that is the challenge presented to producer and sound engineer. It is no surprise that for those who wish to engage in a concentrated musical experience, a viable recorded musical image (let us set aside the issue of particular musical interpretations) is able to offer a better image of gestural and ensemble space than an unsatisfactory live image. And now, with the 5.1 format, whatever its defects for audio alone, the relations among gestural, ensemble, and arena space have to be rethought. These kinds of issues are very relevant to acousmatic composers, who do not work in isolation from the medium or formats which they have taken on as their own. (Smalley, 2007)*

As Smalley raises the question of the interaction between the challenges related to the producer and sound engineer. In my work, sound engineering is the basis of my compositions therefore in order to create an interaction between the audience and the work presented it requires an

identification of the space that it is going to be installed. Here Smalley offers a neat categorization of the space which I find applicable to my work.

> *I refer to as enacted spaces, and they can be divided into two primary types – utterance spaces, which are articulated by vocal sound, and agential spaces, where space is produced by human movement and (inter)action with objects, surfaces, substances, and built structures; we can also include human intervention in the landscape. (Smalley, 2007)*

4.8 Skeuomorphism in Composition

Most audio people would assume I will be talking about replicas of old analog hardware that are created in digital domain in order to give the user the sense that they are dealing with the real thing. Most audio effect processors have skeuomorphic designs that replicates the look and usage of the real hardware.

> *Skeuomorphic design, where user interfaces emulate the appearance of physical objects, has been popular for pretty much the history of personal computing. The ideas of "files," "folders," and the "recycle bin" in Windows could be considered skeuomorphs, intended to help transition early computer users from analog to digital, as could the idea of an "inbox" and "outbox" in email and the paperclip that symbolizes attachments. More recently, a lot of early iOS apps were famous for their heavy-handed skeuomorphic elements, with felt textures and chunky drop shadows. (Lagomarsino, 2017)*

But my main intend with the term skeuomorphism is not the technical, user interface design aspect of things. I am more concerned about compositional approaches that acts similar to what skeuomorphic designs do. My question here is if newly invented instruments should be approached

with traditional musical practices such as tonal harmony and rhythm or is a new compositional method possible, where composer mostly not only shares a musical idea but an entire sonic vision with their listener through use of newly invented instruments on sound production techniques?

In other terms, as most experimental music composers suggest if we can take a train recording and use it as an instrument, what is the right approach to using this recording in a compositional setting? Is it a better way to leave the train sound as is without any changes to its harmonic content or should we make necessary changes to confine it to the traditional tonal music standards? Should we pitch up or down the recorded sound of a train to let's say 440Hz A pitch in order to build other scales using the relative distances or can a train sound without any processing -or at least without processing it to stretch to already declared rules of musical harmony- suggest a new listening experience to regular listener?

CHAPTER 5

5. THESIS

5.1 Bineuro / Installation

Sourcing from my research on low frequency use on various musical genres, artwork and broadcast applications, reading and digesting the ideas of previous pioneers of acousmatic and experimental/avant-garde electronics music composers, the idea of limiting my compositions to a limited frequency spectrum has born.

The idea of taking out all the percussion elements from my compositions and try to incorporate the use pitched instruments as percussion parts of the composition was an already established idea. Outcome of my involvement and research on binaural and isochronic tones was another reason I have decided to limit my compositions to a specific frequency spectrum, to low frequency spectrum in particular.

As I discussed in previous part of my thesis human auditory system allow recognition of 20Hz to 20kHz. By limiting the frequency response of my work, I aimed to create a methodology to create a set of installations where I would be able to dive deep into low frequency sound spectrum where human body acts as a giant ear instead of perceiving sounds using human auditory system. This would allow me to direct my audience to focus on a sonic experience they likely haven't experienced before in such pure form. Our sonic culture usually dictates both tonal harmonic and non-harmonic sonic composers to fill the entire audible spectrum and audience of is expected to experience a sonic work that is mostly focused on one part of audible spectrum.

On the other hand, during the installation preparations I discovered that I must use the space that I am going to be installing my piece in order to compose properly for the work itself. This is due to the limitations of the hardware required to represent such low frequency sounds. Home studios wasn't an option to compose and bring that compositions to the installation area. Most of the time home setups are non-powerful enough to achieve to overall impact of the intended effect. Most home setups do not use subwoofer and even though I had the chance to use a subwoofer, work calls for at least two subwoofers. These challenges shaped the work itself throughout its creation and allowed me to step back as the author of the work and let the constrains and limitations of the methodology I came up with to shape and lead the works future prospect.

5.2 Sound Production

Bineuro uses sine wave oscillators in order to produce sound. Oscillators are limited to 100Hz in *fixed* mode which removes stepping movement between chromatic scale notes. This allows oscillators to produce very precise frequency numbers and intervals allowing experimentation between various frequencies as well as various frequency differences.

Oscillators used are Ableton's Operator synthesizer module.

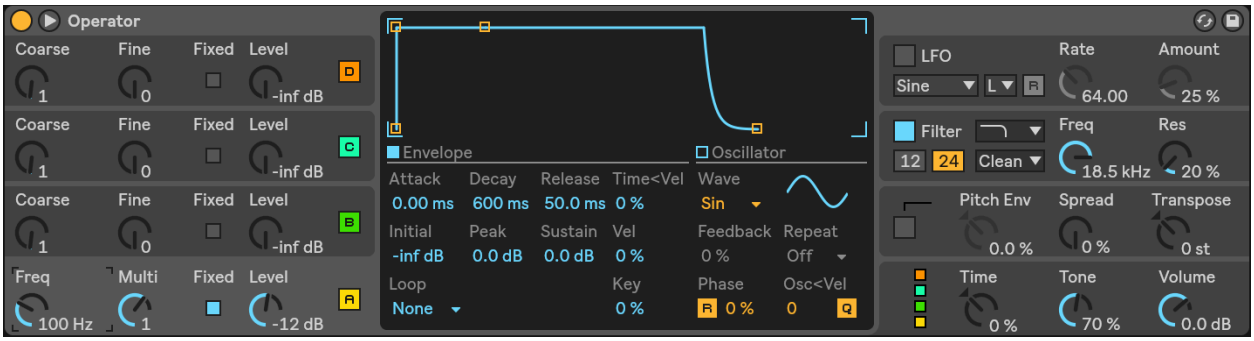

Figure 10: Ableton's Operator Synthesizer Module

This approach allows creation of countless amounts of beatings. I have tried to categorize these groups, but these are not limited to my categorization. There could be many other settings that can offer different effects on the audience.

First group would be high low range, small frequency difference between two sub oscillators.

I take 95 Hz as a starting point and adjust the other oscillator to 95.5 Hz. This would result in a .5 Hz beating as well as two distinct 95 Hz and 95.5 Hz sine waves.

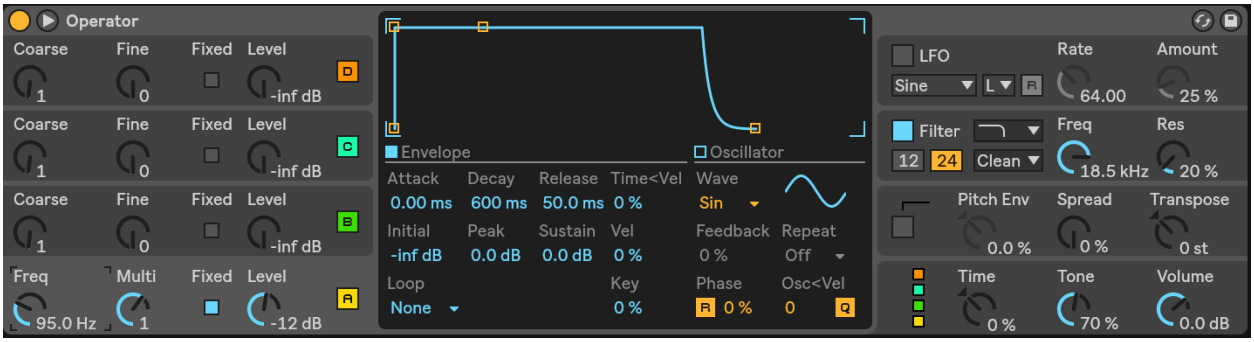

Figure 11: Oscillator 1 at 95 Hz

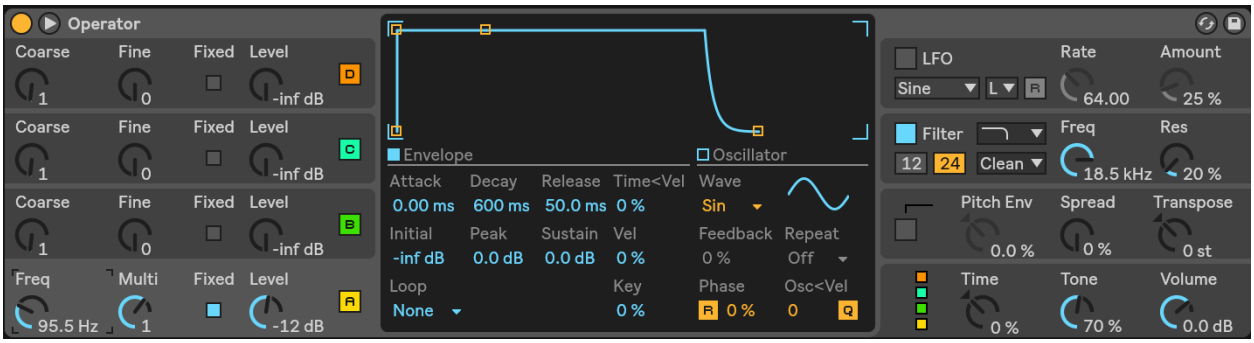

Figure 12: Oscillator 2 at 95.5Hz

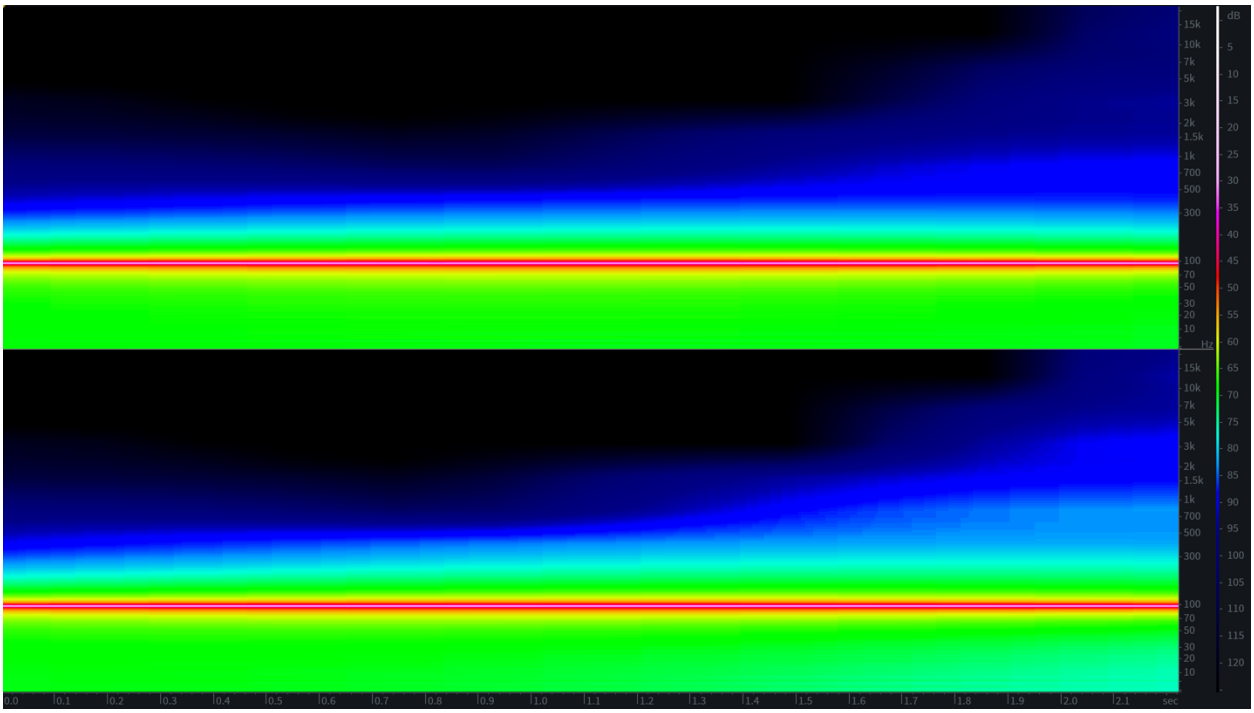

Figure 13: Resulting spectrogram image from 95 and 95.5 Hz waves hard panned

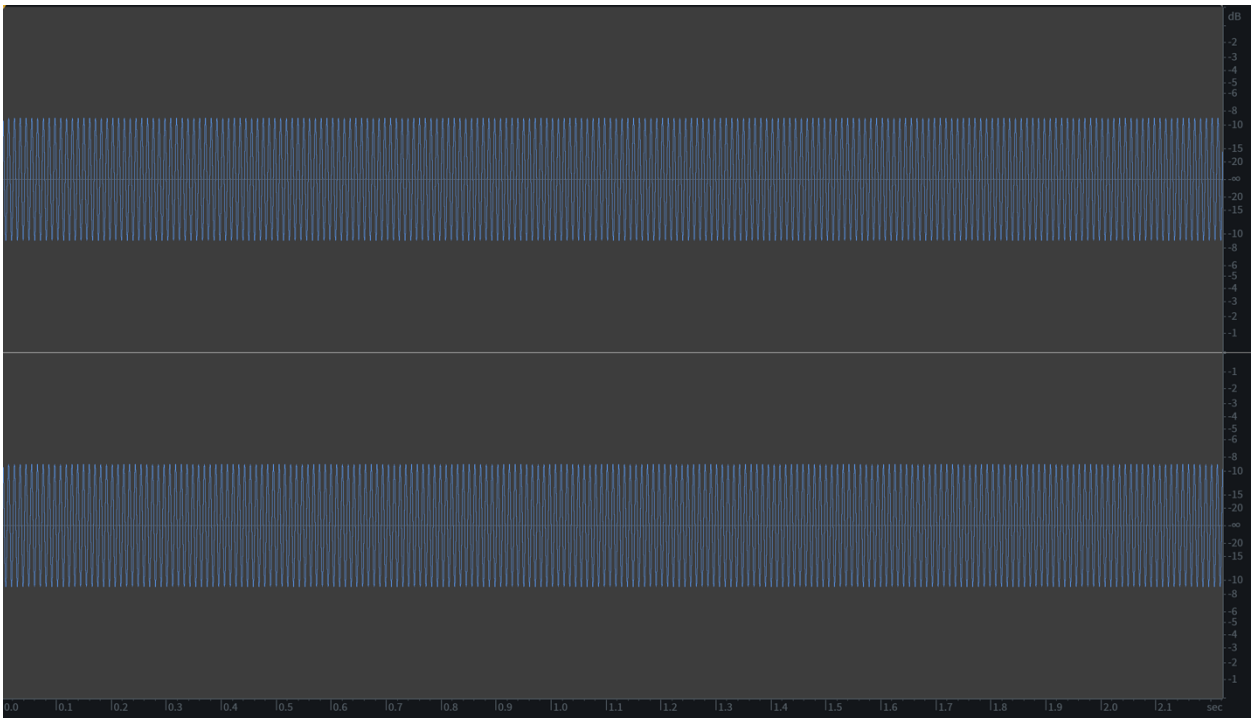

Figure 14: 95 and 95.5 Hz waves in waveform view

Even though Bineuro installation uses separately located sound sources for demonstration purposes to be used in my paper I have created these visuals. Previous two images represent both of the oscillators separately in order to show the differences and interaction between those two signals. Beating pattern is subtle, occurs in higher frequency and creates a more consistent waveform.

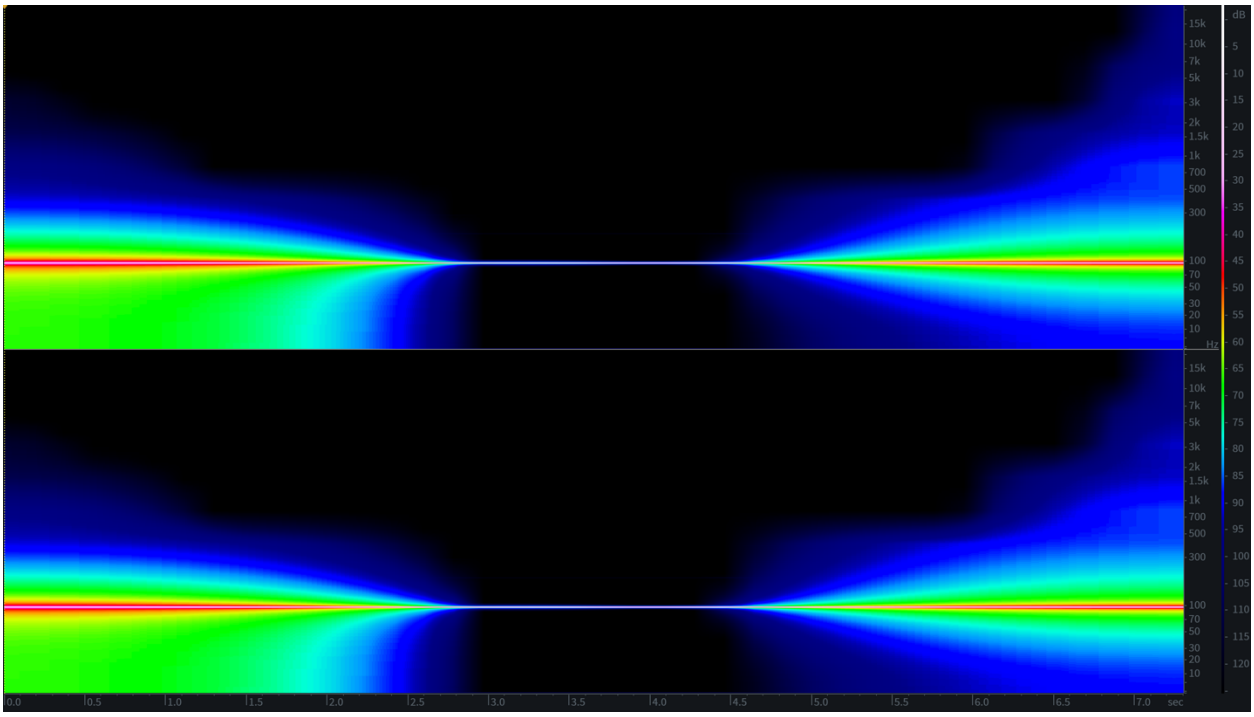

Figure 15: 95 and 95.5 Hz data both oscillators panned to the center

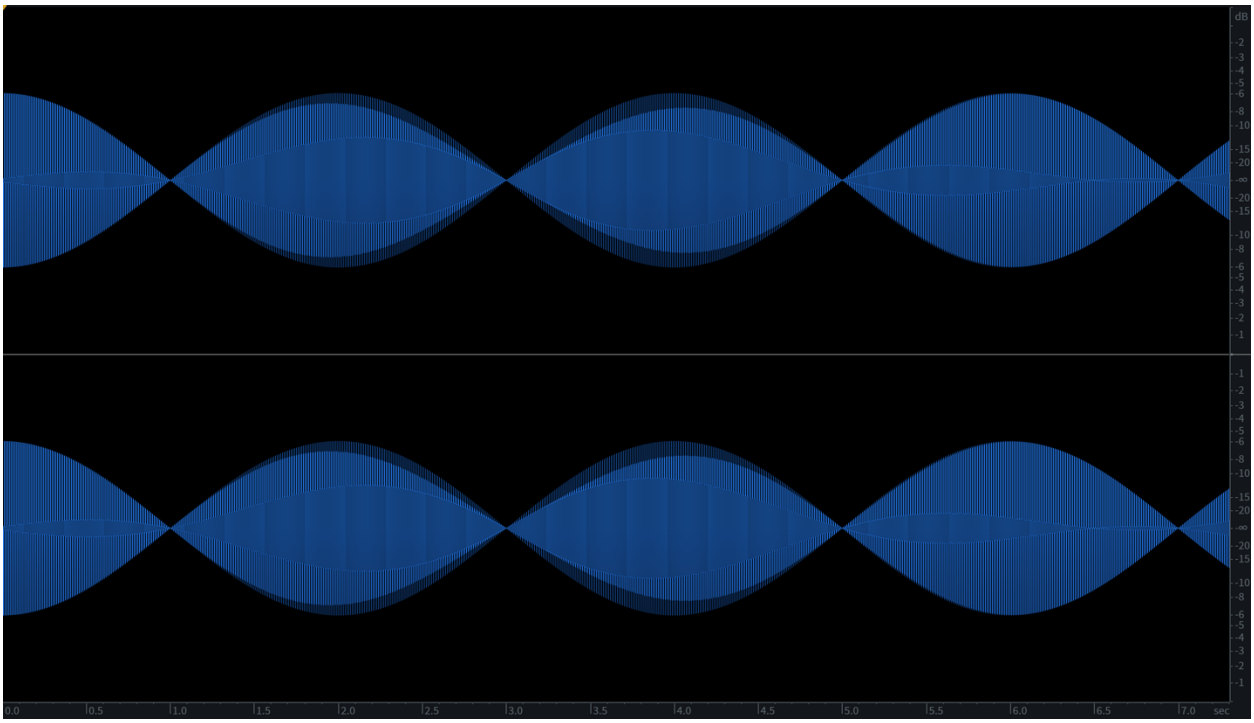

Figure 16: Same data in waveform view

Once both sound sources mixed digitally by panning both to the center, they create entirely different results. Dominant beating is a very low frequency beating existing in the sub sonic frequency domain. This beating represents the beating occurring at the installation space in a real-life situation. Such a low frequency would be impossible to produce by conventional sound reinforcement techniques and also it wouldn't be possible for human auditory system to perceive and process such a low frequency tone. This phenomenon allows us to produce very low frequency waveforms by amplitude modulating one frequency to another.

Before going on with more examples in different frequency ranges with various differences in their pitch I would like to mention that human auditory system is very good at capturing cycles of frequencies. As the frequency goes lower the length of the frequency becomes longer. This is the area where human auditory system starts to get tricked and perceives frequency as sort of a pattern.

For a better explanation I will quote University of Connecticut professor George N. Gibson's definition of difference beats.

> *Human perception of beats*
>
> *Beat frequency is less than about 10 Hz. If the beat frequency is less than about 10 Hz, the two waves are very close in frequency and you will hear only one pitch (which is actually the average of the two frequencies). However, the loudness will vary with a frequency corresponding to the beat frequency.*
> *Beat frequency roughly in the range of 10-60 Hz. This range of frequencies is quite significant and problematic for the human nervous system. It is too fast for the individual events to be discerned, but too slow for the brain to ignore. Phenomena in this frequency*

range can be quite annoying. For example, if a film is played at 10 frames/sec, you can identify the individual frames and it looks like a very fast slide show. If the film has more than 50 frames/sec, you don't see the individual frames and the motion looks continuous. However, films at 20 – 30 frames/sec look very jerky and annoying. The brain does not know whether to focus on individual frames, or try to interpret it as continuous motion. Similar strobe lights at 20-30 Hz can easily produce headaches. When it comes to sound, beats frequencies in this range sound rough and dissonant – they are simply unpleasant to listen to. The pitches are too far apart to consider as one pitch, but too close together to distinguish. The brain cannot follow the individual beats but it is not fast enough to interpret as a new pitch. Simply put, when beats are present in this frequency range, the brain registers dissonance.

When the beat frequency is greater than about 60 Hz, the brain can distinguish the pitches of the two notes and the beat frequency is interpreted as a difference frequency, if at all. (Gibson)

This bring us to one of the main ideas about Bineuro. We are not able to hear below 20Hz using conventional sound production techniques. Human auditory system simply is not capable of such low frequencies, mostly due to its size.

5.3 Installation

Bineuro requires at least two powerful subwoofers that can produce low frequency sounds without being pushed too hard. Most speaker systems have a roll of curve, this usually is not indicated on the manufacturer's spec sheet. What this means is most of the time the defined frequency response from a speaker cannot be achieved in real life situations. Due to these sorts of limitations, Bineuro requires subwoofers that can reproduce frequencies as low as 10-15Hz. This allows a bit of slack for human auditory system's 20Hz limitation and allows reproduction of low frequencies to be produced as they are intended in the composition.

For Bineuro installation 2 subwoofers used that are connected to two separate sound producing oscillators. Although the number of subwoofers can be higher as long as they can be fed using an individual oscillator in my installation, I had access to 2 subwoofers that are capable of producing the frequencies needed.

These 2 subwoofers placed directly facing each other in order to exaggerate the beating frequency effect especially in the middle of the installation space. Results were strong, once oscillators are fed through the subwoofers the installation space becomes an invisible pattern plane where audience can walk around and define the areas by the amount of low frequency beatings. A listener of example can be standing in an area that sound beatings are extremely strong as much as to create some sort of disorientation in listener's perception; strong psychological and physiological alterations of perceived effect of the installation, then listener can step to another invisible pattern area by listening and find that most of the low frequency is gone, opening an empty listening spot that is mostly rumbles and shakes created by the space itself.

5.4 düsHane

düsHane is the next reiteration of the work Bineuro where the frequency range that sine wave oscillators producing is on mid-range of sound spectrum. Bineuro was an experiment to play with limitations and constrains on art making process, specifically sonic compositions. As constrains on Bineuro was immensely helpful to break creative barriers as well as rendering me with the ability to focus on a specific area of composition, düsHane aims to carry these findings and outcomes that I have gathered through Bineuro project to another sound spectrum area.

Producing Bineuro was a very performative process. Since I always worked on very low frequency sounds, I always needed to be present in the installation space, almost completely composing pieces in the time allowed to me for working in the said space. I was setting up all my compositional tools ready to go, so I could use all the time I have with the system that I'm working with, as efficiently as possible. Although I should have seen it coming, this was an unexpected, unforeseen constrain that I did not expect. I should have realized it earlier because this limitation is directly related to the limitation I came up with; constraining frequencies that I will be using to the low domain of sound spectrum. As most home studios are not capable of producing such low frequencies the constrain, I created by limiting my sound range also dictated this new constrain by itself almost turning into a live composition every time I needed to compose for this speaker configuration.

When setting up for a specific speaker configuration in order to compose it is almost impossible to think about Francois Bayle's Acousmatic music ideas.

> *Francois Bayle defines 'acousmatique' as 'a situation of pure listening, without attention being distracted or supported by visible or foreseeable instrumental causes' (Bayle 1993: 179).*

Bayle and Pierre Schaeffer describe acousmatic music as music composed for speakers. They considered the modern era speakers and methods of sound reproduction as the curtain that Pythagoras suggested as a pure listening condition without the effects of what they call an `instrumental distractions`.

> *'In ancient times, the apparatus [dispositif] was a curtain; today it is the radio and the methods of reproduction y that place us, modern listeners to an invisible voice, under similar conditions' (Schaeffer 1966: 91)*

This phenomenon can be easily observed by listening to a piece of music where listener can use their visual perception in order to

1) observe some visual stimulants that are related to the music being played

2) observe regular visual elements that are not related to the music being played

3) bringing visual perception to a complete halt as much as possible (closing eyes being one of the most effective)

It is indeed simple to reproduce these three listening states. Open up a music piece that you preferable haven't listened before that has accompanying visuals i.e a music video. Listening to this music by following visual elements that are composed to support and enhance the overall impact of the music, following other visual unrelated visual elements or closing your eyes and focusing on music completely creates three entirely different listening experiences.

From my personal experiences I know that this is a method that is used by sound engineers and mixers all over the world daily. Most sound engineers I know have a shortcut for completely darken their display so that they can stop focusing on the waveforms but actual music and mixing desk adjustment knobs which corresponds to the second listening state I have described. Another method in use is the third listening state, closing eyes and listening through the piece that is being mixed on the desk.

Bineuro was an attempt to discover and focus on pure sinusoidal waves and frequency beatings that it created in a given space using very low frequency domain. This range can be defined as 20 Hz on the lowest and approximately 100 Hz on the highest frequency. As human auditory system loses most of its locational abilities below 200 Hz One of the outcomes, I have gathered with Bineuro installation was the ability to hide the sound behind a curtain, as in Pythagoras' pure listening suggestion. düsHane follows up the same tradition by hiding itself behind the mechanical curtains; speaker but it is frequency range is in middle range domain in order to experiment using same sound production techniques as Bineuro.

CHAPTER 6

6. PORTFOLIO WORK

Starting from my studies at Istanbul Technical University, focus of my work has been primarily audio and sonic content. I have been exploring different uses and importance of sonic factors as well as their effects on human auditory system. Some of these studies were aimed to explore space and sound relation from an architectural standpoint and while I was figuring out traditional uses of music production and record engineering for both contemporary and classical musical styles.

Throughout my Intermedia Master of Fine Arts degree, I have been exploring various elements and practices in order to expand the research and work I have been focused on. These studies varied in time from visual elements to collaborative performances as well as participatory work and socially engaged art forms.

My work takes sound and sonic phenomenons as its core and tries to build and intermedial, multidisciplinary ways to create and execute art work. Even though most of my work consist of solo projects, I have been involved in collaborative art acts as well. Below can be found some of my work samples both in collaborative and solo projects.

6.1 Data Art

Data Art combines ideas of data visualizations, big data and art making and data collection practices. Trying to discover the ideas behind data visualizations, it follows a circular path; it is a system that is created in order to collect data from a circular system; international space station and transform this data into circular visual representations. It approaches data in an egalitarian manner, does not discard any data and considers all data collected throughout the process worthy of being able to alter piece itself.

As I started my MFA degree at the University of Maine, I started tracking the times and durations of the International Space Station into an .csv file. After 365 days I used this .csv file in order to create visual representation of the collected dataset.

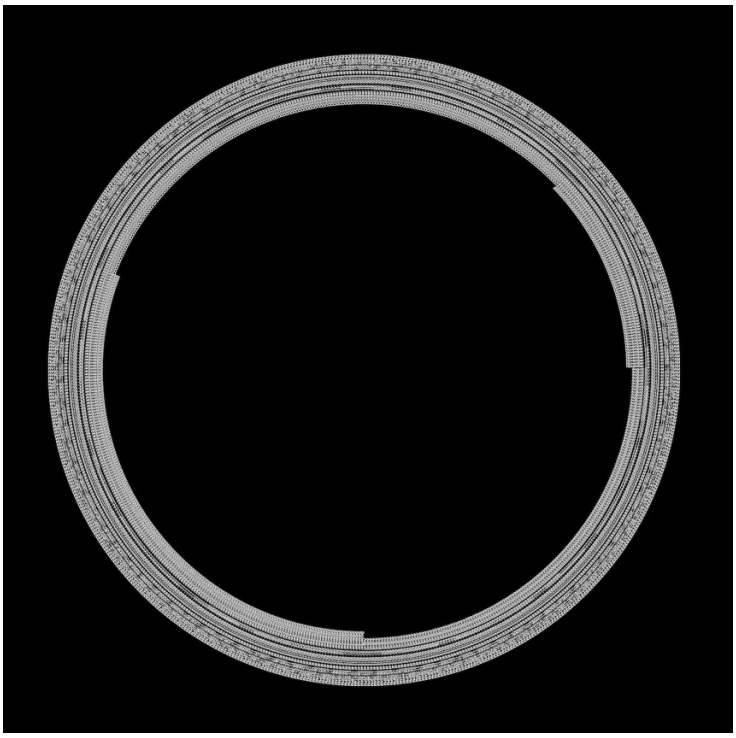

Figure 17: Data Art Example 1

Another presentation of the same dataset;

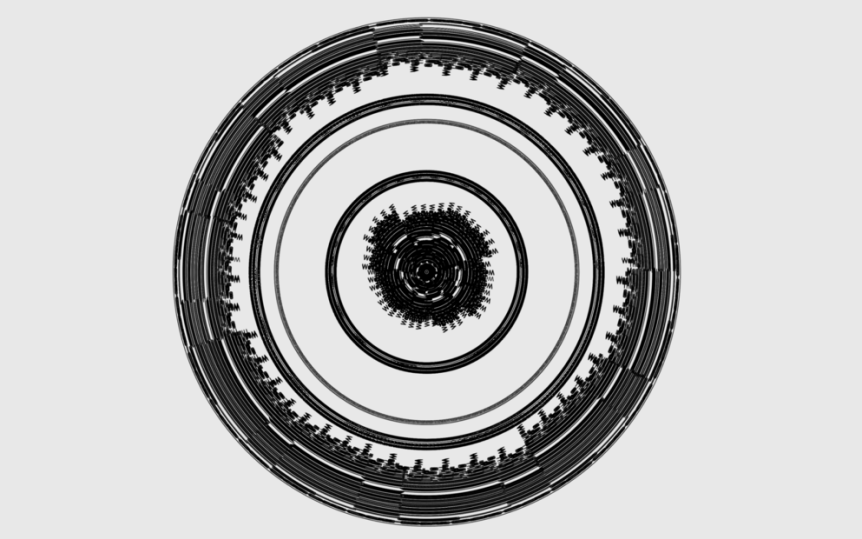

Figure 18: Data Art Example 2

A visual respresentation of jihadist attacks to the western countries using similar visualization techniques;

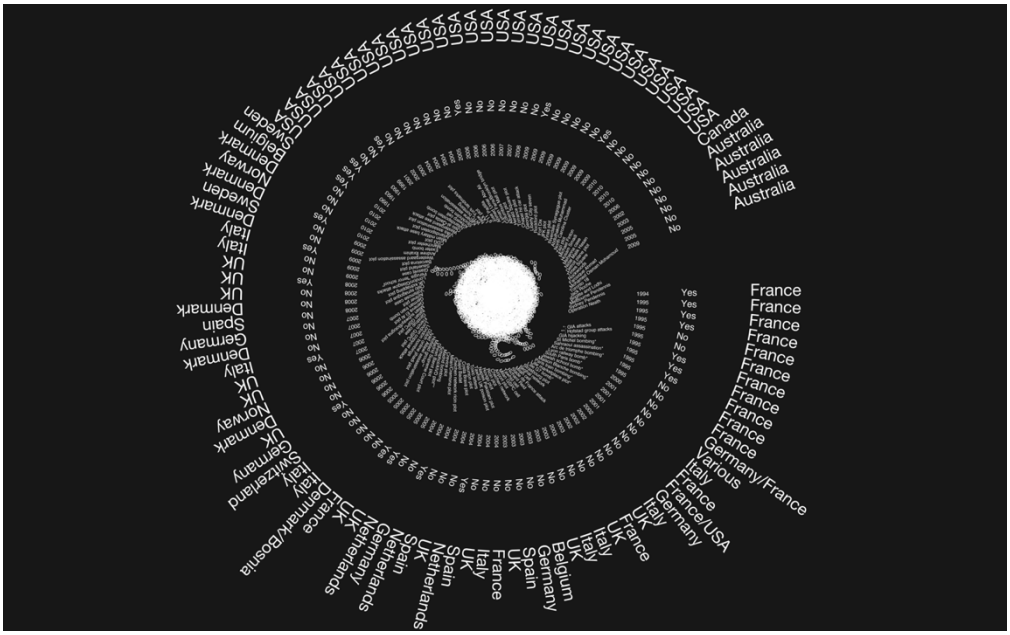

Figure 19: Data Art Example 3

Crime rates, organized by continent, continental region, sub regions and countries;

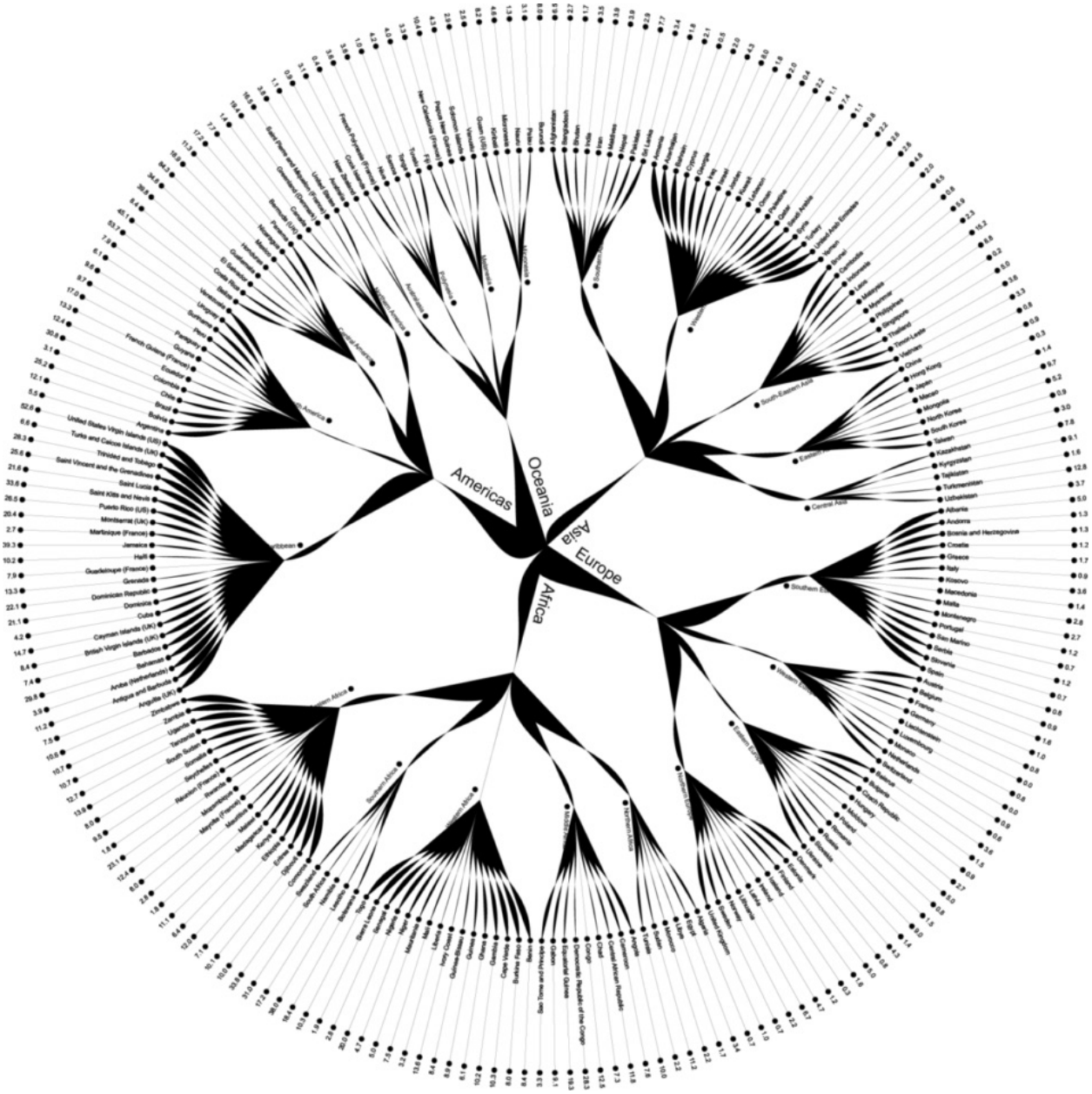

Figure 20: Data Art Example 4

6.2 Cageian Ringtones

Cageian Ringtones is a collaborative/interactive art project where participants given a set of instructions for their mobile devices in order to install “Free Cageian Ringtones”.

Instead of offering 4’33” long audio files with no audible information in them, projects explains participants how to put their mobile devices into silent mode using instruction sets taken from various blogs.

Project aims to discuss the existence of data from a n artistic/creative point of view and tries to explore modern variations of John Cage’s 4’33” in a simple but expandable method.

Participants are invited to share their experiences using cageian@berkaytok.com email address.

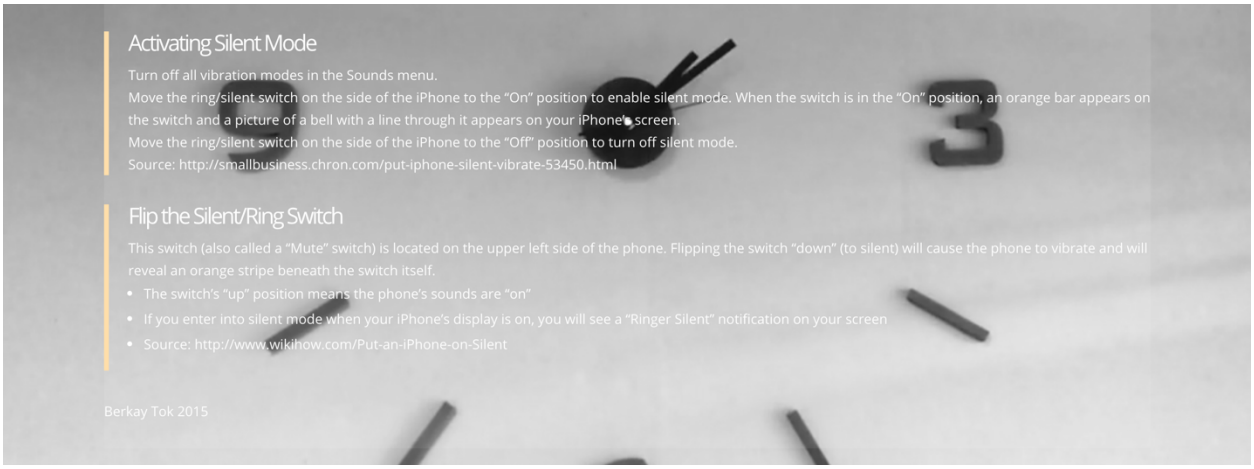

Figure 21: Cageian Ringtones

Participating is still active and can be reached through my website.

http://berkaytok.com/projects/cageian-ringtones/

6.3 Joyride

Joyride is a socially engaged art project executed in a collaborative way. The idea for the project is inspired by Na Nachs of Israel and their routine acts.

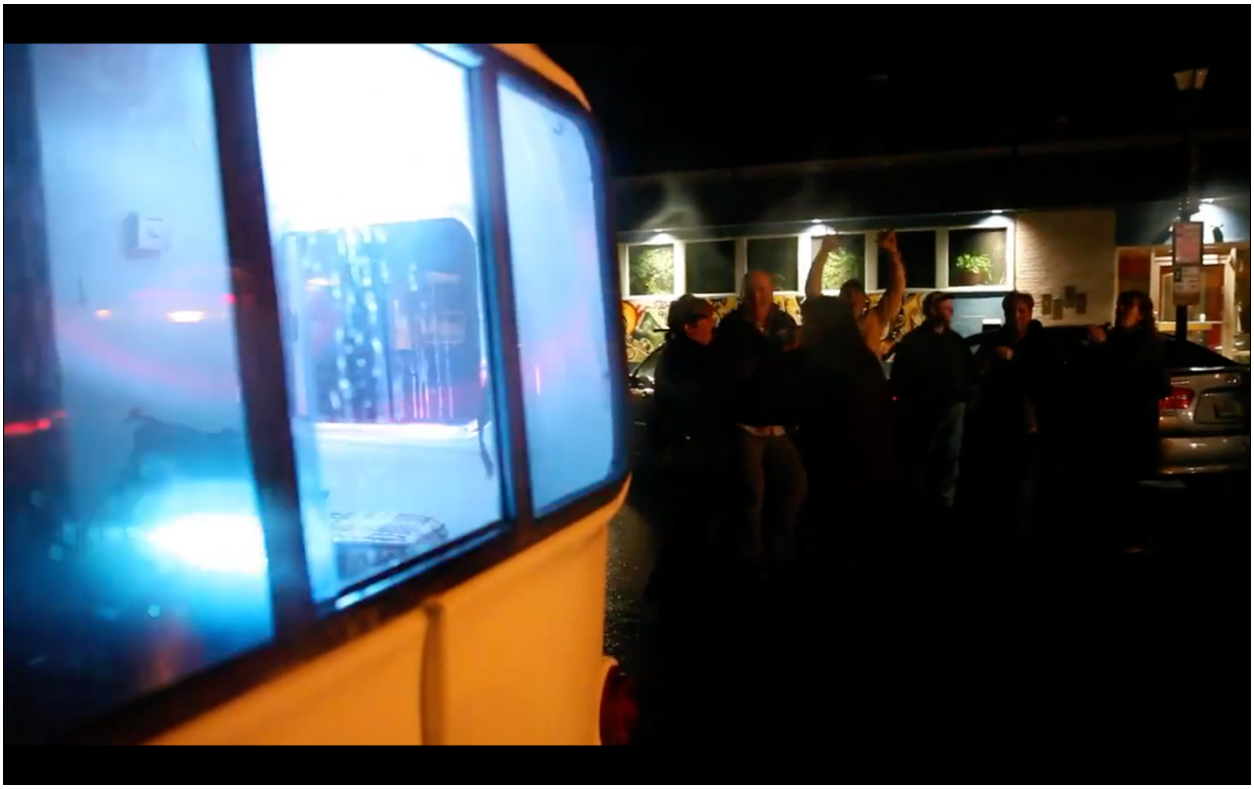

Figure 22: Joyride Screenshot 1

Na Nachs of Israel is a minor belief group. They play loud electronic music from their vans in the streets and they spread out from those vans while waiting on traffic lights in order to preach their belief to the public.

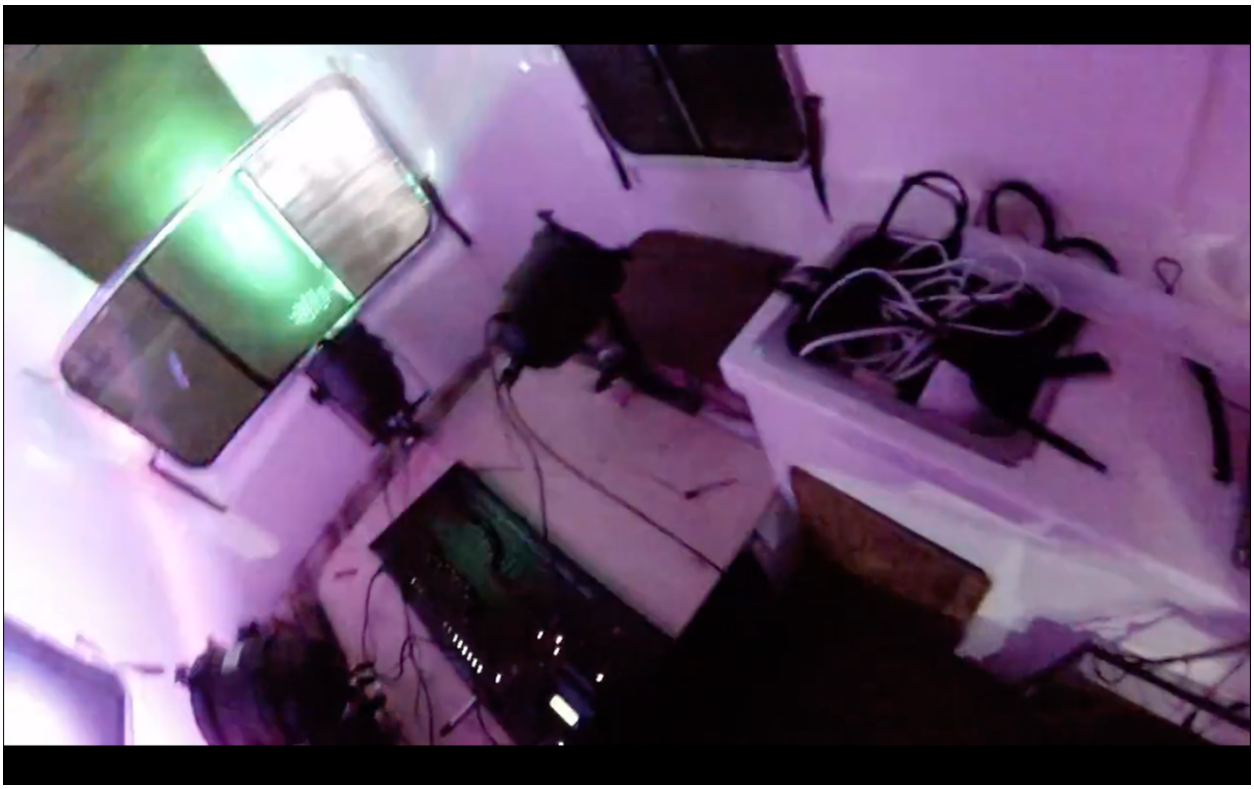

Figure 23: Joyride Screenshot 2

Joyride takes this idea and aims to execute it as a socially engaged art project where a mini trailer converted into a mobile mini disco with lights and sound systems. Project executed in Bangor, ME and Orono, ME with great reaction from random people as its targeted audience. There were cases where people were celebrating a birthday party, some wanted to donate money and most people wondered if there was a schedule for this event.

Figure 24: Joyride Screenshot 3

Full project documentation can be found on http://berkaytok.com/projects/joyride/

6.4 #Nothere

Figure 25: #nothere Screenshot 1

#nothere is a collaborative art installation at the State House of Augusta, Maine. It aims to point out fundamental issue about the refugee crisis and current political environment in western countries about the issue.

Figure 26: #nothere Screenshot 2

500 pairs of shoes were installed at the stairs of the State House. Shoes were pulled from the beginning of the Capitol Park up to the State House.

Figure 27: #nothere Screenshot 3

The documentation of the piece was premiered at the #nothere exhibition between April 25-29, 2016.

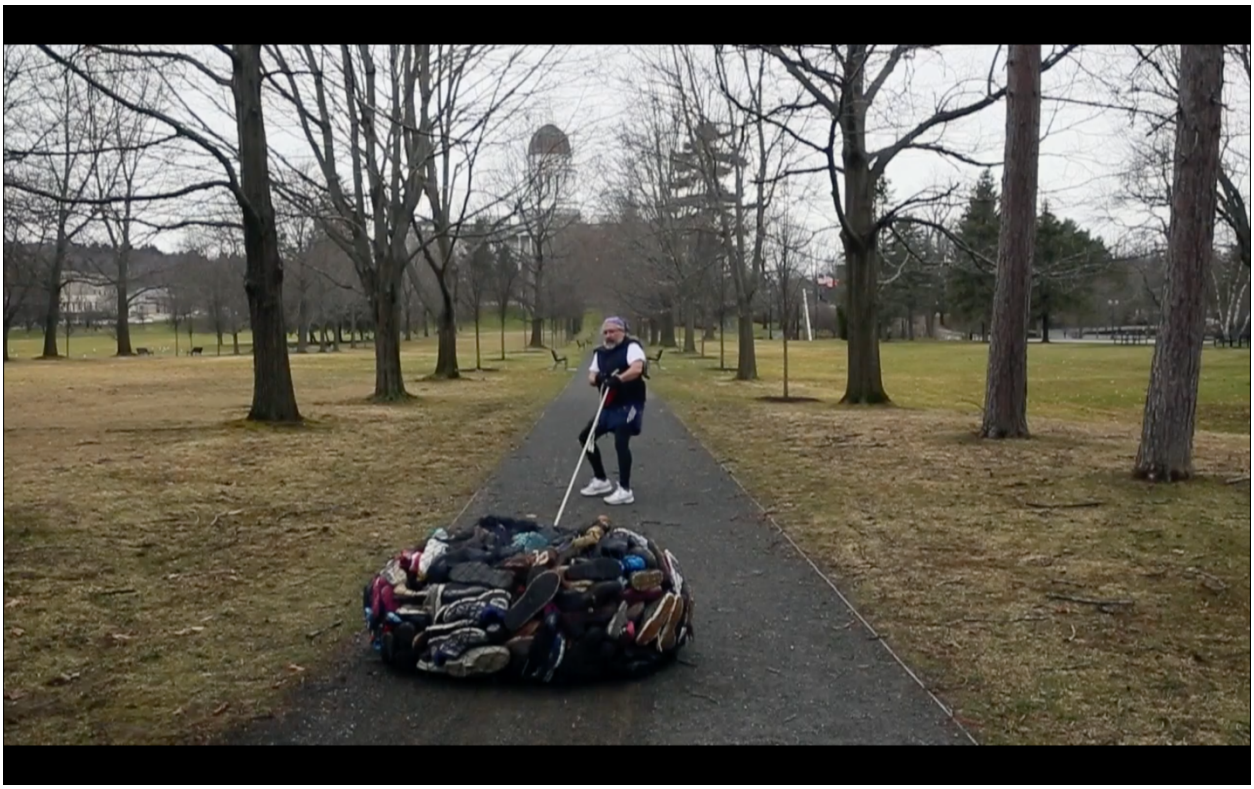

Figure 28: Stanley Lewinski, pulling the stack of shoes to their final destination.

6.4 khumbuGlacier Installation

Inspired by the work of Ryoji Ikeda, khumbuGlacier has been created in order to explore and understand Ikeda's workflow.

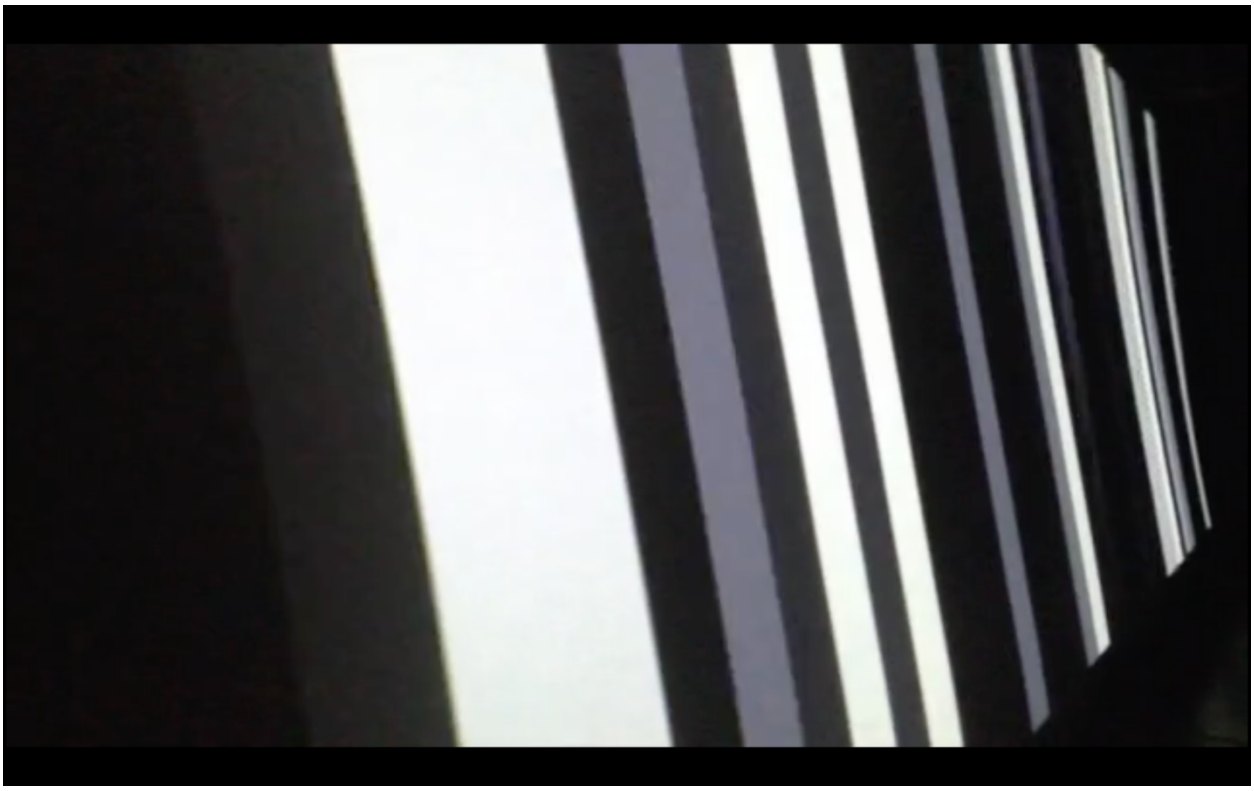

Figure 29: khumbuGlacier Screenshot 1

khumbuGlacier was my first introduction using Jitter platform with Max/MSP. I had the chance to get supervision on Max MSP and Jitter usage from Nate Aldrich for this project.

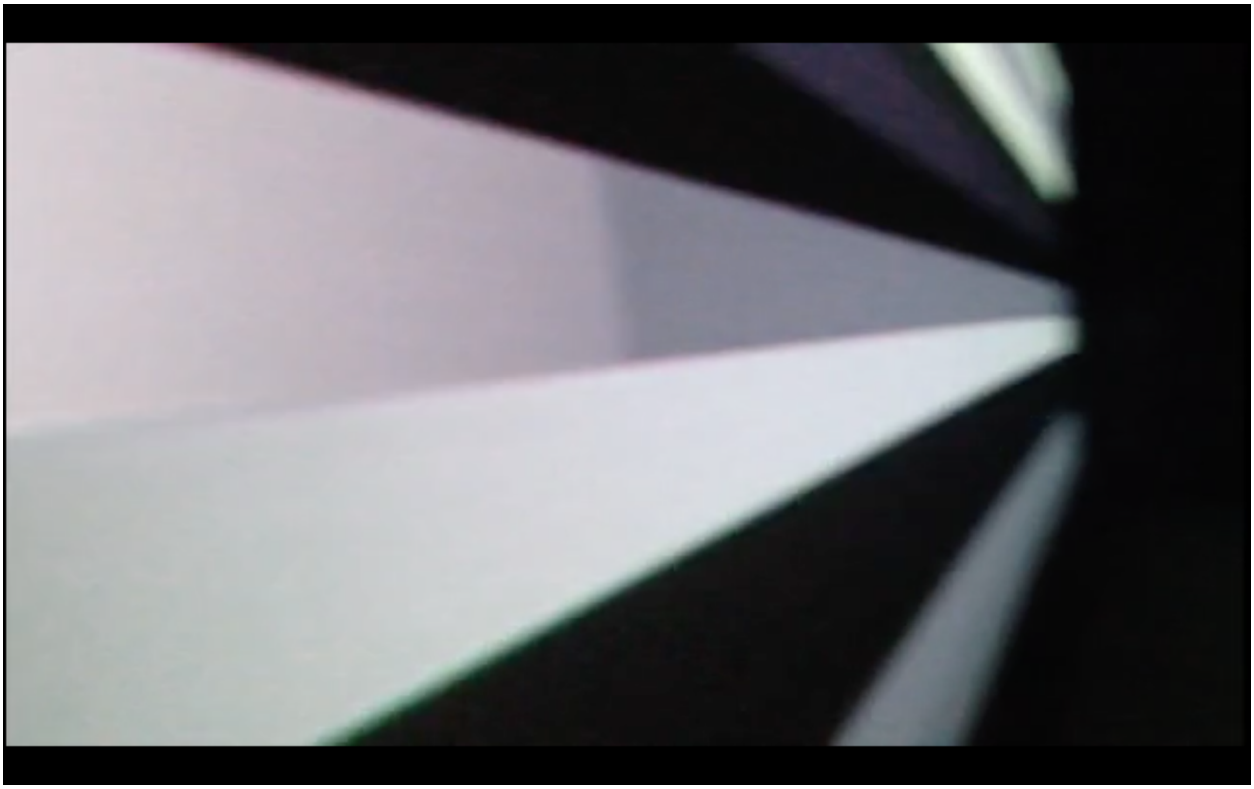

Figure 30: khumbuGlacier Screenshot 2

Even though project wasn't as successful as I expected it to be, it allowed me to further explore the relationship between data and translation of one type of data to different environments in order to create multi-dimensional installations.

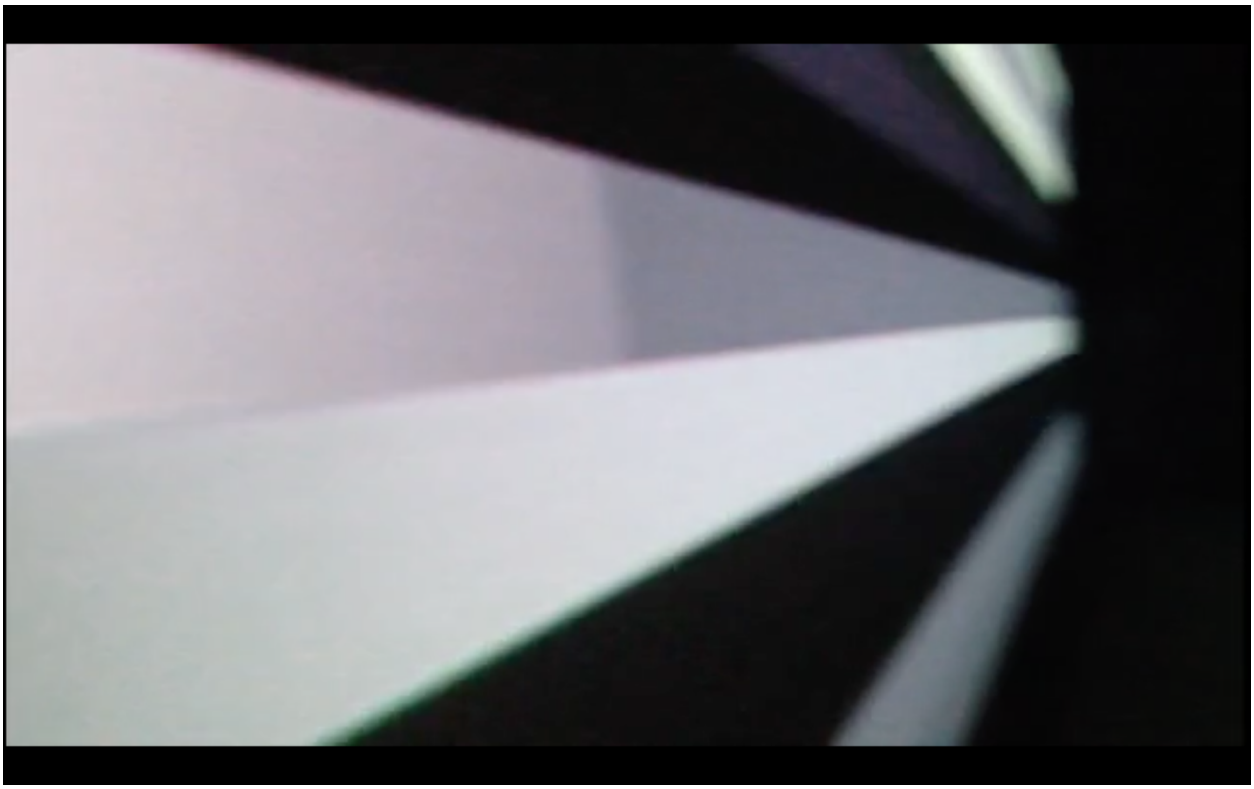

Figure 31: khumbuGlacier Screenshot 3

For this installation, an electronic music piece is composed in Ableton Live and this piece fed into a Max/MSP patch where Jitter objects were triggered by different attributes of the electronic music composition as volume data, frequency data and similar other information as well as indeterministic use of Max/MSP objects in order to create en evolving piece that won't repeat itself at any point.

A screenshot of the actual patch can be seen in the picture below;

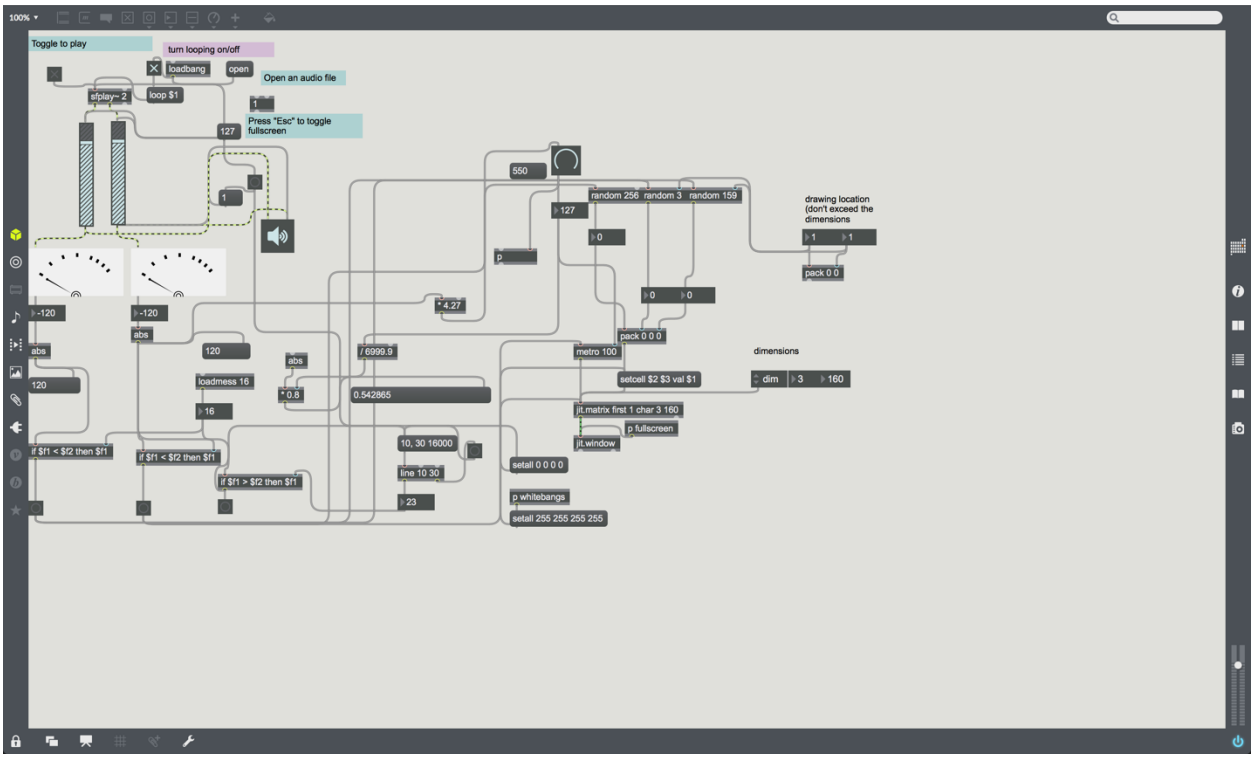

Figure 32: khumbuGlacier Max/MSP project

The patch is also avaliable to download at www.berkaytok.com

6.5 Katahdin the Greatest Mountain

Katahdin, the Greatest Mountain, collaborative audio-visual 3D model installation.

Katahdin is a tribute piece to the greatest mountain of Maine. It is a collaborative art project lead by James E. Francis, Sr. Project consist of hundreds of layers of CNC cut wooden plates in order to create a representation of the mountain. This model of the mountain gave us an area to create a projection mapping installation.

Figure 33: Katahdin The Greatest Mountain, Screen Capture

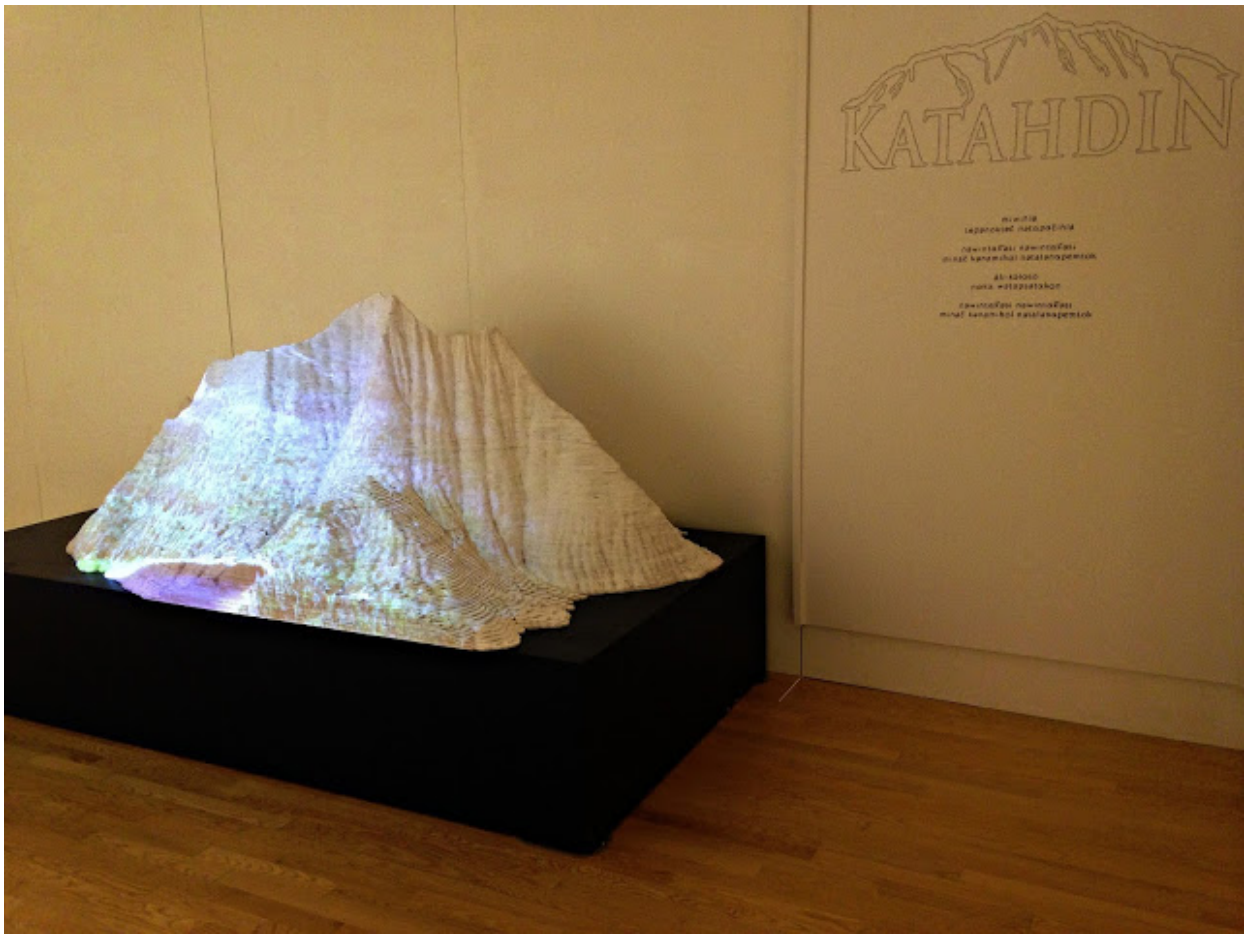

Figure 34: Katahdin The Greatest Mountain, Installation Site, Courtesy of Abbe Museum

6.6 Compositions

http://berkaytok.com/sonic/compositions/

All Compositions listed below can be listened from the link above.

6.6.1 dueTo

dueTo designed and composed to question the necessity of intelligent time spent on the things that are not under our control. It is a piece embracing the acceptance and trying to learn with things that are happened. It believes and tries to demonstrate the fact that some things happen just because they do. It tries to represent the times that our minds feel crippled and unintended falls during our timeline of life. It expands and retracts, a representation of the struggles one experiences here and there in their lives. It is a highly personal piece and focus on this piece is not the audience itself but the composer who felt the urge to create it.

6.6.2 snowLemonade

snowLemonade is a collaborative electronic music composition. It sources its elements from the recordings of Brewer Community School students. These recordings later manipulated into a composition in 2 channels.

snowLemonade focuses on the placement of an electronic music composition into the virtual space by playing dimensions of the place it is taking place. Composition rapidly switches

between mellow soundscapes to almost cartoon like sounds while placing those sounds into spaces that are varying in dimensions.

6.6.3 haciendaHeights

haciendaHeights is a study on frequency modulation. It is composed to discover the almost unlimited offerings of frequency modulation synthesis. It is an experimental piece and its aim is to teach the composer what can be done and what are the possible ways to achieve same results using multiple frequency modulation techniques and settings.

6.6.4 exposeHokkaido

exposeHokkaido is a piece trying to imitate a contemporary percussion piece from an actual acoustic orchestra combined with the possibilites of digital media editing tools' offerings. It is influenced by my personal collaboration performance with renowned percussionist Emil Kuyumcuyan at Cappadocia Classical Music Festival.

6.6.5 receiptScanner

receiptScanner is composed in order to create a sonic representation of proletariat. Piece tries to resemble the struggles and never-ending loops that a person can experience in life without any access to any production authority and tools. This piece is composed at a time where I was focusing on political systems who control what production tools and why capitalism poses a barrier to the working class that creates a never-ending loop and offers most of the time almost no exit.

Piece consists unexpected events throughout its lifetime just like a working-class person could face in their own life.

CHAPTER 7

7. CONCLUSION

Combining years of art research and application my thesis tries to exhibit an abstract of the work I created in the past as well as the future prospect for my upcoming creative process. Basing itself into sonic arts my body of work feeds itself through various disciplines and tools of art making, including multimedia.

My interdisciplinary line of work consists of sonic and visual studies combined with collected datasets in order to expand on and explore various art making practices. My focus is research on art making and STEAM education where I try to combine various artistic and maker approaches into real life working examples and experiences on perception of art and technology.

I have been involved in various art making and maker culture practices where I was able to sharpen my skillset on different approaches to creative practices which allowed me to discover new endeavors. My sonic work represents base or a starting point where my interests expanded in a radial manner allowing me to build other artistic approaches on top of my sonic work. My thesis work Bineuro and dusHane are good examples of these hybrid approaches combining architecture and sound where sound takes space as a part of compositional methodology.

To conclude my findings from my thesis work main I would categorize the outcomes I have gathered in three main categories.

First of all, I believe limiting frequencies used in my composition to specific areas turned out to be an important milestone for my sonic body of work. Music is an immensely complex phenomenon and once the audience is invited out of their traditional comfort zone of listening this complexity can easily turn into a chaotic and cacophonic experience. In order to avoid such a listening experience, I invite my audience to take baby steps into the world of non-harmonic sonic content. This allows me and my audience to deconstruct what is behind a listening experience, let's us to think about what we hear since we are all used to hear tonal musical pieces, immediately recognizing and categorizing them into our predefined knowledge of musical genres.

With these findings from my previous projects I would like to expand these results to other projects. One of these ideas is recording the rumbles and shakes that are created by subwoofer speaker systems I setup in a given space. By inverting the phase of the sinusoidal sound waves that I feed into the speaker system it is possible to remove those frequencies from the recording. This phenomenon is called phase reversal. The result is recorded shakes and rumbling sounds from the space that installation took place. Later on, these recordings will be organized in a compositional manner in order to be installed to the same space. This idea is a homage Edgar Varese's organized sound idea where all noises are considered a musical piece that can be used in a compositional setting. I am excited to conduct this research project in the near future which I believe will add another step to my body of work on experimental and avant-garde music composition practices.

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BIOGRAPHY OF THE AUTHOR

Berkay Tok is an intermediate artist working in digital media creation. Tok worked in various areas of art making mainly sonic arts and visual design. In his artwork he aims to discover immersive audio video installations. In his work he is using various tools such as MAX/MSP, Blender, conventional audio tools such as Ableton Live and Pro Tools as well as procedural compositional tools as FMOD and WWise.

Tok had his bachelor's degree in Journalism from Istanbul University Communication Faculty. Throughout his degree he intensively worked as a sound designer for post-production facilities in Istanbul. His experience on sound design led him to pursue a sound engineering master's degree at Istanbul Technical University Center for Advanced Music Studies (MIAM). At MIAM he discovered avant-garde and experimental composition movements. Discovery of these movements changed his work immensely and he began experimenting on non-tonal musical composition techniques.

Focusing on creating art making methodologies, Tok bases his work on his multicultural and interdisciplinary background. Tok's work demonstrates a concern about art making and funding relation, how art is shaped by political ideas and most importantly philanthropy movements in art funding and poses a question that needs to be discovered further; what's a gallery friendly art? Is gallery friendly art turning the contemporary art scene into a business model where all participants of the scene tend to produce work that are strongly similar to each other.

His current sonic work is constrained to pure sine waves at very low frequencies using subwoofers leaving out all other consumer friendly frequencies allowing him to question gallery friendly installations. He is currently working on creating corresponding visual for his low frequency compositions in order to combine these works together to escalate the overall strength of his work. He is a candidate for Master of Fine Arts degree in Intermedia from the University of Maine in May 2019.