Live electronics: Sounding (of) the coil

Master Thesis

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Abstract

While performing with the digital musical instrument is prevalent in the contemporary music scene, the loudspeaker is no longer used only for sound reinforcement, but has become an indispensable part of these devices that imply a process of sound production that varies from the traditional musical instruments. The fact that musicians using digital instruments encounter a sonic result that is different from studio practising when performing in various venues is common due to the variety of loudspeaker systems. By interrogating the influence of such divergence in terms of live electronic music, this research proposes musician to take the sound of the speaker into account as a source for the composition and resolve this situation. Besides, through investigating the artistic impact of how contemporary musician materialises sound through the loudspeakers and by considering the potential relationships between the sound generating devices and its sounding in the live performance, this research interrogates how the loudspeaker constructs the musical liveness as the sound mediator. As the French tradition of Acousmatic music has exhibited, the loudspeakers were 'staged' as part of the musical performance in the past. This research continues and explores this idea while searching for contemporary musicians endorsing the approach of actively 'playing' the loudspeaker in order to find a new pattern in the existing field.

Keywords: Acousmatic music, live electronics, electroacoustic music, loudspeaker, listening

Declaration of Authorship

I, Tsun Yin Jasper Fung,
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Foreword

This thesis is written as completion to the Erasmus Mundus joint-master programme Media Arts Cultures. Since the start of this programme, I have been researching the artistic discipline in sound at the Department for Image Science in Danube University Krems, School of Communication, Art & Technology in Aalborg University and the department of electronic media in University of Łódź. While the programme has great dynamics in the studies about new media arts, the subject of this thesis falls within the scope of the field of sound art. Although this term is yet to be clearly defined, the discussions mainly encompass the works of art that are usually embedded with the performative nature. The fact that the epistemological bias treating vision over auditory sense for the practice in the arts is still common. Even though sound art has already claimed its territory, there is needs to further stress its practice in relation to other use of media in such a diverse creative environment highlighting collaborations. During the study I have also been performing in different cities in Europe, taking advantages of the mobility of the programme that I got to know more musicians, organisers and venues for experimental music, range from free-improvisation to noise music concerts. Such experience has widened my horizons and is beneficial to my future practice and research as a practitioner.

I would like to thank my supervisor Palle Dahlstedt and Morten Søndergaard as the co-founder of this programme from Aalborg University. As well as Roy Carroll, Annelie Nederberg, Wei Sun, Daichi Yoshikawa for their genuine support for my interviews, and every musician and artist I have met in these two years. Their valuable insights and incessant creativity have given me delightful guidance to complete this thesis.

1 Introduction

In societies that the digital and electronic technologies predominate, one tends to adapt to such environment with the ubiquity of technological devices. In terms of the arts, examples of artists exploiting new technologies with scientists are common in the field we often refer to (new) media art. Work of art creating an immersive environment or virtual reality is prevalent. A multi-sensory experience is so much achievable under the rapid development, and enhancement of audio-visual technologies than in the past for those visually immersive installations involve acoustic elements side by side. However, Rodriguez (2009) states that these technological devices used for media arts remain in a ‘black box' situation—it is first elaborated by Vilém Flusser, which the role of the user—including artist—is predefined and restricted by the design and mechanism of the devices themselves. In other words, these technologies exclude the humans who operate them after the decision has been made. The output is left automatic that one would not need to worry about the execution (i.e. A photo is automatically generated after pressing the shutter of a digital camera). In such case, human intervenes only if the device malfunctions (p.129). By the same token, the black box theory also applies to the audio devices. Since the advent of the loudspeaker on the telephone, and subsequently Edison's invention of the phonograph, loudspeaker remains an important role for many kinds of auditory activities: Announcement on the transports; Siren; music concerts and much more one could name. Evidently, the omnipresent of the loudspeaker has enormously, yet silently changed the auditory perceptions in our daily life.

In a theatre setting, the loudspeakers are usually designed to be transparent while they appear in black or are being hidden with decorations (i.e. in the amusement park). Not to mention the sound quality, some implementations such as audio exciter further conceals the functionality of a loudspeaker by installing underneath the seats in the cinema. Moreover, in almost all music concerts, audiences perceive the contents through the extensive use of loudspeaker and microphone through the amplifications. However, in many cases, particularly in electronic music, the sound output system is separated and further mediated by the sound generating devices. Thus, the actual sound output might not correspond to the expected output, which is different compared to traditional instruments[1]. While Musicians are not able to transport their loudspeaker system in the studio to ensure their performance be sounded ‘correctly', it is the sound engineer's responsibility to fine-tune the sonic result as close as what the musician wants.

There is nothing wrong with that, which such knowledge requires other professional knowledge. One could argue that exhibiting a movie in different cinemas encounter a similar problem that the colour would be slightly different from one another. Although this might be true, such problem could be compensated by careful colour calibration. Alternatively, the physicality of the sound gives uncertainties to its dispersion that varies among spaces. More than that, the transduction of sound could also be affected by other factors such as the number of audiences and the architectural design while many musicians treat these characters as part of their creative source. In additions, in the electroacoustic music tradition, composers have been working with different loudspeaker systems to bring forth the spatiotemporal quality of sound during live concerts. For instances, the sound diffusion system BEAST (Birmingham ElectroAcoustic Sound Theatre), Acousmonium and *Cybernéphone* use considerable loudspeakers with different sonic characters to create an immersive acoustic environment. While computer music is prevalent since the early 1990s, it has drastically changed the way of music production and appreciation within the industry. Issues related to the musical liveness about performing with laptops or digital musical instruments (DMIs) is subsequently raised. Regarding this, Transmediale, the Berlin-based annual festival for art, culture and technology, has specifically addressed these issues about musical liveness in relation to real-time processing and generative system in terms of experimental music as the theme in 2011 at CTM (Club *Transmediale*).

Being a musician and a researcher myself while constantly travel to different places to perform in concerts for live electronic music, I am especially interested in exploring how sound is materialised through the loudspeakers and the potential relationships between the sound generated from the (digital) instruments and its sounding in a live situation. The more I perform in various venues, the more I am aware of the black box situation of the loudspeaker, especially when I encounter technical failure due to the PA (Public address) system. Such frustration triggers my curiosity to further investigate in physically ‘playing' with the loudspeakers, which is also the starting point of this research. I propose musician to stress further the physical use of loudspeaker that might offer a relatively intimate performance experience.

It is the fact that many of the discourses about live electronic music remain on the intimacy[2] between the computational process and the performer through the musical interface. Many Scholars and practitioners tend to focus on a low-latency algorithmic performance with advanced and meaningful sound mapping (Wessel & Wright, 2002; Croft, 2007; Tanaka, 2015).

Besides, the *modular nature* of the digital instruments allows one to concentrate on specific instrumental quality, which is different from the traditional instrument that sound is produced from the body of the instrument.Therefore, in this research, I explore the performance gesture by looking into the sound production process rather than departing from the ways of sounding it. This idea comes from one of my performance set-ups, which I place loudspeakers on different materials, which a contact microphone is attached on to create an audio feedback loop by altering the distance between the loudspeaker and materials[3] without using a PA system.

In fact, there have been numerous examples of idea of composing with loudspeaker: Dick Raaijmakers's *Ideofoon* 1, 2 and 3 (1960-73) and the 25-minute long performance *Intona* (1992); David Tudor's *Rainforest* (1968-73); Steve Reich's *Pendulum Music* (1968); David Behrman's *Wave Train* (1966); Video artist Gary Hill's *Soundings* (1979). For more recently examples such as Nicolas Collin's demonstration of a 'jumping speaker'[4] in his book *The art of hardware hacking* (2006). Eck (2017) has also explicitly investigated the possibility of using the speak*ers as a musical instrument*.

It is true that there has not been so much development since the invention of the loudspeaker. Emmerson (2007) states that we might not aware the dynamic change of the sound of the loudspeaker is perhaps the quantum leap in other music technologies but the loudspeaker instead (Emmerson, 2007, p. 170). Even so, in a symposium hosted by IPEM, a research centre investigates embodied music cognition and expressive music interaction in Ghent University in 2003, Michel Waisvisz has proposed his careful investigations and prediction on the current and the future scene of electronic music practice. His lecture, titled '*Composing the now - notes for a lecture - on engagement with sonic time through sensors, electronica, loudspeakers and ears*' speculates the situation of "loudspeaker all over" with developing loudspeaker with new materials, which allows the space to turn into the loudspeaker itself. Therefore, our sensory experience could be amplified when being immersed in such environment. Waisvisz (2003) states the following:

> "I expect that it will be possible to make EAP surfaces that vibrate rapidly and intense and thus can replace our present day's loudspeakers. Instead of the tunnels of sound that are beamed under high pressure towards us from today`s concert stages, we will be able to design spaces or tents with vibrating surfaces that sound all around

> us and that have distinct movable areas for specific sounds. We will be able to move around in a vibrating environment bathing our ears in sound and sometimes laying down on surfaces that musically excite all our senses." (Waisvisz, 2003)

Though many of the academic discussions and investigations about the usage of loudspeakers are still much about creating spaces which audience are immersed, such as the wave field synthesis. These developments merely provide a better use, as an upgrade of its original function showing how does loudspeaker sound. To put it in another way, the type of immersion of what Waisvisz proposed is different from that of the wave field synthesis. Waisvisz's suggestions involve the *physical aspect* of loudspeaker design. Through physical engagement with the loudspeaker, this idea challenges and intervene the automated black box situation aforementioned.

The loudspeaker alone remains important for this research while other new technologies such as Bluetooth, new materials for the drivers and surround sound design focus on the mobility, the frequency response to improve the listening environment. To reflect upon the status quo in the contemporary filed mentioned above, I assume the loudspeaker and its mechanism reveals the fundamental quality of musical liveness, which one should also listen to the sound of the loudspeaker with its content. The research questions draw primarily on how and to what extent musician physically engage with the loudspeaker as a musical instrument in live electronic music. Secondarily, how such practice relates to the perception of musical liveness from both the performer and audiences' perspective. Additionally, this research investigates the applications of the loudspeakers in both commercial and non-commercial scene, providing an overview of in what ways the musicians and consumer electronics corporations extend the functionality of loudspeaker from a historical point of view.

Following this chapter, the second chapter examines the applications and design of loudspeaker in the past for both artistic and commercial use. It demonstrates the way how it turns into a 'real' musical instrument to be put on staged by tracing the threads of performative aspect of loudspeakers. The third chapter discusses the loudspeaker in a broader sense as in a live event that how it relates to musical liveness; the modes of listening and the auditory experience from the audience perspective. The fourth chapter, followed by the conclusion, qualitatively studies four musicians who perform physically with the loudspeaker in the contemporary field of

experimental music. The interviews are semi-structured. The data are collected either through personal or Email interviews and through attending interviewee's concerts as an observational method.

1.1 Definition of Live electronics and terms

This section provides a general description of what live electronics refer to and the common techniques that musician uses for sound production. Live electronics commonly refers to musical performances, of an improvised nature, to generate sound with the live processing of electronics. The term is first used in the 1960s to represent electronic music performed in real-time, away from the studio while exposing the studio process in a live situation by means of electronic devices (Nelson, 1991, p.85). The instruments musician usually use ranged from any electronic sound generating devices, hacked electronics to computer. Sound amplification and distribution by loudspeaker are significant to live electronics that it is the *mere* way to materialise the sound generated from these devices. According to Emmerson and Smalley (2001):

> "In live electronic music the technology is used to generate, transform or trigger sounds (or a combination of these) in the act of performance; this may include generating sound with voices and traditional instruments, electroacoustic instruments, or other devices and controls linked to computer-based systems."
> (Emmerson et al., 2001, p.59-60)

The aspect of live sound processing, or the instant compositional choice during the concert is particularly important that the musician reveal the way how they create or shape the sound in comparison to a composed piece. Michel Chion suggests the term *musique fixé sur support* to differentiate between live music and composition made upon live (Mooney et al., 2004). The French tradition of *musique concrète* and sound diffusion practice are considered as an early form of live electronics on fixed media—tape, which later the term is expanded to performances involves sound generated in real-time such as live coding and laptop orchestra, producing sound using computation. For a diffusion piece, a performer might be involved to execute the composer's motives during the concert (e.g. Parameters such as volume and panning). Occasionally, the performer and the composer are the same person.

As technology plays an important role in live electronics, which McNUTT (2003) describes a "disruptive" (p. 299) effect might occur if the performer lacks the familiarity with any electronic system or digital musical instruments being used. Thus, "practising with the equipment is, therefore, every bit as important as practising with the score" (ibid.). In fact, many of the musical interfaces nowadays offer high accessibility and are user-friendly, which the musician could easily generate, or alter any (pre-recorded) sound by pressing a button, or turning a knob through certain—built-in and pre-set—mapping programme with little effort. Although the choice of sound mapping is immense that could apply to any musical genres, some technique and device are essential for musician who works in the field of live electronics. The following section introduces these techniques and devices that have been commonly used by musicians for live electronic music.

Audio Feedback. The audio feedback is a loop of an audio signal that the sound output is being picked up by the input. Musician usually manipulates the feedback signal by processing with different audio effect to create distinct sound textures. For instance, it is widely used in rock music since Jimi Hendrix creatively integrates the feedback technique for his guitar solo performance—See video (boogiejohnston, 2008). Such process of generating sound is also widely used in noise music. Performer interacts with the loudspeaker with their instrument as the signal input that the distance between the output and input device create different tonality of the feedback. For the electroacoustic music paradigm, David Behrman composes his piece *Wave Train* (1966), which he claims to "keep the situation under control" (Behrman, 1998) while performing with feedback, implying audio feedback by positioning guitar pickups on two grand pianos to generate sound. The title of the piece refers to the term in Physics that describe a series of waveforms with similar or equal wavelength travelling in the same direction, spaced at regular time intervals—similar to the sea wave near a pier or a shoreline. The piece could be reproduced between two to five performers. The instruments used for generating the feedback includes magnetic guitar pickups[5]—for all performers, the loudspeaker system putting near the pianos and a tape deck with the monophonic output (to be replaced by laptop if necessary). The audio feedback loop is enacted by two layers of feedback loop between the pickups and the loudspeaker system. Firstly, the pickups are placed carefully on the strings on the grand pianos while the performer constantly gain the audio level from the mixer to create the initial feedback

loop with the loudspeaker nearby. The strings are then set into vibrations caused by the acoustic feedback from the loudspeaker, which creates another series of feedback loop that the pickups capture the sound of the vibrating strings and feed them back to the mixer. Steve Reich's *Pendulum Music* (1968) and Alvin Lucier's *Bird and Person Dyning* (1975) are notable examples making use of the audio feedback for composition.

However, audio feedback is treated as the unwanted signal in pop music concert that audio engineer needs to eliminate the feedback and ensure it is not caused by the singer moving around the stage with the microphone during the concert. For this reason, noise musician challenges the traditional way of music making by expressively using these 'unwanted sound' as an act of rebellious.

Contact microphone. It is known as piezoelectric microphone (piezo) or a pickup. Unlike dynamic and condenser microphone[6], contact microphone captures the sound of the targeted object by directly attached to it, whereas the dynamic and condenser microphones capture sound by the change of air pressure through the electromagnetic principle. The most common type of contact microphone appears as a disk shape made of brass, while a round layer of ceramic is glued on top of the brass. These piezoelectric microphones are commonly found in experimental music. Musician explores the sound of the object by attaching them onto different objects through experiencing the tactility between themselves and other matters. The sound captured is sometimes used with other audio effects (Reverb, Echo, and Overdrive etc.) to enhance the timbral quality. Pauline Oliveros's duet Apple Box Double (1965) with David Tudor and Alvin Lucier's *Music On A Long Thin Wire* (1977) are two notable examples of using contact microphones for experimental music.

2 The basic mechanism of the loudspeaker and its applications

> "The idea that the loudspeaker should have a voice which was unique and not just an instrument of reproduction, but as an instrument unto itself."— David Tudor (1985)

Introduction

This chapter provides the information of how a loudspeaker produces sound, from the (amplified) input signals into physical vibrations that change the air pressure as a chain of transductive events. While the advent of the loudspeaker is first invented for telecommunication and served for merely sound reproduction, it is further developed to serve for the use in concert situations for music and theatres, as well as the purpose of sound reinforcement that is commonly seen today. Speaking of the transduction sound, Helmreich describes the transduction process not only from its physical principle, which it has shifted to receptions—by ears. A "dual identity" (Novak & Sakakeeny, 2015, p.223) is formed from its physical nature and has become "cultural artifacts" (Sterne, 2003, p.22) that create social meanings. On one hand, the loudspeaker, acting as a mediator of sound that separates the origin and the recorded in different time and space (e.g. Phonograph) allows more variety in creating music. On the other hand, the loudspeaker reinforces not only the audio signal but also the sense of hearing by the recipient (i.e. listener)—that will be discussed in chapter three.

Apart from John Cage's *Imaginary Landscape*(s) (1939-52), which many consider it as the first piece of electronic music, French composer and engineer Pierre Schaeffer, who is for his theory of reduced listening referencing Husserl's phenomenological reduction, has developed the concept of *musique concrète* (Concrete music) around the same time in Europe. Acousmatic[7] music, which is the concert format for *musique concrète* brings forth the use of loudspeaker on stage through the sound diffusion system that spatialisation of sound becomes a part of the composition. The conceptual and technical details of the sound diffusion system, namely, *Cybernéphone* is exhibited following the discussion of *Imaginary Landscape* and the Schaeffer's concept of concrete music.

The last section of this chapter demonstrates the commercial use of the loudspeaker out of the art music paradigm, echoing the loudspeaker as a black box aforementioned, which has silently integrated into our daily lives. Furthermore, the legendary studio loudspeakers among the

commercial music production world, namely Yamaha NS-10 is reviewed with mentioning the tissue effect. Such creative use of tissue demonstrates how the sound engineer physical manipulates the sound output as a physical filter attaching on the loudspeaker. Then, the use of loudspeaker for the musical instruments such as guitar cabinet is mentioned. The function of PA (public address) system in relation to its effect on soundscape will be discussed followed by the artistic example by Cardiff and Miller, *FOREST (for a thousand years...)* (2012) that shows how a PA system applies to an installation of sound. The politics of using PA system are discussed through the demonstration of the ongoing project *Acoustic Infrastructure* by Sondergaard and Allen, and also Mallzzi's *Outpost Returns* (2012). Lastly, private audio such as headphones and home usage of loudspeaker illustrate how th sound mediator integrates into one's daily life as decoration while creating a territory defined by sound with mentioning Thompson's *Walking Machine* (2012). The bone conduction technology rounds up the chapter by indicating the implication of the future design of audio transduction device in terms of listening.

2.1 The sound mediator: Loudspeaker

Generally speaking, a loudspeaker is sounded through the electromagnetic principle. The term electroacoustic is the combination of electronic and acoustic that describe the production of sound through such concept. It is 'the study of the transformation of a sound wave into an electrical signal and vice versa; the treatment of sound waves by electronic means; the recording of sound waves; and the reproduction and deferred transmission of sound waves.' (Nelson & Poissant, 2001) Besides, the term *Stereophonic*, commonly used as stereo, is an important term to understand the way how the loudspeaker project sound with spatial characters. According to Oxford English Dictionary, stereophonic refers to the sound systems "using two or more channels of transmission and reproduction so that the reproduced sound seems to surround the listener and to come from more than one source" (*OED*, 2017). The configuration of the surround sound or quadraphonic system nowadays appear in the cinemas and home theatres could be described as a stereophonic system. The term roots from the Greek word 'Stereo', which describes a concrete and solid form with depth like a three-dimensional space. 'Phonic' relates to matters of speech, sound and tone. In contrast, monophonic refers to delivering sound with a single channel.

There are several loudspeaker components which are important to discuss its artistic use. Generally speaking, a loudspeaker—or a driver—is a transducer that transforms one energy form

from one to another. In theatre, most of the loudspeaker cabinets are painted in black, whereas the design is usually more attractive for the domestic audio system. The result of the sound varies from speaker to speaker.

Dynamic loudspeaker is the type which is widely used since its invention in the 1920s. The electromagnetic mechanism of a dynamic loudspeaker is essentially the *reverse* of a dynamic microphone in terms of polarity. The transformation of the sound waves to electrical signal—microphone, or from the electrical signal to sound wave—loudspeaker, are seen as two terminals in terms of electroacoustic production (Nelson et al., 2001). Loudspeakers are usually housed in the cabinet(s) which forms a rectangular box made of wood or other robust materials. One or more input(s), which could be sent by any audio apparatus are fed into the loudspeaker as an output through amplifying the electrical signals on the both sides. The function of the audio amplifier is to strengthen the signal before outputting to the speaker. Usually, an interface such as an audio mixer is connected between the input(s) and output(s) to fine tune the parameters such as volume and filter. Some of the amplifiers, for example, those used for Hifi has these built-in functions. In the past, most of the loudspeaker system are design to be passive that a separate amplifier has to be connected. In pace with the widespread of miniature electronic components and the decrease of its production cost, active loudspeaker systems gradually replace the passive ones on the market.

The system design usually includes the crossover[8], path and the cabinet construction. Crossover is a type of electronic filter circuit that divide the input signal according to different frequency range and distribute to suitable drivers. It would be a passive crossover system if it is placed after the amplifier whilst the active one is positioned before the amplifier and this type is mostly called bi-amped because there are two amplifiers in total to supply the treble and mid range speakers. The distribution of sound could be affected many factors such as the size of the speaker cone—equivalent to the driver that is mentioned below—and the material it is made of, the placement of the system in the room or the wire used for the connection. The cabinet or the enclosure also affects the sound of the speaker system with various materials and its main purpose is to prevent the unwanted cancellation of the sound wave emitted from the back and serve for general protection with the electronics inside. The speaker system is usually connected with two wiring points—one positive and one negative—while many of the speakers nowadays could be connected wirelessly with Bluetooth.

Types of drivers. Given that the common hearing range of human is between 20 Hz and 20,000 Hz while it varies from time to time, loudspeaker drivers are designed to specifically serve within this range. Typically, the driver made for high-frequency response is called tweeter—or treble speaker— (2,000 - 20,000 Hz); the mid-range driver (250 - 2,000 Hz) serves for middle frequency; sub-woofers (20 - 200 Hz) is used for radiating low frequency. One or more drivers could be found in one speaker cabinet that forms an individual loudspeaker system. The combination of drivers varies between different manufacturers. In other words, technically speaking, the more the drivers are in one loudspeaker unit, the more details the sound one could hear.

The basic mechanism of a speaker is based on Faraday's law[9] which explain the phenomenon of electromagnetic induction. A speaker driver contains a voice coil being placed in between a magnet in which the dome-shaped speaker diaphragm—or cone— is attached. When there are electrical signals sending to the coil through the amplifier from any input source (i.e. Laptop or the pick-up microphone from a guitar), the electrical signal is transformed into physical movement under the effect of the magnet, pushing the air around the cone and create the sound wave. Different materials for producing the speaker diaphragm are used in different drivers that seek for a greater damping factor in response to the rigidity of the material. The diaphragm could neither be made too stiff or soft. Paper and plastic are common materials for producing the diaphragm while fibreglass, aluminium and titanium could be found in the high-end loudspeaker system. Normally, full-range driver deliveries a wider frequency range for human auditory sense. The difference between the two is that the full-range driver contains an additional material called Whizzer cone (*Figure 1*)—some company only use a single material. This additional cone maximises the frequency range of the driver driven by the crossover of the frequency. One should not be confused full-range with the coaxial loudspeaker. The latter usually

contains more than one drives that could distribute the sound with higher resolution (*Figure 2*).

Figure 1- Electro Voice Michigan MC20 full range driver. (Source: http://rutcho.com/speaker_drivers/ev_mc8/ev_mc8.html)

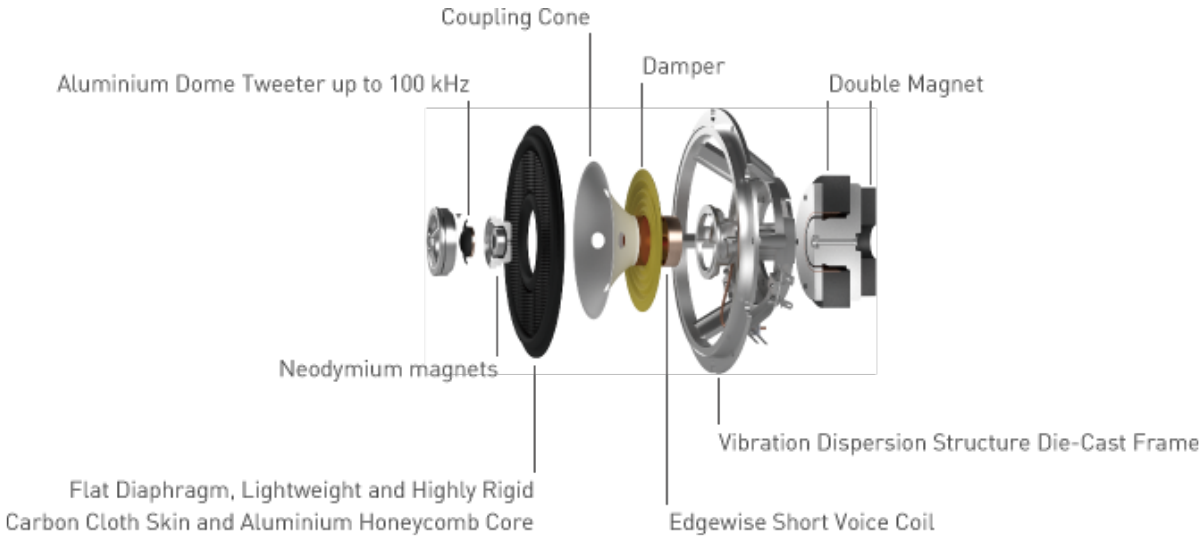

Figure 2- Technics coaxial two-way speaker unit SB-C700. (Source: http://www.technics.com/us/products/c700/sb-c700.html)

Tactile transducer and Exciter. All of the drivers mentioned above consist of the diaphragm, which is the movements of the surface compress the air particles, creating series of longitudinal wave—sound wave—for the reception of human ears. On the contrary, a tactile transducer, or audio exciter, diffuse the sound in a different way that it does not consist of a diaphragm. The tactile transducer is also called ‘bass shaker’, providing physical vibration while exciter is a more generic term for such type of technology. The exciter is designed to attach to any objects, for instance, glass, a metal plate or wooden board, which replace the function of the diaphragm. Hence, the vibrations of the moving coil caused by the change of electromagnetic field are asserted directly to the surface a tactile transducer is mounted. There are numerous manufacturers produce tactile audio products. Clark Synthesis, Inc. is a company which assemble powerful bass shakers for cinema and home theatre. The model such as *TST429*

Transducer[10] series is made for mounting it on a chair frame or beneath the floor that is invisible to an audience. Correspondingly, the *Invisible Speaker* by Feonic Technology Ltd.[11] is a robust and waterproofed exciter that the company claim the mounting surface would not be damaged anyhow based on their micro-vibration technology. The invisibility and its high-quality sound have made it competitive to other exciters. Besides, the bone conduction technology, which could be found on *Google Glass* recently apply the similar concept of the audio exciter to create an audio-haptic experience to the user—the discussion will be continued in the later part of the chapter.

Artistically speaking, David Tudor's *Rainforest IV* (1973) has acquired the technology with tactile transducers, which he attaches numbers of them on different objects and sound these objects with signals from sound generators. Tudor himself describes the piece as follow:

> 'Each instrument was set into sonic vibration through the use of electromagnetic transducers. The sound materials used to program the instruments are collected from natural scientific sources and are specific to each instrument, exciting their unique resonant characteristics. The excited resonances are routed to a conventional audio system by the use of one or more pick-ups attached to each instrument.'
> ("MoMA | MoMA Collects: David Tudor's Rainforest V (Variation 1)," 2016)

This approach of attaching exciters on different materials to produce sound with the resonance of the objects is still common within the live electronics and experimental music—it is arguable if it was still being considered as experiment—scene.

2.2 John Cage's *Imaginary Landscape*(s) (1939 - 52)

Speaking of electronic music, Cage's Imaginary Landscape series is considered as one of the earliest pieces involves the use of electronic source. His discovery of the pure test tone on a record triggers him to explore the use of found sound for a composition in a recording studio in Seattle. I*maginary Landscape No.1 (1939)* is created by playing the tone on two phonographs, which the performers vary the spinning speed of the turntable to alter the pitch of the. Cage composes the piece with other objects and instruments include a muted piano and cymbal. This piece shows the preliminary use of the loudspeaker in a live situation in terms of electroacoustic

music. Cage is interested in the *acousmatic* dimension of the test tone and therefore he decides to use it for live. In fact, such dimension comes from the technological limitation, which Bonnie Bird[12] mentioned that it is not possible to have the phonograph set up in the theatre. Therefore, the performers operating them have to stay inside the radio studio—attached to the theatre at the backstage— during the performance while other performers appear on the stage. It is the loudspeakers with the amplification link the two instrumental events together that they are happening simultaneously. Bird describes her experience of listening to *Imaginary Landscape No. 1* is extraordinary, which trigger her imagination of ones' "legs at one side of the stage, the head at the other, and between the triangles the torso" (Dickinson, 2006, p. 72). It seems to be a poetic answer explaining something is detached from the source. Interestingly enough, this metaphorical experience also unfolds the essence of electroacoustic music. The use of loudspeaker becomes the "body" of such musical form that making a piece stands on its own right from the source, connecting the performer and the listener. Then, the piece extent the theatre space into an imaginary space where the live event is.

As in *Imaginary Landscape No. 4* (1951), a similar approach is applied. Twenty-four performers—pairing up as duo— are staged with twelve radios by tuning the radios lively. The portable design of the radio that a speaker with the built-in amplifier circuit allows the performers to treat the radio as a sound object itself. It hints at the potential of constructing an intimate relation between the performer and the loudspeaker as an active instrument. For the other three pieces in the series, it is common that Cage combines electronic devices, objects and traditional musical instruments to create distinctive landscapes representing the future. The music produced is highly based on chance operations in which Cage does not show too much interested in manipulating the electrical sound source. Instead, the sound coming out from the speakers are mostly ready-made so as in *Imaginary Landscape No. 5 (1952).* Performe*rs* could openly play with any phonograph records. Cage once speaks about the use of recording in an interview and says:

> “I don’t think it has any use, because people think they can use records as music. What they finally have to understand is that they have to use them as records. And music instructs us, I would say, that the uses of things, if they are meaningful, are creative.” (Dickinson, 2006, p. 28)

Likewise, in *No. 4* the way that Cage uses the radio tells that he is not specifically interested in discovering the timbral variation of sound. He rather reveals how the orignal source sounds like. Thus, the use of phonograph and radio remain their authentic use for musical composition throughout Cage's motives for this series.

2.3 *Musique Concrète* (Concrete Music)

In the early 20th Centuries in Europe, Claude Debussy's non-conventional approach of shifting the focus of melody to the subtle layering of timbres[13] with different instruments has highlighted the evolution of innovative orchestration[14] at that time (McHard, 2006, p.51). Influenced by Debussy, Edgard Varèse names his music 'organised sound' (Varèse & Wen-chung, 1966, p.18) bring forth the utilisation of timbres as a compositional element that is rarely found in the western traditional music at that time. This musical breakthrough has also influenced the subsequence practice of modern music. Until 1936, Pierre Schaeffer (1910-1995), who initially works at ORTF (*Office de Radiodiffusion Télévision Française*) as a telecommunication engineer has made the breakthrough for electronic music production. He uses the innovative recording technology, co-inventing different analog devices (i.e. *Phonogène*) to experiment his theory for music. In 1948, he coined the term *musique concrète*, which the method of composing focus on the post-production of both self-recorded and pre-recorded sound from the radio's archive to produce works. These works are firstly broadcasted on radios and later one could listen them through the concert's loudspeaker. Such approach challenges Schoenberg's twelve-tone technique that *musique concrète* emphasises the abstraction of sound, leaving the original sound source alone.

While the spirit of the experimental music in Cologne (*Studio für Elektronische Musik*) in the same period aims at creating music with synthesisers, works of *musique concrète* are produced strictly through the recorded materials. These pieces are assembled with the tape machine and highly driven by technologies (i.e. tape splicing and experimentation with turntable). The composing strategy intervenes the timbral characters of the sound by altering their attack, decay, sustain and release, as well as deconstructing the sound by speed variation or reversing the recordings. In other words, Schaeffer morphs the sound quality employing machine operations. Later, Schaeffer founded the *Le Groupe de Recherche de Musique Concrète*

(G.R.M.C) in the French Radio Institution after publishing his concrete music pieces while working with Pierre Henry— the co-inventor of *musique concrète*. From there, Schaeffer is allowed to use the machines in the studio in the laboratory to continue his experiment while he later invents the *Phonogène*.

Schaeffer's idea attracts various composers such as Edgar Varèse, Pierre Boulez, Karlheinz Stockhausen and Iannis Xenakis. They work together with Schaeffer, compensating with his engineering background. In 1958 after Pierre Henry has left[15] G.R.M.C, Schaffer renames the group as GRM (*Groupe de Recherches Musicales*). Pierre Henry expresses his methodology of constructing pieces f*or concrete* music as follow:

> "*Musique concrète* was not a study of timbre, it is focused on envelopes, forms. It must be Musique concrete was not an affair of timbre, it is an affair of envelope, of structure. It must be presented by means of non-traditional characteristics, you see…one might say that the origin of this music [concrete] is also found in the interest in'plastifying' music, of rendering it plastic like sculpture…I address, myself, there, to the origins of musique concrete. The origins of elec-tronic music, evidently, are much more ancient. There had been the Ondes Martenot, the organs and things like that. […] For myself, I have always detested the Ondes Martenot…well, it [use of electronic instruments] is, rather, a matter of instrumentation . . . whereas musique concrete, in my opinion, has led to a manner of composing, indeed, a new mental framework of com- posing.' (James, 1981, p. 79)

Therefore, the originality of the sound could not be easily distinguished by the audience as in most of the traditional and modern instruments. One is required to listen to *musique concrète* with the aural mode of pure listening[16] as to isolate the original sound source so that the composer could focus more on the sonority of sound. In 1975, Schaffer merged GRM with *Institut national de l'audiovisuel* (INA), short for INA-GRM and the organisation is still active today. Although Schaeffer's idea does not have too much significant effect on an institutional level at that moment, his ideology is still resonating with the electronic music scene, in both technical and conceptual terms until now.

The *Phonogène*. The *Phonogène*[17] is invented in 1951 by Schaeffer with the help under engineer Jacques Poullin. It is the first tape machine that built for producing pieces of *musique concrète* while he uses phonograph until then. This device could alter the sound texture and manipulate the frequency of sound. *Phonogène Chromatique* (Chromatic Phonogène) is the one out of the three versions that consist of twelve black and white keys that look like a piano keyboard. Each key triggers different rotating speed of the magnetic tape so that the samples are played in variable pitch. Alternatively, *Phonogène à coulisse* (Slide Phonogène) uses a control rod that allows the user to adjust the tape speed freely. Another device *Phonogène Universel* (Universal Phonogène) could play the same length in different pitch by adjusting the tape head.

***Object sonore* (Sound object).** In addition to the technical dimension that Schaeffer experiments with the machines in the studio and later the development of the *Phonogène*, he develops his phenomenological approach for *musique concrète*. Schaeffer describes the sonic materials that he collected for composing through means of recording on the tape as an object, which "refers to a physical-material thing—a source for the production of sound" (Kane, 2016, p.15). Schaeffer further explains the characteristic of these objects "[are] never revealed clearly except in the acousmatic experience" (Cox & Warner, 2004, p. 80). Sound objects are neither the magnetic tape itself nor an instrument. They are particular matters, which is not a state of mind. In other words, a small fragment of tape—say 3 centimetres—might contain various sound objects, depending on the way of its playback. If a track is slow down on the first centimetre and speeded up for the rest, it results in two different sound objects, which they are stand-alone, having no connection with the origin of the sound and the recorded—playback with normal speed. As illustrated, the composition for *musique concrète* relies highly on the concept of *object sonore.* It evolves subsequently to the form of Acousmatic music that combines the techniques of *musique concrète* with live sound spatialization by chains of the loudspeaker (i.e. Acousmonium, *Cybernéphone* and BEAST), which illustrates in the following paragraphs.

2.4 Acousmatic Music

Originally, the form of *musique concrète* does not serve for the live performance purpose. The premiere of Schaeffer's notable series of works *Cinq études de bruits (1948)* (Five Studies of Noises) is released through radio broadcasting. For concrete music, the role of loudspeaker

stays in private use that either musician uses it for the production of music or audience listening to the radio at home. It is the notion of Acousmatic music and later the Acousmonium—a more sophisticated sound diffusion system— which moves a step forward to present this form of music in a live concert. It takes some time for Schaeffer to name this particular musical form that involves the theoretical and philosophical discussion about veiling the causality of sound. Eventually, Acousmatic music brings forth this idea that Schaeffer, together with François Bayle find the way to hide the sonic origin by explicitly presenting only the loudspeaker on stage with performers absent. The concert for Acousmatic music is situated in a dark room situation that the listener perceives only the diffusion of sound throughout the composition. Pieces are specifically dedicated to this system in a designated hall. Typically, a diffusion score is presented as part of the composition that tells the composer-interpreter how the sound should be "projected" towards the listener. Until 1974, Schaeffer presents Bayle's invention of Acousmonium while Bayle himself uses the metaphor of "sound projector" and "screen" (Bayle, 2007) to explain his concept about the system. The Acousmonium uses *stereo* input do diffuse sound objects throughout the concert hall. Below Bayle describes how he conceptualises the sound thorough the diffusion system:

> “My interest in stereo is that the object-message becomes ‘alive’ when it is no longer dependent upon one or other of the projectors but goes on to establish itself in immaterial space between the two.” (Bayle, 2007)

The signal of sound here, as explained by Bayle, is emancipated out of the immaterial space that turns into a concrete experience as objects travelling around the hall via the extensive treatment of diffusion through vibrations. This method of the sound spatialization, as Michel Chion describes, where a fixed compositional space—the playback— is projected to an external circumstance—the live—that this result is variable to the position and the type of loudspeaker are used or the acoustic of the physical space itself. Even though the listeners is situated in the darkness, it is the loudspeakers, acting actively as if the performer in the orchestra unveiling the live aspect of sound, and hence, transforming these sonic objects as animated.

2.5 Cybernéphone

Apart from Francois Baley's Acousmonium for *musique concrète* concert in France, Christian Clozier, who is the director of the *Institute international de Musique Electroacoustique de Bourgeois* (IMEB) in Bourges, has developed another sophisticated loudspeaker orchestra for live electroacoustic music. It is the *Gmebaphone* with six versions that the last version is renamed *as Cybernéphone.* The original version comes to life in 1983 in Bourgeois during the third International Festival of Experimental Music hosted by Groupe de Musique Experimental de Bourges (GMEB). Unlike a classical music concert that the listener could see the cause of the sound, Clozier believes that the diffusion of sound in the venue is a crucial matter to study while the cause in unseen with loudspeaker being the mediator of sound. He highlights that the appearance of the musical piece is equally important to the composition itself in which the composer has the responsibility to reveal the piece properly with sonically high fidelity in coherence with space.

Technically speaking, *Cybernéphone* is a digital system and has a software compatible with the console that recognises MIDI input. It consists a console, computations of six groups of loudspeakers with amplifiers in a specific position, which form networks between the groups that each of them give unique sound characters. The sonic elements are distributed according to their timbral nature. One could imagine these groups are split into two parts, where four of those (V system) deal with the two-dimensional aspect of sound and the rest of the two (reference system) configure the spatiality of sound that listeners perceive a virtual sonic space in the concert hall. There are 60 loudspeakers in total—Acousmonium has 80—and they are lit up by spotlights during the concert. It has eight inputs for the sound source while the Acousmonium runs only stereo signal. The *Cybernéphone* analyses the signals from the console playback, with the availability of automating part of the diffusion movement stored from the CD-ROM and physical control by the composer during live to render a high definition of a sonic environment which the listener results in having an experience to closely communicate with the composer's artistic concept.

The fact that the high sonic fidelity of *Cybernéphone* has helped to the composer to create a decent environment that listeners are immersed in an illusionary space in which they are simultaneously conscious of the existence of concert venue. The convergence of the "internal"

and "external space" (Chion, 1998) gives the listener another dimension of how could be a piece sound differently in different venues with variations of speaker system arrangement.

> "When the *Cybernéphone* is properly played, the ear cannot pinpoint any single sound source. Instead, spaces and the relationships between them are heard. The loudspeakers on stage make up an ensemble of abstract volumes in which the music is generated, that movement of colored time developing its own space." (Clozier, 2001)

As a musical instrument, *Cybernéphone* highlights the importance of the spatial factor when the sound source is absent, which is very common in nowadays electronic music concert. The only causality of the sound in a live situation is the change of air pressure initiated by the paper cone on the loudspeaker. *Cybernéphone* is indeed a phonographic synthesiser that brings a comparatively comprehensive experience to the listener to unfold the implicit musical space from the electroacoustic composition.

2.6 The commercial standard: Applications of Loudspeaker on the market

The previous examples show the possibility of using the loudspeaker in a live situation that Eck (2017) calls this approach "generating" in which different from the mechanism of the acoustic instruments. The system of *Cybernéphone* uses the loudspeakers to create an illusionary space in the theatre that listeners are flooded with the diffusion of sound. Whereas Cage offers an imaginative space that is free for the listeners to interpret.

This section introduces the commercial use of loudspeakers. The development of the retail loudspeaker formats is very much similar to the French traditional used for avant-garde music, which both focuses on the fidelity—spatialisation, diffusion quality and the truthfulness of sound—of 'reproducing' the sound from the status of how it is being recorded. For instance, in the audio production industry, sound engineers require one or more pairs of studio monitors (loudspeakers) to get the closest sounding result comparing to the original audio signal concerning the difference of the frequency response in each pair of monitors. It is similar to the colour calibration of the screen done by the photographer before editing the photos on the

computer. The following section discusses the commercial use of loudspeaker and its design which serves the proposed for music production and appreciation.

Near-field studio monitor. Broadly speaking, sound engineers look for loudspeakers which sound 'the worst' as to reveal the deficiency in the audio mix so that they could compensate with post production technique. Many of the high-end and advanced speaker systems could be found in the studios for sound recording or filmmaking to ensure the quality and the fidelity of the audio tracks before publishing. It is always a high demand for an 'honest' loudspeaker system in audio production. These loudspeakers, technically called near-field monitors are specifically produced for sound engineers to work in a studio environment. Supposedly, as many engineers believe, the track would sound good in most of the domestic speaker system if it sounds good in the studio playback through the studio monitors. Their design is relatively compact so that most sound sources are delivered from the speaker and are not affected by the reflection of the room. The placement of the drivers varies among different manufacturers while the most common one consists of a tweeter and a mid-range woofer built in the cabinet. The tweeter driver is mostly installed above the drivers with lower frequency response, forming a vertical orientation for sound distribution. Alternatively, coaxial studio monitor—the tweeter and the mid-range cone are on the same axis, similar to full-range speaker—are also common. For example, the C5 (cube) powered studio monitor manufactured by the American company KS Audio is a light-weight and handy coaxial studio graded loudspeaker with a built-in amplifier that allows engineers to carry them to work in a different studio environment. The C5 contains two drivers, which the dome tweeter is made of cloth and the 6.5-inch mid-rage/ bass driver is made of carbon fibre. Each of the 'cube' is driven by a 170W bass amplifier and another 70W for treble.

The Yamaha NS-10 series. Alternatively, The legendary Yamaha NS-10M Studio—a discontinued model, originally designed for the domestic hi-fi system, is an example of the passive studio monitor with the drivers being horizontal oriented. With its iconic white mid-range/ bass paper cone design, the NS-10M is famous for its unique characteristic for pop and rock music production since the late 70s. It is known for its 'bad sounding' among other near-field monitors. Apart from that, some sound engineers use the white mid-range driver

alternatively as a dynamic microphone—as mentioned before loudspeaker is essentially microphone in reverse—for capturing the sub-low frequency (below 60 Hz) of the bass drum.

Technically speaking, there is not much difference between the domestic NS-10 and the NS-10M Studio while the studio version is horizontal oriented. One could imagine a Hi-Fi enthusiast would be annoyed by prolonged listening to the shortcomings of the tracks with its characteristic of flat frequency response—that means the high, mid, low frequency is ultimately balanced which it does not 'lie'. Nonetheless, this is the turning point for Yamaha to introduce the model for studio use. In the article '*The Yamaha NS10M: Twenty years a reference monitor. Why?*' (2007), the authors execute a series of scientific experiment, taking NS-10 as the subject of the investigation to analyse its performance (i.e. harmonic distortion, frequency response) in technical terms. The article compares NS-10M to other studio graded monitors—36 in total—to find its objective characteristics. 'Subjective perceptions' are included in the discussion by using the NS monitor for a mixing session and compare, referencing from the objective Data generated. Detailed comparisons between various monitors and scientific Data could be accessed from the book '*Loudspeakers: for music recording and reproduction*' (Newell & Holland, 2007).

The Tissue effect. The American music producer Bob Clearmountain, who has worked with the renowned band such as The Rolling Stone and Bon Jovi, has demonstrated a creative use of the first generation of NS-10. Due to the excessive brightness character of its tweeter—the issue has been improved in NS-10M studio, Clearmountain solves the problem by using tissue papers to mask it over the tweeter and roll off some of the high frequency. Evidently, there are various methods to address this issue, for example, adding a high-frequency shelf filter in electronic terms, which might be a comparatively promising solution in the long run. The reason he has done is unknown, but it is interesting to mention regarding the theme of this research. Based on Clearmountain's creative solution, Hodas (1986) analyses the effect of applying different brands of tissue and toilet papers on the tweeter in response to an engineer using the NS-10, complaining "they had the "wrong" type of tissue paper covering the tweeters" (Hodas, 1986). However, Clearmountain admits at the end and concludes that "the use of tissue layers is certainly a very uncontrollable and non-linear method of doing the job" (ibid.), which he prefers a reliable with electronic means. There is no doubt a sound engineer would prefer to acquire a relatively reliable method instead of endlessly purchasing tissue papers from the grocery.

However, regarding artistic approach, the tissue shows possibilities and suggests how physical engagement with the loudspeaker could significantly alter human's auditory perception and one's cognitive experience towards music which could not be perceived without the loudspeakers existed.

Loudspeaker for instruments. Generally speaking, the sound of any instrument could be picked up by microphones and disperse with a PA system (Public address system). Nonetheless, it is not rare that musician, especially for guitarist and bassist, to use guitar cabinet to create unique sonic texture with the built-in (tube) amplifier—Fender Twin series is one of the legendary examples. For instance, distortion is a type of sound effect that is vital to rock music, could be made by over gaining the amplifier. One of the most well-known examples is Jimi Hendrix. He adapts the distortion and audio feedback generated from his guitar with the guitar amp cabinet to create specific tonality in the rock music with a controllable result. Apart from that, the Leslie organ rotary speaker usually uses with a Hammond organ, is another remarkable speaker cabinet for the instrument. It consists of two drivers—usually one treble and one bass speaker—that the musician controls the rotating movement of the speakers in the cabinet to create a *tremolo* effect while playing the organ.

Public Address system (PA). The functionality of a public address system and its functionality is technically different from those in the recording studio. Sound engineers pursue a listening environment with high fidelity that the loudspeakers tell the ‘truth’. Whereas, the public address system aims at distributing and amplifying any audio contents through the microphones to ensure the messages reach the public with a large scale. PA system is widely applied in political, educational and religious events to broadcast speeches to the target listener. Furthermore, thanks to the blooming of the semiconductor industry, such system are nowadays made conveniently portable that the mobility of the speaker system has significantly changed the audible environment.

Despite traditional loudspeaker design, ultrasonic speaker, a type of directional speaker which deliver sound to a precise spot are relatively new technology for audio production in the last few decades which the first working device comes to life in 1998, produced by F. Joseph Pompei from the Massachusetts Institute of Technology and is commercially used afterwards.

The ultrasonic speaker has a much promising “diffraction value” (Jin et al., 2001) of the sound wave than that of conventional loudspeaker—dynamic speakers with moving electromagnetic coil and cone. The nature of ultrasound deliberates sound to a much further distance, appropriated by the piezo-ceramic transducers. These speakers are widely applied for military and security purpose as an apparatus for sending warning signals from coast guard on the sea and crowd control. There are numerous companies provide products for directional speakers including Holosonics Research Lab and LRAD Corporation from America; Panphonics Ltd. from Finland (Kuutti et al., 2014). LRAD particularly provides services for military use while others supply market for displays in department stores or museum installations. In Additions, Meyer Sound Laboratories has adapted the technology of directional speaker (SB-1; SB-2) for public address system and produce a comparatively larger device for outdoor use.

2.7 Loudspeaker and Soundscape

From an acoustic ecology point of view, a soundscape—the term is coined by R. Murray Schafer in his notable book *The Tuning of the World* (1977)—is significantly influenced by the electrification of sound through the means of signal transmission. It leads to the issues about noise pollutions in urban and sub-urban areas. Schafer proposes the term “Schizophonia” to describe a chaos brought by the technology that removes the original structure and sequence of sound (Schafer, 1969). Inasmuch as the tremendous change of the acoustic ecology with electronic products for audio reproduction and sound amplification, Pauline Oliveros (2016) has particularly offered workshops for engineers—those who produce apparatus to generate or receive audio signals— about her renowned notion of deep listening. In a lecture organised by Red Bull Music Academy, Oliveros has described her interaction between herself and the engineers as follow:

> “Now, engineers often ask me, ‘“Well, why do we have to listen to the noise pieces?”’ Then I have a lot of fun. I say, “Why don’t you guys go to your machine shop and make a recording?” Then I say, ‘“What about the sound of New York City? Do you know who composed that?”" I say, “You guys. You guys, you engineers, you’re the ones that have risen the noise level in New York City and other places so high,” so I said, ‘“Why don’t you do some deep listening?”’ (Oliveros, 2016)

Oliveros believes the issue regarding noise pollution could be resolved with the way of how one listen to the environment, while she does not intentionally confront the overwhelming noise level from what the reality appears to her but from the inside—her mind—of herself. In particular, she utilises such ‘pollution' as a source for her artistic practice, creating a dialogue between the sonic environment and her playing with the accordion, which could be revealed in many of her improvisational performances in outdoor situations. Moreover, Oliveros also claims the listening activity among the deaf and the ‘universal deafness as the ultimate consequence’ (Schafer, 1992) in terms of cultures could be achieved through sonic meditation. Similarly, the use of loudspeaker could transform one place to another in terms of aural experience. For instance, an artificial environment of rainforest in an amusement park could be easily reproduced by hiding loudspeakers from the trees and decorations, looping recordings of the sound of tropical insects and creatures which enhance the experience of the visitors. The site-specific installation *FOREST (for a thousand years...)* (2012), a 28-minute audio loop by Janet Cardiff and George Bures Miller in dOCUMENTA (13) in Germany is an example of exploring the relationship between the use of sound reinforcement system and space. The two artists construct an intensive, yet immersion experience to the spectators through a narrative strategy, transforming a forested area in the Karlsaue park in Kassel into a war field. The installation “move[s] the audience from one scene to another as if in a dream, ranging from the intimate noises of a mother and child talking to intense soundscapes of crashing trees and bombs falling.” (Documenta, Christov-Bakargiev, Sauerländer, & documenta und Museum Fridericianum Veranstaltungs-GmbH, 2012, p.334)

2.8 Politics of the loudspeaker

Other than the artistic and recreational use of the loudspeaker, the discourse about the public address system might involve the investigation of its social and political dimension. The target audience is yet to be defined with the ubiquity of loudspeakers. Questions such as who is the public to be addressed and the authorities that have the power to address the people are being asked by activists, artists and acoustic ecologists. For example, the publication and curatorial project *Acoustic Infrastructure* initiated by Morten Sondergaard and Jamie Allen address such problems to reveal the politics of public space by means of sound with the discussion about technological mediations in the practice of art. Besides, the performance *Outpost Returns* (2012)

by Lou Mallozzi of which he uses the public address system to *publicly address* pedestrians and describe their features in details by using a telescope on a street in Chicago. The artist explores the issue about surveillance while turning the public area into a theatre-alike environment. Mallozzi acts as if he was the 'big brother' in the movie *Nineteen Eighty-Four* (1984), based upon on the story written by the English novelist George Orwell, keeping an eye—and ear—of the citizens through telescreens and microphones installed even in every private property as to control the citizen's behaviour. In the movie, the loudspeaker turns into a weapon, the representation of the totalitarian authority that brainwashes the people, 'reinforcing' their mind through the transmission and amplification of the audio signals.

2.9 Home and private audio

Other than applying loudspeaker in public, the consumer electronics industry also provides a different personal audio system such as surround sound for home theatre, wireless audio speaker, stereophonic Hifi system, computer audio and car audio. Many of these products have a unique design, which also serves as home decorations out of the functionality as only loudspeakers.

Loudspeaker as the household decoration. While the loudspeaker has a role in its visual character, it is not rare that it is being advertised even as a piece of furniture. The notable Danish company for high-end domestic sound systems, namely B&O (Bang & Olufsen) manufactures unique audio products such as the most recent standalone wireless speaker model Beoplay A9, integrated with an innovative touch control interface while it could be connected with any smart devices (i.e. smartphone) with Bluetooth. It has an ultra slim design as a loudspeaker device that it comes with replaceable legs with different wooden materials—oak, maple or walnut—with designer's fabrics speaker protection cover. The company advertises it as if it was a modern furniture. In fact, the flatness of Beoplay A9 looks similar to the ultrasonic speaker aforementioned while the next focuses on its functionality over the appearance. For computer audio, the Soundstick, a 2.1 loudspeaker system designed by Harman/Kardon is another example showing the speaker as a decorative design with its iconic transparent cabinet and its high-quality full range speakers. As Emmerson (2007) states, "there is a desire for strong visual presentation through attention to design detail and lighting" (p.147). Unless one would

listen to a record in complete darkness at home, the visual element of the loudspeaker remains vital, at least for the consumer electronic devices. In contrast, Brown's (2010) suggests a similar idea in theatrical practice that the speakers should be removed from the audience's sight as to uphold the listener's attention to the sound (p.170).

Spatializing the private space. Bose Corporation, commonly known as Bose, is another audio equipment manufacturer offers unique home listening experience by producing loudspeakers using the reflections in the room to expand acoustic effects while attempting to create an auditory illusion of a large listening space. For example, the 301 series, designed as bookshelf speaker has its two tweeters facing away from the listener, which is different from conventional design for bookshelf speakers. They are designed to be placed at the concern of the rooms and work with a pair to achieve the greatest effect of reflection from the wall like the notable model 2201—the first loudspeaker model of Bose in the 60s—that first used this design. This design allows a more distributed acoustic environment, whereas other manufacturers focus more on the direct sound source emitted from drivers—all speakers facing to the listener—for the home listening environment. However, it is necessary to take into account the signal process of in multichannel audio signal processing, especially in the digital era, that reverberation and delay have been widely applied to ‘provide and enhance the sense of localisation’ to overcome the deficiency in such home listening space. (Stefani & Lauke, 2010)

On the other hand, the domestic sound system set up for movies, namely, home theatre, also suggests the possibility of spatializing one's living room by sonic means. Not only we could find multichannel audio systems in the theatre acousmatic music mentioned before, or in the cinema, the development of the private surround sound system is competitive to that of the sound diffusion system one could experience with, which highlight the effect of sound spatialization. Qualitatively speaking, many of the surround sound system for home theatre, such as the 5.1 surround sound system, are very much competitive to those in the cinema. Dolby has released guidelines for setting a home theatre surround sound system, providing ways to fine tune configure the individual speakers to achieve a better room acoustic. To put it another way, as Wilson and Harrison (2010) has stated, “the increased availability of multichannel home theatre systems and powerful laptop computers – has had a democratising effect on the field as a whole.” Both artistic and commercial development of such system has significantly accelerated by its

availability and the universality on the market. On the other hand, defining private and public spaces in terms of sound also becomes more difficult due to the presence of these powerful amplified system found in many residences. The problematic diffusion of low frequency in domestic use could easily invade and affect the neighbourhood, whereas the cinema has its sound proofing architectural design. Such discourses related to defining the private space with the use of headphone or wearable device, alongside with the effects and consequences that have significantly altered a city's soundscape.

Wearable audio devices. In the same fashion, wearable audio device like headphones create an enclosed, yet exposed auditory environment for music appreciation regardless of location. Regarding as a type of hedonic technologies (Ernst et al., 2013), commercial headphones are designed for leisure activities like playing video games, watching movies and listening to music. Particularly for the common use of smart phones embraced with their size for mobility, one could argue about the privacy brought by these devices, which the territory between oneself and another becomes vague. The interruptions of environmental sound—traffics on the street—transform the background to a foreground into which *intrude* one's musical experience with headphones. Don Ihde (2007) describes the phenomenon as follow:

> "Ideally, if music is to reach its full presence, it must be "surrounded" or "secured" by a silence that allows the sound to sound forth musically. This is one of the aims of a set of headphones that do not so much improve the music as help close out the other sounds and thus procure a relatively "surrounding" silence." (Ihde, 2007, p. 111)

Conversely, the Canadian artist Jessica Thompson embodies the city's soundscape, sonifying the walking sound by putting contact microphones in spectator's shoes in her performative piece *Walking Machine* (2012). The sonic result is a combination of a cityscape and different footsteps, which compose a cinematic alike listening experience that "let loose an acoustical delight in finding place" (LaBelle, 2010, p. 102) mediated by the headphone, amplifier and other electronic technologies.

Zungle: The sunglasses that sounds. Following the headphones, Zungle[18] is a start-up company which produce sunglasses with built-in bone conduction speakers with the microphone. This technology—a type of transducers that audio signal is directly sent to the inner ear—could be found on Google glass. *Zungle* claims they have improved the sound quality over the Google glass with the partnership company who holds the patent for the technology. The advantage of applying such technology is that the users' ear canal is not interfered by any objects—in-ear phones. Therefore, their ears are completely opened from which the environmental sound is not blocked. Additionally, as the transduction of sound is caused by resonating the skull, any audio content would barely be heard by others except the user. Hence, such technology suggests an implicit the privacy in contrast to that of using headphones, which the privacy is partly constructed by the physical isolation of the ears. It opens up an interesting discussion over the phenomenon Ihde has described: Through the evolution of technologies we are now biologically capable of listening without ears.

3 Listening to live

> "Listening is a lifetime practice that depends on accumulated experiences with sound. Listening can be focused to detail or open to the entire field of sound. Listening is a mysterious process that is not the same for everyone. Humans have developed consensual agreements on the interpretation of sound waves delivered to the brain by the ears. Languages are such agreements. To hear and to listen have a symbiotic relationship with a questionable, common usage. We know more about hearing than listening."[19]
> – Pauline Oliveros (2015)

Introduction

Previous chapters have examined the use of the loudspeaker in commercial applications and that of artistic practice. From traditional acoustic music production to Luigi Russolo's futuristic manifesto; from Cage's influence on avant-garde music; the phenomenological approaches of the (Post-)Schafferian tradition to the advent of computer music and its 'aesthetics of failure' (Cascone, 2000); the return of analog technologies; the rise of maker and hacker culture, DIY electronics and the concept of modularity of musical instruments in the post-digital age, these phenomena has suggested the variety in contemporary music making by which musicians have also exhibited in the practice of live electronics. Although the history of such is much shorter in comparison to that of classical music, the shift in the meaning and the semantic of music is yet noticeable.

While new technologies for musical expression are evolving rapidly, this chapter reviews the perceptions in live electronics from both the performer and the audience points of view instead of only resolving for an intimate musical control for the. Theories about musical liveness are discussed by reviewing Philip Ausland's theory of liveness (2008), Simon Emmerson's insights for live electronic music (2007) and John Croft's *Theses on Lliveness* (2007). Furthermore, this chapter differentiates a live musical event from its physical and psychological matters in relation to the events associated with the loudspeaker for live electronics. From the physical point of view, the discussion includes the exploration of spaces and the musicians' mobility with today's musical instruments. In additions, the transduction of sound in a performing venue with measurable matters—in a scientific way—and acoustics of space is

mentioned. On the other hand, the psychological aspects, namely the semantic of live electronic music and the modes of listening, which are important for the cognitive process of the listeners will be discussed. This chapter is followed by several in-depth personal interviews with the musician who explicitly use the loudspeaker to investigate their musical motives in relation to technologies, in particular by applying in the field of live electronic with the theories about liveness discussed here.

3.1 Musical liveness

Investigating the degree of liveness—in musical performance—is interrelated to the subject matter of this research. While assuming to engage loudspeakers as a musical instrument might offer both performer and listeners degree of liveness in the practice of live electronic music, it is necessary to justify what constitutes the liveness in a live event and how musician speaker about it. Evidently, laptop music further complexes such discussion while it allows the musician to produce sound with absent of a musical instrument. Academic conferences such as New Instruments for Musical Expression (NIME) addresses problems and prospects in live musical performances with (new) technologies. The discourse such as the design for Digital Musical Instruments (DMIs), musical gesture and the "intimate musical control of computers" (Wissel and Wright, 2003) are common topics of this conference.

Musical liveness in the commercial scene. Apart from the discussion within academia, the problem of liveness is evident in any musical performance in the commercial scene ranges from pop and rock music to electronica with the presence of digital technologies. The extensive use of digital sampling technique amplifies such problem—or maybe it is not an issue at all. Musical playback in a rock concert with the band or a lip-sync performance is common. Evidently, going to a concert has its social or even political values in which a network is formed among the audience through the vibration of sound that constructs a ‘live' scene. For instances, the repetitive rhythms in the (EDM) Electronic Dance Music like techno signify the rebellion of the social system that emphasis on the audiences' liberation through the music. This genre does not aim at the aesthetics of listening and composing but massively ties to the audience's non-stop dancing movement driven by the amplification of the sound to create a social event, through the

DJ to the dance floor. This performative event could be seen as a feedback loop that this music genre is creating a sort of mediation between the human movement and music generated from the machine or laptop. The audience creates a collective movement response to the vibration of sound while the energy of motion is transformed into a social interaction. According to an article, Pedro Peixoto Ferreira (2008) writes in Leonardo Music Journal, "Human movements making visible what machine sounds are making audible". (ibid.) This suggests an inter-relationship between human and machine while they are functioning together in a social context instead of opposing each other.

Philip Auslander (1999) discusses the cultural values of liveness that a live performance owns. He interrogates the ‘oppositional relationship between the live and the mediatized' (ibid, P.4) regarding the (mediatized) culture and the economy based on the cultural consequences. Furthermore, he argues about the mis-representation—the authenticity comes from the studio playing instead of the live— of rock band's musician which “defines the experience of rock for its listeners” (ibid., p. 72). Asulander discusses the rock culture by bringing authenticity into the discourse while he quoted Goodwin (1990) to describe the fact that the advent of digital music instruments has changed the status of using the analogue synthesiser that once is viewed as alienated. He adds, “Synthesisers, once seen not as musical instruments but as machines that had no place in rock, have come to be seen as just another form of keyboard instrument” (ibid., p.83) while “the image of a technician hunched over a computer terminal” (ibid.) becomes more problematic from time to time.

For Auslander, in rock music, ‘sound alone cannot establish rock authenticity (or inauthenticity) any more than visuals alone' (ibid, P.87) that the visual evidence—or artefacts—bring forth the formulation of the musical culture of such genre which the concert itself does not give too many meanings. Therefore, the idea that the opposition nature between the live and the mediatized in the rock culture exists only on a level regarding social economy instead of the modes of performance per se.

Alternatively, Eck (2017) stresses that all music records are reproduced based on the same principle of the electromagnetic mechanism—the loudspeaker system. For her, most of the classical music records produced by the industry are ‘reproducing’ the live concert and bring forth to the listeners’ living room through the loudspeakers as if the listeners are listening ‘live’ in the concert hall. Even though this is true since the advent of the phonograph, the ephemerality

of a live performance could merely be reproduced. It is the fact that *the signal* is being reproduced through the process of receiving—microphone—and transmitting—loudspeaker, but not the music itself. In other words, a record of Beethoven is different from listen in the live concert. Not to mention the microphone technology are not able to capture the reality as it appears in any case, the space itself—concert hall and the private living room—limits the idea of reproduction to merely a representation, which a live concert also involves social engagement. Many of the records are done without the presence of the audience—unless it is an undoctored release which is simply a replication of the live concert—that their presence has already altered the acoustic of the venue. Richard Scott (2014) specifically differences between the recordings for a live concert in terms of improvised music as below:

> "However complete they may appear to be, documentations and recordings of improvisations can never be complete; something essential is always missing. Although they have the allure of a certain objectivity, these too are "partially coherent views" and easily mistaken for actual objects. Abstracted from a "natural" performative logic the structural conclusion of a process might easily be mistaken for its starting point." (Scott, 2014, p.13-14)

It is true that once the improvisation is recorded, the content is being fixed in a certain medium that it functions to 'recall' the memories in specific time and space. The ephemeral moment of listening in parallel to the performance could never be 'reproduced' through the recorded medium, which it is a mere representation of the live event. One should be aware such difference especially for the discussion of music in the arts illustrated in the following paragraphs.

The non-commercial: Liveness in Art Music. From Auslander, we understand that the musical liveness has its value from which could be accessed to in terms of culture and economy. Although this might be true, for live electronic music, in particular, those embedded with the experimental and improvisational nature views the liveness from different points of view. Much of the discourses about liveness encompasses causality and the agencies that (digital) technologies play a major role throughout. The phenomenon of using DMIs (Digital musical instrument) and laptop in live performance are extensively discussed ontologically and

metaphysically. Such discussions interrogate liveness from a micro-level, whereas Auslander demonstrates the other way round. For live electronics, performer's gesture in relation to the design of the musical interface, the listeners' cognitive experience and response are common topics that scholars and partitioners try to seek for a higher level of communication through the distribution of sound. Recalling the principle of how acoustic instruments work might provide support to investigate music which could only ‘play' through the electromagnetic mechanism.

Generally speaking, performers playing with DMIs would not have the same feeling as playing on the traditional instrument (brass, string and woodwind instruments, etc.) due to the technological difference in the production of sound. It is certain that they feel barely ‘connected’ with the instruments. For instances, a pianist could never feel the strings vibration from a digital piano through their fingers while sonically he/ she still perceive the same effect from a real piano. The absence of the hammer on the digital piano contradicts with the sonic result of sounding from a real one. The performer comprehends his/ her experience by knowing the mechanism of an acoustic piano, whereas the digital one is merely an audio sampler for piano sound. Kaffe Mattews (2012) describes her childhood experience in learning violin the following:

> "[I] had a little vibrating box under your chin and you bowed with horsehair. You got this strange sound coming out. You got this great feeling here (pointing at the neck). Moreover, I think that feeling connected with my bones went through my body and that for me was the experience of music." (TEDxHackney, 2012)

It is the fact that the vibration of the violin—so as the others acoustic instruments—enhances the intimacy between the performer and the instrument and this is partly where the performer embodies the liveness. The resonation connects the two in a close relation as if the musical instrument becomes an extension of the performer’s body.

In contrast, performing with DMIs lacks such relationship due to the electromagnetic mechanism. In fact, the *virtuosity* of playing a traditional instrument could hardly apply on some of the contemporary musical interfaces. Moreover, regarding the cause of the sound, listener do not have a common ground on, for example, how does a broken glass or a violin sound like as sound objects. “There is no sonic expectation raised through the sight of a loudspeaker, contrary

to the sonic expectations the visual appearance of, for example, a piano is causing" (Eck, 2017, p.115). In the paradigm of DMIs and electroacoustic music performances, we barely pay attention to the fundamental cause of the sound, which is the loudspeaker in a live situation. One would comment on a piece performing with a DMI and says 'it sounds good'. What 'sounds good' is in fact purely the musical content while *the sound of the loudspeaker of itself* is overlooked. So to speak, it is ambiguous to address whether the synthesised sound or the loudspeaker that sounds the musical content sounds good.

Thus, the performer's physical gesture upholds the listeners' experience, which the causality of sound is obvious in live electronic music. The quality of liveness hence lies highly on the "mapping" of the performer's gesture in parallel with the sonic result. Low latency algorithmic processing is one of the key factors establishing the performer-listener communication.

In the essay *Liveness through the lens of agency and causality*, Berthaut et al. (2012) describe the problem of using DMIs nowadays is that it carries much less visual communication than acoustic instruments. Therefore, they carry out a set of experiments to justify the perceived causality between the sonic result and the performer's gesture is the essence of liveness. Alternatively, in the article *Theses on liveness*, John Croft (2007) argues for 'a fine-grained responsiveness' of the performer's gesture that applies more on the practitioner's side. He defines two types of liveness, namely, 'procedural' and 'aesthetic' liveness, which focus on the transformation of the performance gesture to the output of sound. Given that the transformation of the materiality of sound is realised with the present of digital technology. 'Aesthetic liveness' could only be achieved by executing on top of 'procedural liveness', which an 'aesthetically meaningful' input is mapped to the output, by which this transformation is taken place in real time:

> "the onus of justification of liveness is shifted to the causal link between the performer's action and the computer's response. It is a question of the specificity of the relation: if many perceptibly different inputs generate outputs with no pertinent differences (in other words, if the aesthetically pertinent mapping is many to one), then the liveness is merely procedural and not aesthetic – pre-recorded sounds would do the job as well or better." (Ibid.)

Croft further categories various relationship between the electronic sound, performer and the instrument/ interface to justify the importance of having a promising output—low latency with synchronisation *in details*— in relation to the input. It is similar to the idea of 'intimate musical control of computers' that Wessel et al. refers to. For Croft, the degree and the aesthetics of liveness are built upon a meaningful sound mapping from the body gesture that formulates the causality of the live sound perceived by the listener. This process relies highly on the specification of the technological tools and their users—performer or composer. Yet, the role of the loudspeaker acts merely as a mediator, which is evidently not included as part of the instrument design. Moreover, the liveness and the intimacy discussed above seemingly put much emphasis on a sophisticated sound mapping system—one-to-many—with performer's body gesture, whereas the mapping of sound from the loudspeaker to listeners' and performers' ears deserve more attention in the discourse about liveness in music making.

Although this research encompasses the discussions about loudspeaker in live electronics. I found that the piece *Aphasia* (2010) by Mark Applebaum, associate professor of music at Stanford University, that I have watched earlier has provoked certain lines of thought from discussing liveness in music, in which this piece might connect to synchronisation, perception and the imaginations aforementioned. Applebaum's musical practice ranges from orchestral, electroacoustic compositions to live electronics with self-made instruments. *Aphasia* is a 9-minute piece for tape and singer. The singer here refers to a metaphor of a (muted) singer suffering from Aphasia. A soloist—the performer, is requested to sit at the centre of the stage, performing with various daily hand gestures (turning a key, using lipstick, etc.) designed by the composer through precise synchronisation with the tape, while practising with the rehearsal tracks (audiovisual) is needed. The performer is restricted to the notation and the composer's guidelines that no radial expression are allowed but re-presenting it with the flattest expression like a robot. Yet, Applebaum claims the possibility of a variation that improvisation of hand gestures could be presented under the title *Aphasia—Dialect*. The piece is commissioned by the GRM (*Le Groupe de Recherches Musicale*) and several other institutes. The tape contains a 2-channel recording and is available in CD format. Musically speaking, the tape is composed by vocal sampling, treated with editing approaches for electroacoustic music (time-stretch, reserve of the sound, etc.). Figure 3.1 below shows the first page of the score from *Aphasia.*

Being a listener myself in this piece, it is not hard to notice from the very beginning that the performer's hand movement synchronises with the tape playback. A question comes to my mind quickly: Where is the Kinect and how are the sounds being triggered? Interestingly, not only me but others are also in doubt about the presence of such device and the way the sound is made—causality. Though, whether the performer follows the tape or the other way around (triggering the samples by the body gesture), there would not be much difference from the listener's point of view in an era that the ubiquity of sensor devices is so common. The "fine-grained responsiveness" (Croft, 2007, p.60) established by performer gesture to the listener, or Emmerson would call it a "meaningful response" (Emmerson, 2012, p.1) is built upon the clear gesture-sound causality. However, some could argue that the fixed tape limits the aesthetics of live electronics production. This would be rather a pragmatic issue, given that if the listener could grasp precisely what causes the sound with the motion sensor's presence or not.

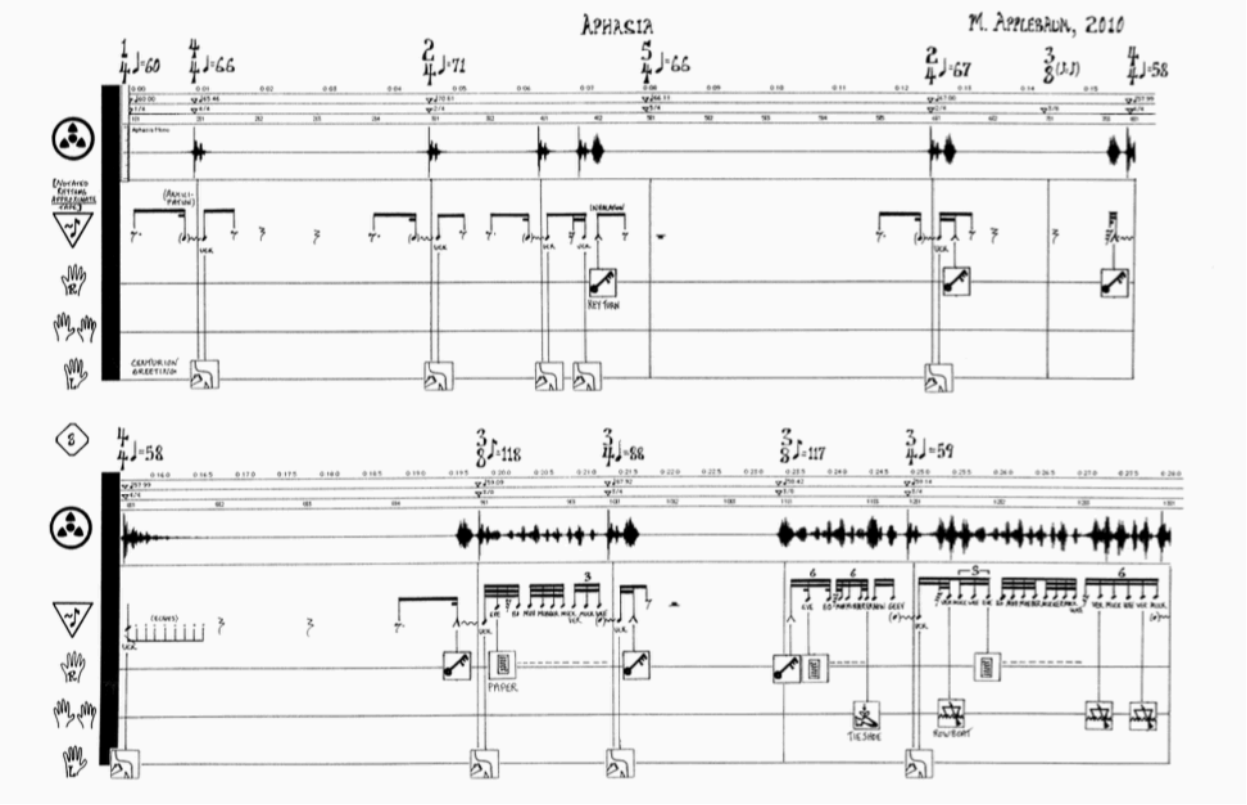

Figure 3- The first page of score from Applebaum's Aphasia (2010). (Source: http://londontreatise.blogs.wesleyan.edu)

Apart from Croft and Berthaut et al., Simon Emmerson discusses liveness in a border sense which he analyses the nature of electronic music from the beginning of electroacoustic music. He does not only investigate the liveness as merely a theatrical event but expand to the world that "[it] has thus become a vast musical instrument which can be heard through *sonification*" (Emmerson, 2007, p.55) through composers' imagination.

The making of electronic music is a process of "reanimation" that gather objects, information from outside of the music world—extra-musical materials—in which the composer/ performer project to their composition/ performance. Emmerson sees the music nowadays produced with (new) technologies is a penetration of the mechanical system—non-human— to the human activities. While he used to claim a difference between "live" and "real-time" (Emmerson, 1994), the technology could not surpass the 'live' by excluding the existence of human which is the essence of liveness. He suggests the dislocation of sound in terms of spatiotemporal brought by the mechanical system, for instances, the advent of Edison's phonograph, is not a negative phenomenon. Instead, "the new technological discoveries were an answer to distancing not its prime cause – the mew media allow us to reach out, to bridge the gap – to link together" (Emmerson, 2012) which is in contrast to Schafferian's idea of bracketing out the origin of the sound. The discussion about the dislocation fits well into today's phenomenon of laptop performances which listener might encounter difficulties in what they see is not what they could hear. Therefore, the concept of 'relocation' (Ibid) is vital to live electronics in which performer's gesture bring forth the perceptual experience by mapping of sound.

Other than that, Emmerson analyses the aspect of live in which he calls "local" and "field" in which a concert takes place. The space frames of the local contain the event, and the stage while the field contains arena and landscape. Here, he suggests the space per se forms a narrative, and by using different musical models, the composer creates a 'meta-space' out of the physical space where the live event takes place (Emmerson, 2007, P. 102). The notable work of Alvin Lucier's *I'm sitting in a room* (1969) explains how live electroacoustic music deals with space in which the sonic result is not confined to it but turning its characteristic into part of the composition's elements. Such concept is a fundamental difference comparing to acoustic music, given that the instrument's position is fixed on the stage without engaging with the characteristic of the space.

3.2 Modes of listening

We realise a pencil fell from the desk by not witnessing it because of hearing the sound while the pencil makes contact with the concrete floor, causing either or both objects resonate in a way that our ear could perceive. Our ears do not have lids like our eyes do whereas we can choose not to see when watching a horror movie in the cinema. Our ears are constantly exposed to the environment encompassing us and keep receiving information from it. We hear sound, but we might not have listen to them. Consciousness might not be involved in hearing, but we construct the knowledge through the means of listening as a cognitive process. Besides, the visual predominant scene has apparently suppressed our auditory sense since the 19th Century. David Toop (2012) addresses the phenomenon of Ocularcentrism[20] and argue about what John Berger (1973) mentions in his *Ways of Seeing* about the 'muted situation' of the paintings. Toop quotes the following from Berger and argue about the idea of paintings are silent and still:

> "Original paintings are silent and still in a sense that information never is. Even a reproduction hung on a wall is not comparable in this respect for in the original the silence and stillness permeates the actual material, the paint, in which one follows the traces of the painter's immediate gestures. This has the effect of closing the distance in time between the painting of the picture and one's own act of looking at it." (Berger, 2008, p. 58)

In the lecture 'Finding sound, listening to quietness'—title translated at Taipei National University of the Arts in 2014, Toop further discusses one of the Johannes Vermeer's oil paintings *The Milkmaid* (1657-1658), which describes a woman pouring milk in a kitchen next to a window. In fact, there has been much discussion about this painting from the iconographic and semiotics point of view, Toop suggests an alternative way to 'view' the painting with our ears, pointing out different sound could be realised from the painting that it is not silent and still at all. Toop pinpoints that sound is possibly penetrated from the outside of the window to the room where the woman occupies. Besides, the milk made sound while it is being poured into the utensil. For Toop, he perceives the painting without ignoring the auditory sense, but 'listen' to the painting together with his eyes opened. (Guo, 2014)

Although, it is not to differentiate between hearing and listening but to comprehend how we construct meanings through our sense of hearing physically and psychologically. There is no doubt the means of listening is vital for the discussion about how humans perceive the surrounding with ears, which also applicable to contemporary musical practice, for both musician and participator[21]. The audience get to understand what is happening in a live electronics by seeing and listening, which is very much rely on the principle of the causation of sound. Some might say that there is lack of musical liveness in a performance because the performer does not show explicit gestures in relation to the sound, whereas some might close their eyes and treat the visuals as distraction. A performer's intentionality of producing the sound might differ from the audiences' *intentionality* of perceiving the sound. Moreover, much of the issues about the musical liveness are discussed from the performer's point of view, whereas the ways of audiences listen to a concert is usually out of the scope. Therefore, this section examines different modes of listening to suggest the ways of listening for experimental music concerts, followed by the discussion about the semantic of electronic music as the final section of this chapter.

Causal Listening. In *Audio-Vision: Sound on Screen* (1994), French composer and theorist Michel Chion[22] examines three listening modes following Pierre Schaeffer's acousmatic idea, providing thorough examples and explanations. He introduces causal listening, semantic listening and Schaeffer's reduced listening. According to Chion, causal listening is the most common mode of listening that basically gathers information from a source, or the cause of an event. Sound provides complementary information when there is a notable cause. For instance, the sound produced by a sealed potato chips package when you shake it to know how full is it. In this case, the sound source comprises the general source of information while the cause is not visible. Causal listening could therefore help in telling any unseen causes by logical prediction from the sound. Chion highlights that 'the human individual is probably the only cause that can produce a sound, the speaking voice, which characterizes that individual alone.' (Chion, 1994, p. 26) Besides, he specifically points out that in some cases the cause is *unidentified* that the incapability of human to identify the barking of the same species of dog individually. Chion further elaborates different kinds of causal listening by introducing various causes. He mentions a category rather than an individual such as mechanical sound that could be noticed by the

rhythm of the machine. In short, causal listening looks for the sound caused by an event, which provides different layers of information in various cases on different levels.

Semantic listening. Apparently, semantic listening refers to a mode that we focus the meaning of a language, or what we hear is to interpret the meaning of an encoded message, rather than focusing on the sound quality and the cause. Morse Code or any linguistic studies are examples of semantic listening that we require certain knowledge to decode and get to understand what we hear. Basically semantic listening ignores the difference in the pronunciation, or phoneme if the spoken sentence is clear enough for its meaning. This is considered 'as part of an entire system of oppositions and differences' (ibid., p. 28) while the difference in pronunciations are ignored. It is interesting to apply the combination of both causal and semantic listening at once to study how and what people say. Semantic listening formulates a different level of understanding by our ears and knowledge that we search for the cause from a voice semantically while we read the written text as perception of the handwriting in order to grasp its meaning.

Reduced listening. Pierre Schaeffer proposes the concept of reduced listening while he focuses on the perception of the subject. The subject he refers to is the sound itself with 'bracketing out' its cause. This idea rejects any descriptive information about acoustic and the physicality of things that stresses the listening experience. It emphasises the process of listening to the sound for its own sake in order to grasp its sonic values and characters without taking into account its source. Listener should try as much to disconnect with the physical, cultural and psychological references from the sound and therefore, it requires very much of practices by the listeners. The goal of reduced listening suggests to treat the perceived sound as the self referential object of the sound itself. There are two steps of reductions. The first step is to "bracket out the spatio-temporal causes, and distinguish them from what we are immanently hearing" (Kane, 2007, p. 17). In other words, it is to isolate the acousmatic sound alone itself to eliminate the cause of the sound as to pursue an objective mode of listening. The second reduction rules out the reference to anything beyond the sound—for example, imagination—that imply a subjective listening attitude so that any meaning of the sound is lost. *Etudes aux Chemins de Fer* (1948) from the collection of Five Studies of Noises (*Cinq études de bruits*) is

one of the earliest pieces that Schaeffer extensively experiments with such idea and is prolonged in his works of Concrete Music later. The piece is composed by manipulating and re-arranging the recording of the noise of the train. The piece consists of rhythmic sound, which one could merely affirm that it is the sound of a moving train. Besides, fragments of melody that sounds like bird's singing reveals Schaeffer's strong musical background in processing extra-musical contents.

Reduced listening requires a fixed, veritable object that is recorded and repetitively being re-play. This explains many pieces of concrete music looped sound extensively. The advantage of reduced listening is that it opens up our ears to the very primitive physical qualities of sound—vibration. Through this practice, our ears are trained to focus on not only the causal and the meaning sounds but also the quality of sound. This attitude thus provides another dimension of compiling our listening experience that we could treat sound in a more comprehensive way. However, it is problematic to ask one to separate the cause from the sound. One could not easily describe the quality of the sound element—it is certainly easier for experienced musician or sound engineer—without mentioning, or relating it to the cause of it and therefore, turning the situation even more ambiguous. For example, the very first question that one usually asks while listening to a sound track without the presence of visual is 'What is that sound?'. This question has already raised the question that is related to something else than the characteristic of sound (i.e. the cause).

Spanish field recordist and ecologist Francisco López, who is also famous for his blindfold performance[23], further stresses Schaeffer's concept of reduced listening to a stricter discipline. He rejects the objectivity of the theory of soundscape and believe sound to be treated as virtual. The recorded sounds—the composition—themselves could not function on a representational level. He coins the idea of profound listening as in the absolute concrete music that he created. According to López (2004) explaining the idea of profound listening for his renowned album *La Selva* (1998), he states:

> "the richness of this sound matter in nature is astonishing, but to appreciate it in depth we have to face the challenge of profound listening. We have to shift the focus of our attention and understanding from representation to being." (Cox & Warner, 2004)

López upholds Schaeffer's concept, suggesting sound matter has its transcendental quality that neither represent or document richer world than the reality. Instead, he pinpoints the "inner world of sounds" (ibid.), resonating with Schaeffer that the sound itself should stand on its own right and free from the representation of the real world.

Alternatively, various composers such as Luc Ferrari, Trevor Wishart, Michel Chion who have worked with Schaeffer, ruling out López, have demonstrated the notion of concrete music differently that it is not necessary to 'bracket out' the sounds of real world but to relate to them instead through reduced listening. For Ferrari, he allows recorded sound function as music without any treatment on them. Sound works as a tool of narrative in this case and he invites audience to imagine the sound source and compile a narration. Ferrari is if fact influenced by Schaeffer, while he co-found the GRM in 1958. However, Ferrari establishes his specific way in exploring Concrete music by "self-consciously emphasising the materiality of recorded sound and producing an aesthetic situation that encourages reflection upon the affordances of recording devices" (Kane, 2014, p. 11) for the production of concrete music. For instance, his classical piece *Presque rien No.1 ou Le lever du jour au bord de la mer* (1967–1970) is full of recognisable sounds within the twenty-one minutes edited from a day-long audio footage. He manifests the functionality of the microphone to record the soundscape of a beach in Yugoslavia. To quote Kane again, the piece "turn[s] away from the sonorous object back toward the facticity of its own recording, it re-articulates the condition of possibility of musique concrète […] one might call its transcendental condition" (ibid.). Apparently, *Presque rien* "is generally characterised as a gesture of aesthetic transgression" (Drott, 2009) that the post-Schaefferian musician would describe as a "return of the repressed" (Chion & Reibel, 1976, p.67), whereas López puts his effort in stressing the continuation of sounding matters by ways of profound listening.

Besides, Chion also critically questions about Schaeffer's idea of reduced listening in terms of the acousmatic dimension. The fact that Schaeffer tries to establish a concrete system that could be comparable to the classical music hierarchy as he intensifies the very physical dimension—textures, velocity and mass—of the sound reveals that he merely treats the sound manipulated in the concrete music as musical notes. Nonetheless, Chion argues that it is reasonable, and practical to combine Causal and reduced listening to achieve a relatively comprehensive listening experience. Thus, we could perceive the sound by treating the cause of

the sound on top of their physical characteristic, which is a way of reconstructing the sound-in-itself that Schaeffer highlights.

Deep listening. With today's overwhelming city noise that one's capability of listening become so 'low-fi', while R. Murray Schafer states, "environmental sound reaches such proportion that human vocal sound are masked or overwhelmed, we have produced an inhuman environment" (Schafer, 1980, p. 207). Such phenomenon asserts physical and psychological effects on us that significantly weaken our ability to listen. Pauline Oliveros coins the term deep listening which she thinks it is "a way of listening in every possible way to everything possible to hear no matter what you are doing" ("About - PAULINE OLIVEROS," n.d.). As quoted at the beginning of this chapter, Oliveros expresses her theory of deep listening, which is a continuous practice with one's body and mind through the means of listening. Hearing occurs in every single second in our life as physical events because humans are surrounded by air particles, which cause the vibrations that transform the energy from one form to another. For Oliveros, deep listening "is learning to expand the perception of sounds to include the whole space/ time continuum of sound" (Oliveros, 2005, p. xxiii). The act of listening turns the physical state of hearing into sensing the sound both acoustically and psychologically. Oliveros's one of the most notable collaborations, namely, Deep listening band with trombonist Stuart Dempster and David Gamper on keyboards and electronics explore the underground spaces with their instrument, create a fruitful reverberation to realise the space[24]. She also holds the deep listening workshops, teaching participants to listen not only with ears, but through the means of mediation.

3.3 Performance spaces for music

Historically, the design of a concert hall for classical music concert aims at eliminating any potential distractions to the audience to prioritise the sense of hearing. The newly built *Elbphilharmonie* in Hamburg, claiming its perfect acoustic and architectural design with the parametric design, which the acoustic secured by '10,000 panels feature one million "cells"—little divots that look like someone used a seashell to carve out a chunk of material' (Stinson, 2017) to disperse the sound. In additional to provide an acoustically isolated environment for classical music concert, the notable hidden orchestra in Germany in the 19th century introduces the hidden orchestra and choir, which the audience only see an empty stage. Kane (2016) explains the importance of the hidden orchestra in terms of acousmatic as follow:

> "With its strict separation of the eye and the ear, an especially potent form of this phantasmagoria employs the acousmatic situation to occlude the mechanism of musical production for the sake of musical transcendence. The more the body is hidden, the less the eye sees, and the more grandiose are the claims about music's power." (p. 123)

Theatre. In contrast to conventional concert hall, Luigi Russolo's thought of introducing the industrial sound from the outside of the theatre by performing with his self-made instrument Noise Machines. These machine could produce sound similar to vehicle engines that the pitch could be shifted up and down. However, the noise machines have a common technical problem that the volume is too low that they could be hardly present on the stage. Russolo publishes *The Art of Noise*[25]and later in 1929, he is invited by Edgard Varèse to perform with the noise machines for the last time, whereas composer Claude Debussy challenges if the sound of the noise machine is competitive to that made of the actual one in the real life (Debussy, Lesure & Smith, 1988). Nonetheless, Russolo influences different avant-garde music experiments such as *Symphony of Sirens* (1922) [26] by the Russian avant-garde composer Arseny Avraamov. The piece is composed by the sound of whistles, steam locomotives and factory sirens as the motive, together with sound such as machine guns, artillery, ambient sound of factories, hydroplanes, trains and singing of the workers.

Gallery Space. While *Symphony of Sirens* shows the art of reproduction of sound from the phonograph with the choirs, the idea suggesting the separation of body and sound with the use of technology is later appeared in the audio reproduction technologies such as radio transmission and record players through the means of electromagnetic mechanism. A contemporary example from Vito Acconci's performance piece *Seedbed* (1972) implies this idea into the space for art gallery. Acconci makes use of the specific architectural space with the loudspeaker, exhibiting the power of such body and sound separation, in particular in a gallery space, which his murmuring is amplified through the microphone and speakers by not letting the visitors know about his existence.

Living Room. Other than a proper concert venue or an art space, musician also eager to explore alternative spaces for musical performance. Apparently, there are immense artistic examples exploring such dimension, facilitating with loudspeaker as the essential element which this paper could not include all. Instead, an overlook of various platform that musician would treat as the performance space is provided.

Yan Jun, Chinese sound artist and poet, the organiser of concerts in the living rooms in Beijing. He is one of the pioneer who dedicates to the experimental music scene in China. Yan has organised the living room tour for more than 5 years in Beijing and some other Asian cities such as Singapore. It is an open call at regular time intervals for the 'host' who are interested in providing their living place as the concert venue. Yan will then visit the hosts with musician and invite small group—up to 20—of audience to participate. The idea of the tour could be seen as a reflection on his scepticism about the public live music venues in China in terms of both sound quality and the level of attention brought by the audience. Therefore, he believes that locating a concert in a private place could take more control of the performance environment. Such domestic setting provides both audience and performer an intimate, yet creative environment that create the possibilities for the engagement with sound. Yan (2017) himself speaks about the living room concerts and a staged one in a concert hall as follow:

> "[…] a living room concert is not more authentic than a concert hall one. An avant-garde composition is not more authentic than a classical one. A master piece is not any better than an auto-tuned teenager song." ("The Only Authentic Work," 2017)

The living environment is transformed into a vast instrument that anything audible could contribute to the improvisational piece by all participators—musician, visitors, the host and the household applicants. Conceptually speaking, it is similar to Cage's *4'33"* (1952) which a sneeze from the audience also becomes a part of the performance. Occasionally, the concert might sound like a regular music concert that musician uses amplifier and loudspeaker with acoustic instruments, whereas sometimes it would be closer to a nature domestic soundscape that musician 'play' with kitchenware. These performances take advantage of the ephemerality in this form of music, upholding the act of improvisation.

Virtual space. Performance with the form of live streaming is not uncommon with nowadays broadband's high access speed. Networked music performances are benefited from it while enabling musicians to perform via the internet in different locations. Cage's *Imaginary Landscape No. 4* aforementioned demonstrates the possibility of musical performance through signal transmission. On the other hand, academia evaluates the tele-musical interaction and analyses "the ways in which the qualities of sound (timbre) in melodic interaction are perceived and acted upon by networked musicians" (Candy & Ferguson, 2014, p.109-122). The British musician Jake Williams's *Chat Room* (2014)[27] manipulates audio streams from sex chat rooms simultaneously with a dancer having the stage being broadcasted on a sex-cam site. The real-time chat room is projected on the stage. The audience is therefore extended in a sense that netizens becomes virtually part of the crowd which they in fact contribute also to the performance.

3.4 Musicians' mobility

The examples above illustrate how musician deal with spaces for live performances. While musicians mostly require their own musical instrument, for both electronic and acoustic, to perform and they usually travel worldwide to different places with the equipment. From the last chapter we understand that the sound quality might be a problem for some musicians that stimulate their idea of using their own loudspeaker even though most of the venues have in-house sound reinforcement system. On top of that, for some live electronics musician, their set-up might be particular that are built by the musicians themselves. Thus, the mobility for musician for their equipment becomes a concern when performing abroad.

Apparently laptop might be a solution when musician go for touring that they do not need to carry all gadgets and instruments on boarding. Softwares and light-weight controllers are not unusual in nowadays market. Nicolas Collins (2004) depicts the trend for electronic music as follow:

> "the aesthetic has spread well beyond the confines of the avant-garde: Hip-Hop, House and other forms of dance music and Electronica share a similar obsession with the quirks intrinsic to specific pieces of audio hardware or software. Every Pop producer has a signature gizmo. Music software, such as Max/MSP and

> Reaktor, emulates the creatively corruptible modularity of 1970s-era electronic technology, and the latest software plug-ins strive to mimic obsolete but beloved hardware." (p.2)

Even these replications of popular softwares have a similar result of the original hardwares, musician such as John Richards (Dirty Electronics) would rather focus on an intimate experience between instruments, performer and participators through collective making. In his article '*32kg: Performance Systems for a Post-Digital Age*', he comprehensively addresses that musicians in the field of live electronics face problems from the economical, aesthetic, cultural and social perspectives about transporting and performing with electronic musical instruments. Therefore, he proposes a modular system[28] for the field of live electronics even though laptop performances has become so popular among the electronic music scene. He points out the "[…] intimate performance settings, a focus on instrumental nuance and "discrete" voices, and the idiosyncrasies of a performer or their instrument" (Richards, 2006), which are the vital aspects for live electronics performance.

3.5 Participator's reception

It is important to establish a clear and understandable path between the performer and the participators to enhance the overall understanding and the perception of skill in terms of live electronics. As mentioned elsewhere, live electronics performance differs from that of acoustic instruments due the latter's all-in-one nature of the virtuosity—the production of the sound is embedded in the musical interface (i.e. Violin). The dialogic relationship of the listening processing, which has the ability to expand the spatio-temporal quality of the performance is hence part of the study in live electronic music. The meaning making process of such musical form links to the its gesture-sound causality, which affects the perception of liveness. There is no doubt about the technological advancement in the music industry, offering low-latency signal processing that easily unveil the linkage between the performer, the (digital) instruments and the generation of sound. According to Barry Truax (2001), "Signal processing may involve analysis that yields data about certain parameters of the sound, but information is created and communication takes place only through the cognitive ability to distinguish what is significant about the results of that analysis" (Truax, 2001, p.19). He draws distinctions between the signal

processing—actively by the performer—and information processing—passively by the recipients, which is applicable to the case of live electronics and DMIs performance.

The research carries out by Anıl Çamcı (2012) encompasses the issue about the cognition of electronic music by the listeners with his composition made by granulation algorithms and certain audio effects (i.e. Delay and reverb) of a few-millisecond white noise burst as the sound source. He invites participants to note down their impression of the same piece, namely, *birdfish*—of a narrative compositional strategy that engage with organic morphology, in order to draw the significants of the listener's interpretation from the composer's narrative approach. He concludes that the result demonstrates 'the potential of electronic music to trigger recollections of extra-musical sounding events and the visceral qualities of the cognitive approach behind the gesture/event model' (Çamcı, 2012). Çamcı's experiment suggests how the composition is perceived by the listeners in response to the compositional approach on a semantic level.

4 Case Study: Sounding (of) the coil

> 'Use sounds as instruments, as sounds on tape, without the causality. It was no longer a clarinet or a spring or a piano, but a sound with a form, a development, a life of its own.'[29] – Luc Ferrari (1998)

Introduction

The fact that the computer music performance with mobile digital musical instrument nowadays has raised the issues regarding the musical liveness in relation to the performer's virtuosity and the design these interface. Apparently, it has altered the performance environment in relation the production of sound as well as the interaction between the performer and audience. Therefore, critiques over the lack of *intimacy* between the musicians and the contemporary digital interfaces become valid in comparison to traditional instruments. The musical liveness is questionable with the present of technology that in various aspect the computer has distanced the musician from their act of playing (e.g., performing with the keypad on the laptop as if one doing internet surfing). Equally important, the *modularity* nature of these interfaces face the issue that the sound dispersing events are detached from the process of sound generation, which the loudspeaker is the mere terminal connecting the performer, audience and space regarding a live situation.

Wessel and Wright (2003) have suggested a conceptual framework and have developed a digital protocol—OSC—corresponding to specifically the network between the performer, the computer and the musical interface. Wessel et el. propose 'a higher degree of control intimacy, which can be attained with compelling control metaphors, reactive low latency variance systems, and proper treatment of gestures that are continuous functions of time' (Wessel & Wright, 2003) through the explicit mapping technique from the gesture interface to the generative algorithm. Laetitia Sonami's *The Lady's Glove* (1994-2001) is one of the example revealing such idea. This discourse mainly lies merely on the *intimacy* between human performer and computer interaction while Emmerson (1994) differentiates between the live and real-time processing.

While the loudspeaker also serves as the input for the audiences' auditory perception, the loudspeaker should not be treated separately as a black box within the discourse for musical interfaces. As Nicolas Collins's jumping speaker (2006) has demonstrated the musical

instrumentality of the loudspeaker, I propose a shift from exploring the control intimacy of DMIs to a deeper listening into the sound of the loudspeaker for electronic music to reveal certain degree of musical liveness.

This chapter investigates four contemporary examples of musician who use loudspeaker(s) physically as the ‘active' instrument based on the theories discussed earlier. The scope of these interviews is limited specifically to the filed live electronics. It serves the purpose of *mapping the filed* and draw attention on those who are aware of the problems and prospects performing with loudspeaker. Their intentions, the creative process and its conceptualisation, are analysed through the data collected from the qualitative interviews respectively.

4.1 About the interviewees

The information is provided by either the artists themselves from the interviews or the internet. The order is in alphabetical order by their surnames.

Roy Carroll (b. 1974). Carroll was born in Dublin and currently resides in Berlin. He owns a Master of Philosophy in music and media technologies from Trinity College, Dublin. His work encompasses musical composition, choreographic collaboration and live performances. His works show his interest in the electro-acoustic musical processes, which he refer to the acoustic and physical manifestation. His latest practices involve investigating ‘the unstable interactions between diverse electro-acoustic media' ("Roy Carroll," 2017) using transducers, feedback, signal processing.

Carroll's uses mainly the digital sampler (occasionally laptop) which he claimed it as an 'electro-acoustic' instrument. He starts ‘playing' with the loudspeakers since 2009, positioning them on different materials and objects to explore their distinct sonic texture with resonance. He believes the alternative function and its expandable aspect of loudspeakers 'in addition to their function as outlet for audio from the sampler' ("DOCK 11 & EDEN Studios Berlin: Spielplan: Magic Valley," 2011), which the loudspeakers become the acoustic sound sources, standing on their own. Carroll reveals the acoustic and kinetic interactions between the speakers and salvaged materials.

Annelie Nederberg (b. 1961). Nederberg was born in Sundsvall in Sweden. She is currently pursuing her doctoral degree in the UK at the University of Surrey in Guildford after finishing her Master by research degree in musical composition in De Montfort University Leicester, where she researches for John Young. She is a former part-time lecturer in the same university. With a strong support of her academic background, she is also a sound designer and composer whose works encompasses acousmatic music—the traditional electroacoustic diffusion approach, performing art, in particular, drama and contemporary dance, and live electronics performance with a gesture feedback instrument tailor-made by herself. Her current research focuses on "corporeality in electronic music from a contemporary animism perspective" (Nederberg, 2017) as a practice based research.

Wei Sun (b. 1976). The Beijing-born artist Sun uses sound as the primary medium, and his work encompasses field recording, sound installation and live performances with electronics. He is a graduate of Sichuan Fine Arts Institute in Chongqing, China. For most of his works, he manifests his concepts with ultrasonic recordings, underwater frequency and the everyday-life background noise. He first uses loudspeakers for live performances in 2009. Then, he integrates the idea with using both audio transducers and loudspeakers for live in 2015. According to the artist, he is interested in exploring 'the relationship between sound vibrations and the environment' (sunweistudio, 2017) He believes sound could be understood as a 'concert' way of some experience and he stresses about the new listening experience and its possibility from the daily life. He also works with noise music, and he is a member of the Chinese noise group Dead Sea. He has presented his work and performs in Germany, the Netherlands and the USA.

Daichi Yoshikawa (b. 1986). Yoshikawa was born in Tokyo and currently resides in Berlin. He has been actively engaged in the experimental music scene in Berlin and London for more than seven years. While working at Cafe Oto—a well-known venue for experimental music in London—when he was studying his bachelor degree in London college of communication in Sound art and design, Yoshikawa develops his sonic language by the extensive use of audio feedback and founded objects through free-improvisation. Other than playing as a solo artist, he frequently collaborates with other musicians from all over the world. His collaborative projects include the trio lll人 with a drummer and a saxophonist, while another called *наказание* with a

percussionist and a double bassist. In additions, He organises the concert series for experimental music at *DZIALDOV* in Berlin as a platform for exchanging musical ideas between musicians and artists.

4.2 The setting of the interviews

The collection of Data focuses on musicians who experiment with the act of playing of the loudspeaker in a live format. From the interviews, I will examine four contemporary musicians who ‘play' the speaker actively in the live electronics paradigm by conducting interviews with the musicians—for their particular live set-up—to collect qualitative data. The collected data are analysed under the lights of the theories about the musical liveness, in particular of live electronics, which has been discussed in the pervious sections. The findings are presented in descriptive and narrative form, instead of as a scientific report that the readers—who might not have direct or general experience in live electronics performance. Alternatively, the findings could serve as a vicarious experience for those who are familiar with, or as a practitioner in this genre to call for more attention to the subject—loudspeaker as the instrument—this research proposes.

The research and interviews are done in Berlin. While being a researcher and a practitioner myself at the same time, I acquire information from the musicians I have shared the stage before and look for the musicians who could participate in the interview. The reason for carrying out the research in Berlin is because of the relatively higher accessibility to related concert within the limited time frame—3 months—and its variety. Therefore, multiple data could be collected through participating in the interviewees' concerts to construct the first-person experience as an observer, audio-visual documentations for the concerts and the face-to-face interview(s) and supplementary information on the internet. However, due to the limitation of time and the dislocation between the interviewer—myself—and the interviewee, text-based interviews through Emails, are applied to the musicians who do not reside in Berlin—and for one who lives in Berlin but refuses to conduct a face-to-face interview. Though, these interviews are conversation based—more than one response from the interviewees—that clarifications are made on both sides to achieve a relatively reliable set of Data.

The Researcher’s Role. It is necessary to clarify that the researcher—myself—is also a practitioner uses loudspeakers directly as an instrument in live electronics performance. All of

the interviewees are noted with my role of musician while they have not participated in any of my concerts. To achieve a comparatively objective result, the questions designed for the interview only focus on the interviewees' musical practice without intervening by my practice. Exchange of musical ideas is excluded. However, my perspective and the insights on the interview topic are inherently existed in the data analysis section with the support of the literature and theories discussed.

4.3 Collection of Data

All four interviews are semi-structured with the similar set of questions, which each musician got the same number of issues with the content varies regarding the different concept of the piece and the technical set-ups.

The interview questions are divided into three parts, which investigate the musician's artistic intention and the content of the piece/ live set-up, the creative approach and the technical details for the production. The questions related the metaphorical contents revealed by the piece, or merely a system-based concept is discussed in the first place. To comprehend the intentionality of the musician playing with loudspeaker, the second part of the questions guide the interviewees to address what is the musical liveness in live electronics means to them, *which related to the assumption that the musical liveness is brought fundamentally by the change of air pressure through the loudspeaker*. Lastly, the discussion about the equipment used—use of technologies—reveals how the musicians materialise their sonic idea and their experience in engaging with (digital) technologies.

The face-to-face interview with Daichi Yoshikawa is open-ended. Audio recording is made throughout the entire interview process, and the conversation is transcribed. Complementary notes are made during the survey. The interview is taken place in his studio apartment in Berlin, three weeks following a concert he has played a duo set with the French artist Pascal Battus, which I have participated as an observer. The musician does not know about my intention to interview him until the concert is finished. Audiovisual Data are collected with mobile phone during the performance without the musician noticing that. Another interviewee, Roy Carroll, has requested for an email interview while I also have attended one of his concerts in Berlin. Similarly, he does not know about the interview in advance. No video or audio recording was made, but filed notes are made during the concert and are included as a narrative for the data analysed. On the other hand, the rest of the two interviewees, who are Wei Sun and Annelie

Nederberg, are contacted through Emails with no direct encounter and participation in their concerts. Their audio-visual documentations, text-based descriptions on the internet are studied upon formulating the interview questions. Part of the information which cannot be found online is provided by the musicians while they have consensus with the correctness of the online information. For all of the interviewees, some other audiovisual materials found online related to musicians' artistic practice are included in the discussions.

Organising the collected materials. Besides the data collected through the interviews and from the field notes made during two concerts by the interviewees respectively, audio-visual materials found on the website are also used in this research. Although watching or listening to a video/ audio documentation is different from being physical ‘there' in the concert, these materials serve as supplementary elements, which correspond to the theories that have been discussed before. A list of the audio-visual data is made available in the attachment at the end of the paper. Among the interviewees, the audio-visual data collected from Yoshikawa is the more comprehensive, while documentations with reliable quality could be found online for both Carroll and Nederberg. However, Sun does not appear to have a proper archive for his performance with loudspeaker but the audio tracks and records he produced. As a result, Sun’s resources—mainly the answers from the survey—will be used as a support in terms of concept and theory. Besides, the text collected from Sun is in Simplified Chinese, which the research uses traditional Chinese that some technical terms are slightly different. The researcher has to translate the data into English before the coding.

As long as the data—text and audio-visual—collected are dense, some of the data will not be used but to select and frame (Guest, MacQueen & Namey, 2012) the collected information to focus on specific ideas upon the surveys are coded, aggregating the data into a few number of themes.

4.4 Presentation and analysis of data

The interviewees' profiles display a diverse interest in live sound production. All of them has institutional training in arts while Sun does not participate in any sound art or music related academic programme. Among four of them, Nederberg shows a structured, yet condensed response, showing her musical practice is much supported by certain theories and concepts. In spite of the academic training Yoshikawa gains from his bachelor degree in sound art, he inclined

to put efforts in dedicating himself to the non-academic music scene (i.e. playing in a club) while Sun and Carroll have the same approach. Therefore, the form of knowledge gained varies among them, and it reveals from their musical practice.

The analysis of data is divided into two parts while the surveys consist of three. The creative approach is discussed in parallel with the content of the chosen piece or the musicians' body of work to response to the question about how the instrument—loudspeaker reveals the musical liveness.

Observation on the concert by Yoshikawa. The concert is dated on 26th March 2017 at *DZIALDOV* in Berlin, which is a gallery usually presents experimental music concerts and contemporary art (i.e. Sculptures and paintings) located in the basement with noticeable reverberation. The entire gallery does not consist of any sound-proof materials on the wall. The gallery is divided into two areas, separated by a wall with two entrances at the two sides without doors that visitors could access to both sides that the size of each room is roughly equal (around 40 sq m). As a duo set which they have played roughly for 35 minutes, Yoshikawa is staged at one side of the while Pascal Battus who is on tour in Germany from France plays in the other room. Battus plays with salvaged objects; the sounds are made by putting them on a rotating motor—the mechanical sound is insignificant—while the objects touch the motor's surface to create the resonance. For some times, Battus amplifies the sound via the loudspeaker—it was a pair of KRK studio monitor but serves as a PA system—for the less audible objects.

Technical set up for Yoshikawa. Yoshikawa creates the sound from his set up with audio feedback, which he directly 'play' with and on a pair of loudspeakers—lying horizontally with the speaker cones facing up—by putting two piezos on each cone respectively. The sound is primarily generated by the right channel with the piezo that Yoshikawa could alter the bouncing rhythm by adjusting the length of cable attached to the piezo with the hand's hold position. He could further adjust the dynamics of the feedback volume with the foot pedal control. The signal from the right is partly sent to the left, causing the sponge on the left speaker cone to 'jump' while Yoshikawa has a wooden stick on his left hand to create additional layers with the metal spring attached. A needle is stuck on the left speaker cone so to create more varieties of sound when the metal spring hits it. Occasionally, he lies the wooden stick directly on the cone surface to make a less aggressive sound—with longer attack. All sound produced from the left are

slightly sent back to the right channel, intervening the steady bouncing piezo microphone by the panning knobs as shown in the routing below (See *Figure 4*).

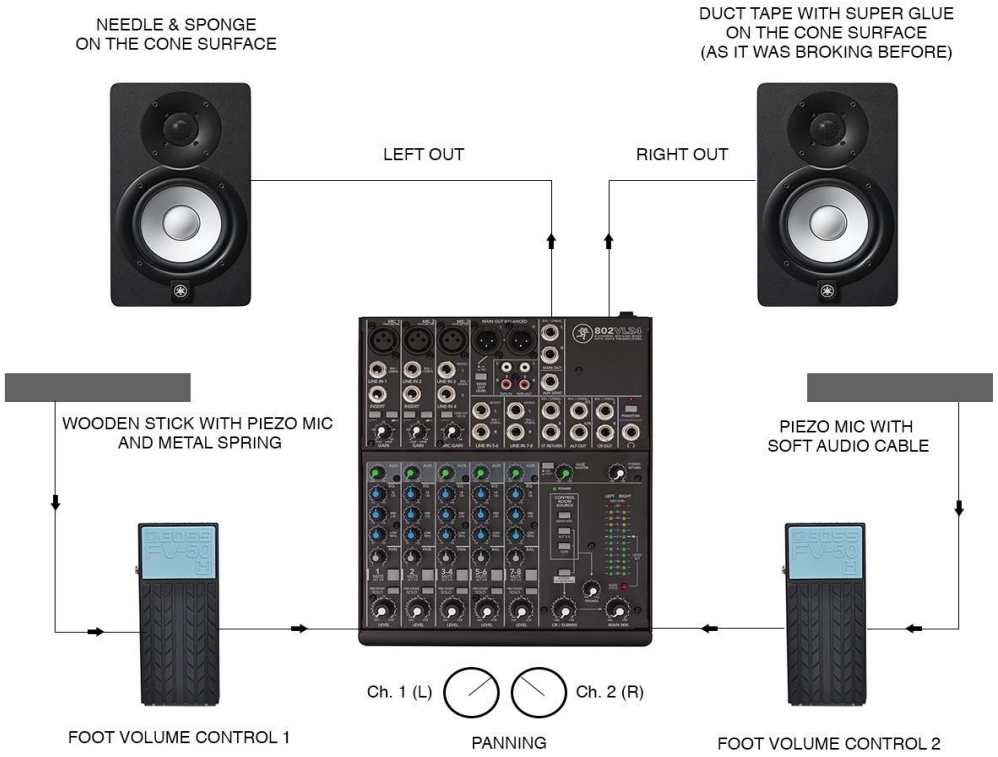

Figure 4- Signal Routing for Yoshikawa. (Yoshikawa, Personal communication, 2017)

The sound is mostly repetitive like drumming but with various sonic textures due to the resonance of different objects, while the microphone also picks up the ‘jumping' sound of itself. The video—see attachment—shows the principle of how Yoshikawa manipulates the set-up with a small part of the concert revealing the space and the sound from a first-person perspective.

Musical dialogue. As the musician are separated, not seeing each other when performing, therefore, the sound becomes vital for the communication between two performers that they ‘talk' to each other with the musical language they established with their instruments. Not like the world of acoustic instruments, which certain style of musical languages has been well developed and understood by both listeners and musicians. The communication is grounded, for example, in a philharmonic orchestra, the conductor serves as the frame of reference for all musicians in the performance. Thus, in most cases in the collaboration for live electronics, the attention falls much on how the musician create the sounds for communication, for both

experienced—practitioner—and general—newbies—listeners. This process is complex for gaining such cognition as it might also be affected by one's experience that the phenomenon of the remix of cultures in the digital age and the cultural identity should be taken into account. In the non-western cultures, the project such as Ensembles Asia, initiated by Otomo Yoshihide, renowned pioneer of experimental music in Japan particularly addresses such phenomenon and establish a platform and network among musicians of experimental music in the East. (Lippit, 2016)

Unfortunately, the musical dialogue between Yoshikawa and Battus could hardly be noticed that there are only very few moments I feel that they are communicating. It seems Yoshikawa has certain restrictions for his loudspeaker while Battus has developed a more dynamic flow of sound. Although the repetitive style of playing is not a problem nowadays, Yoshikawa seems lack of awareness of what is happening in another room, which at certain moment Battus has to compromise or spare some ‘space' acoustically with Yoshikawa's dominant act of playing. Sonically speaking, the total experience of the performance is intriguing. The sound fits in well with the venue's acoustic that the reflection of sound lifts up the industrial-alike musical style, especially when Battus plays with a splash cymbal. Alternatively, in my opinion, a solo set by Yoshikawa and Battus respectively might work better in regards to the distinct sounds that they own.

After the concert is finished, I have a brief talk with four of the participators outside the venue, and some notes have been made. It is a group discussion, and three of them know each other. Person A and B are musicians—A is free improvisation guitarist and B plays live electronics—while person C is a visual artist. All of them agree that the performance is visually appealing and inspiring. Person C especially likes the bouncing movement of the contact microphone Yoshikawa plays. Even though person A disagree on the separate placement of the musicians, both person A and B acknowledge that the soundscape created fits the venue. However, person B expresses he finds Yoshikawa's sound is dull and lack of communication with Battus. As person A is the only one who regularly walks around in between two rooms, he explains that such movement helps himself in selecting what he wants to listen to. Therefore, he perceives constantly-changing auditory dynamics about his movement within the venue, given that person B stands at the entrance between two rooms and person C sits on the chair at Yoshikawa's room throughout the whole concert.

Observation on the concert by Carroll. The concert is dated 17th March, 2017 at a performance venue called Liebig12 in Berlin. Liebig12 is a comparatively more formal space serves for experimental music, which there are proper audio equipment and a less-reverberant room acoustic. Carroll's performance is a duo set that he plays with Aniana Heras (aka JD Zazie), an Italian turntablist based in Berlin. They play around 45 to 50 minutes. Heras uses records of water dropping sound, water bubbles and later some speeches with occasionally samples of low frequency electronic sound. She plays with audio effects like a normal DJ would do that she alters the speed of the spinning records with her hand to create more sonic textures, but in a gentler way.

Technical set up for Carroll. He uses in total six loudspeakers, which four are dynamic drivers and two are exciters. The loudspeakers are posited on different salvaged objects such as aluminium foils hanged on a stand and several cylindrical paper containers for Glenfiddich's whisky. At the beginning of the concert, he puts one of the paper containers with an exciter inside near the main entrance of the gallery surrounded by part of the participators. Carroll produces the sound in two ways: Create an audio feedback loop between the microphones and the loudspeaker putting on the salvaged objects that they resonant with the speakers; Generate sound from the laptop and send to the loudspeakers positioned on the salvaged objects to create resonance with them. He uses two piezo microphones and two magnetic pickups—similar to those for electric guitar—respectively for the feedback. The sound-generating program from the laptop is Reaktor by Native Instruments (Carroll, personal communication, 21st April, 2017).

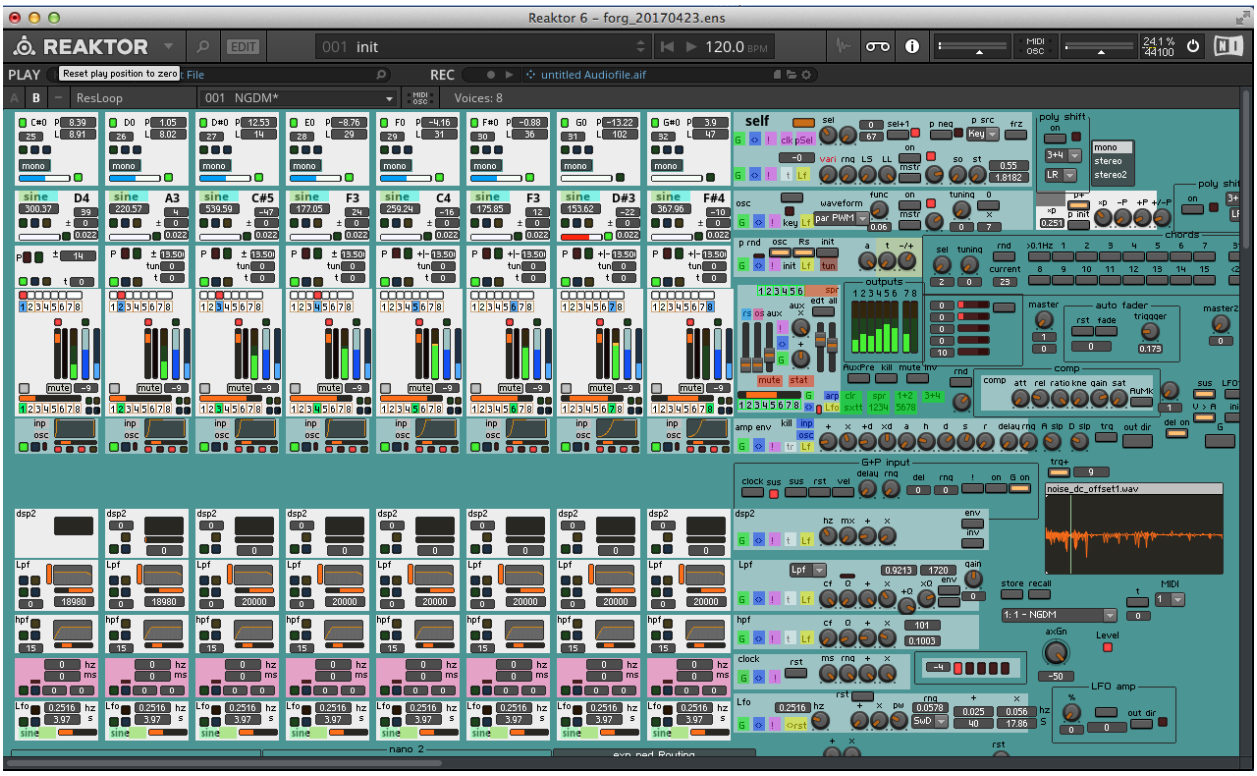

Figure 5- Carroll's Reaktor's performance patch on his laptop (Carroll, personal communication, 2017)

Carroll produces sonically dull and hollow sound with his loudspeakers even though he uses additional sounds generated by the laptop sending to the loudspeakers. Musically speaking, what Carroll produced sounds slightly uncontrollable that Carroll can barely manipulate his instrument for better expressions. Though, some experimental musicians might take this as an advantage as they look for unpredictable outcomes as part of a live performance. Carroll seems being restricted very much from the excessive feedback while Heras contributes a high-quality sound with fidelity from her turntable. It sounds as if Carroll is detached from Heras that most of the musical motives are initiated from her samplings.

Live Set-up by Sun. Similar to Carroll, Sun plays with resonants on founded objects caused by the vibration of the loudspeakers. Sun's set-up does not generate the sound from the laptop—digital. Rather, he composes the musical textures with two to three analog sound oscillator—with (CV) Control Voltage, which the sound (i.e. Pitch) is manipulated by the immediate change of the voltage—as the sound sources. As Sun explains (Sun, personal communication, 19th April 2017), he uses the analog oscillator (JMT Synth) as the input signal to the numbers of 2-inch—from Soundking—and 3-inch—from Genelec—full-range loudspeaker

respectively through a Mackie 402-vlz3 audio mixer and a surround sound amplifier by Knoll Home Audio. The number of loudspeakers varies in different performance. Occasionally, a hacked tape machine, metal spring, piezo microphone(s) or loudspeaker(s) with paper cone removed are used. During the concert, Sun discloses that he has tried to put cling film on a vibrating loudspeaker drive while he adds salt on top of the film to alter the sound texture and simultaneously 'enhance the randomness and the sense of experience'. (Ibid)

***Seeress (2014)* by Nederberg.** The piece is performed with a custom-made gesture feedback instrument by Nederberg herself. Nederberg's playing is different from all other interviewees. She does not produce sound with manipulating the physicality of the loudspeaker. Instead, she utilises the audio feedback as the initial sound source, created by her hand gesture with two omnidirectional microphones (DPA 4060) taped on each of her hand that she could freely alter the distance between the loudspeakers and the microphones to generate the feedback. She highlights about the 'relatedness' (Nederberg, personal communication, 25th April 2017) between herself and the loudspeaker—and other matters in a live performance, which will be discussed in the next section—with the gesture feedback instrument.

According to Nederberg, the microphone is run through a 2-channel digital wireless system (Line 6 ZD-V55L) to the Nord Modular G2—a synthesiser (Electronic musical instrument)—for sound processing. The Nord G2 is connected with a laptop (Macbook Pro) running several patches from Max/MSP—a common visual-based programming software for performances and (new) media art production—to control the volumes and presents of sound. Nederberg explains that she used to use an iPhone—taped on her arm—to wirelessly control the laptop via MIDI (Musical Instrument Digital Interface) and OSC (Open Sound control)—protocols for communication between electronic/ digital musical instruments and other interfaces such as laptop—to control the parameters from the patches. However, she finds this method is not enough reliable while performing and later she directly operates the patches on the laptop. *Figure 6* shows the signal routing of Nederberg's gesture feedback interface.

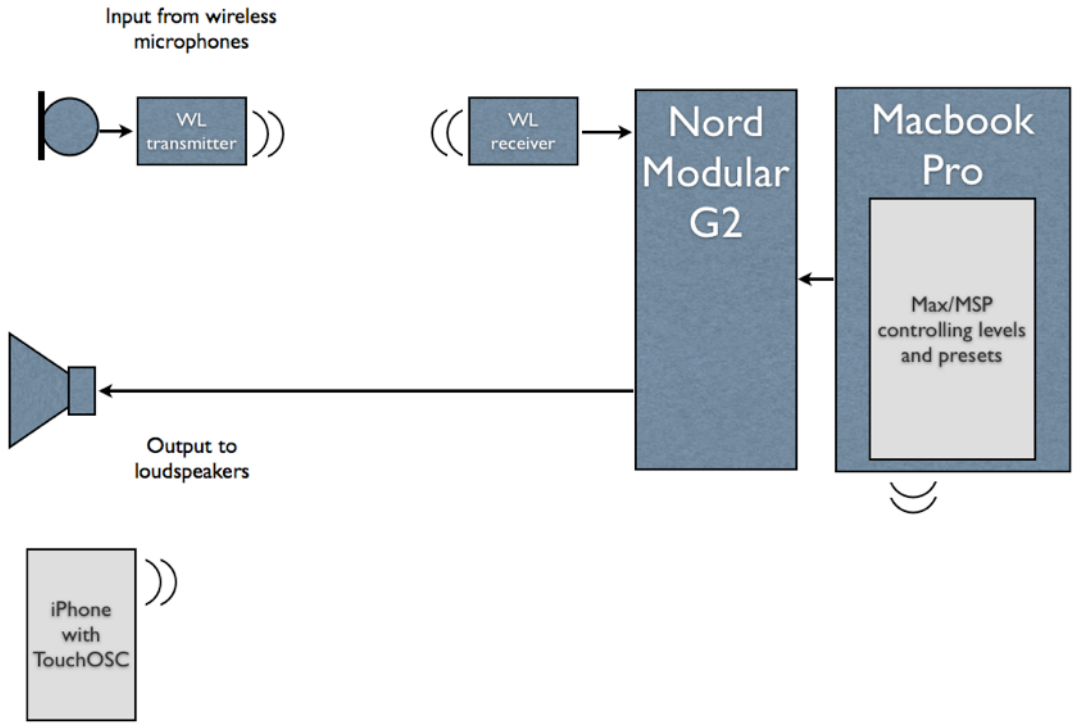

Figure 6- Signal routing of Nederberg's gesture feedback interface. (Nederberg, personal communication, 2017)

The sound output from the Nord G2 is connected to a pair of loudspeakers—mostly Genelec 8020 for its promising frequency response—with stands, positioning at a reachable distance by Nederberg on the stage and a subwoofer for low frequency distribution. Occasionally, she adds one additional Genelec loudspeaker lying on the floor facing her. The following response shows further interpretation on how the sound relates to her gesture:

> '[…] the timbres change as it is run through different patches. These patches guide which gestures I am using: if the patch is slow, i.e. has a high latency (or added delay to slow it down) my gestures become slow as well. In addition, the relatedness inspires additional gestures that are not needed to play the instrument but serve as expressive or relation creating. These gestures also influence the sound of the instrument. When I developed the patches I was mainly searching for a variety of ways in which to co-behave with the instrument, different corporeal relations. There is one patch where the sounds can be considered mapped: a percussive patch, where a

> short, percussive sound is triggered when the sound level reaches above a certain threshold.' (Nederberg, 2017)

Nederberg further explains her concerns about the live sound output. She usually does not perform with a PA system unless the venue is too huge to reach a desirable sound levels. The gesture feedback system is totally self-contained. Yet, it still depends on the performing environment that she has performed outdoor in a park, which she uses the PA system to disperse the sound further from herself.

4.5 Results

This section exhibits the discovery from the interviewees' practice and serve as a summary of facts on how they conceptualise the role of loudspeaker in relation to musical live performance. In additions, the findings echo the researching by exhibiting in what ways the interviewees materialise their musical ideas through and from the loudspeaker in relation to musical liveness.

According to the coding process that has been made, the responses from the interviewees could be generalised into two themes: The materiality of sound revealed by the loudspeaker and its relation to the performance environment. In particular, they discuss their approach through applying the words such as relatedness, contemporary animism, representation—of sound, robustness—of the loudspeaker, system—as refer to non-acoustic musical instrument, timbre, mobility, randomness, tactility and social interaction. The following section focuses on four themes: Relatedness, musical liveness, musical gesture with its mapping and robustness of the loudspeaker, while others keywords will be treated as complementary findings and display in the next chapter.

Relatedness. This concept is frequently mentioned throughout Nederberg's response, which the other three musicians also show similar expression resonating with this idea. In explaining the relation(s) between the room, sound images and loudspeaker for *Seeress*, Nederberg states the following:

> "In my conceptualisation of Seeress, I am exploring this idea as if the sounds, the loudspeakers, the images and the room are parts of the *dividual* that is Annelie (or the Seeress: The Völva). I have avoided making any form of mapping between the six selves and the parts of the music, to instead find an expression for the fluidity and dynamic interchangeability of the parts, and the relatedness and mutuality between them, which are more interesting ideas for me." (Nederberg, 2017)

Narratively speaking, Nederberg develops the piece based on the character of a prophet—the Völva—of an old Norse saga, drawing on the belief of contemporary animism. This idea suggests that even inanimate objects have spirits—or consciousness, which the original concept is developed by Edward Tylor in the 19th Century. Nederberg further explains that 'there is a form of knowledge that is only accessible through relatedness: by being in relation with what is studied' while '*dividuals*' is vital to such concept that 'persons (and other-than-human persons) are constituted not as an indivisible individual separate from nature, but as consisting of parts that *fluently interact with nature*.' (Nederberg, 2017) Therefore, the relatedness between entities—animate and inanimate, the 'fluidity' and the 'dynamic interchangeability' between them becomes the core concepts of Nederberg exploration of music that is also manifested through her 'playing' in live performances.

Nederberg's musical approach shows similarities of what Simon Emmerson discusses in his book *Living Electronic Music* (2007) mentioned earlier. Emmerson draws attention and examines the musical and non-musical aspects, especially in the era that various forms of (digital) sampling are not uncommon. Contemporary musicians adopt these non-musical materials and relate them to the sound itself on a metaphorical level for musical creation. Emmerson argues the functions of explaining existing phenomena found in the traditional scientific model is different from that of new music, which the latter is a generative *process*, creating new musical material in various forms. Besides, these musical models could be found on both human—language and social relations—and non-human—architecture, astronomy or cosmology—activities (p. 41-42). Such process of generating new musical ideas is also found while Nederberg explains the experience constructed through *relatedness* "is different from scientific knowledge. It is based on separation, dissection and dividing things into parts without always taking into account how they interact" (Nederberg, 2017). Nederberg employs the ideas from contemporary animism, relating

herself to different entities: loudspeakers, the feedback instrument, the audience and the performance environment that the *fluidity* between theses matters constitute the musical liveness. Correspondingly, Yoshikawa's response implicitly shows consensus in the relatedness of his performance to the surrounding: 'Seeing the things, seeing the audiences, seeing the room, hearing the room' (Yoshikawa, personal communication, 2017). In additional, he mentions the word 'nature' while further explain his playing: 'The *circulation* thing is coming from the beginning when I started to play". (Ibid) Evidently, he thought has emphasised about the connections formed by the both human and non-human activities, which resonates with Nerderberg's idea of the fluidity of the presence of matters in a live concert. Likewise, Sun believes that the live sound, the audiences' experience and their responsiveness to the performer, which formulates a live feedback situation, continuously looping during the performance, should be seen as one entity (Sun, personal communication, 2017). Nonetheless, Carroll focuses on "immediate control over the simplest parameters, -on/ off volume, etc. [and their] accessibility" (Carroll, personal communication, 2017). Hence, it leaves certain rooms for more communication not only with the audience, but to realise the environment of the concert and its connection to the transduction of sound. In other words, Yoshikawa and Carroll approach the loudspeaker by generating sound physically that the results rely on the objects' sonority. Whereas, Nederberg and Suns are more conscious about the *process* of how they "relate"—borrowed from Nederberg speaking about relatedness—to the loudspeaker through performance.

Musical Liveness. The previous section shows how the interviewees' practice related to the musical liveness. This part further investigates the liveness with the means of using audio feedback as all interviewees manipulate such technique for their live electronics performance. Audio feedback could be considered as a self-contained system, which other systems would affect the quality and the parameters—i.e. Level, tonality and duration—of the feedback. *Talking to the room* (2011) shows a self-contained feedback situation is intervened by the external factors. In other words, the result of audio feedback would never be the same, which changes over time and is determined by the environment. In a concert situation, feedback truly justifies that 'space itself can "tell a story"' (Emmerson, 2007, p. 102) from the division between 'local' and 'field'. For the feedback system of Yoshikawa, Nederberg and Carroll, the sound generated are different from each time because the environment contributes much for the input of their

microphones. Even they perform in the same venue, the position of the stage, the number of the participators and any unpredictable sounds from them might significantly alter the result. Whereas, the creation of feedback of Sun's set up happens mechanically in his instruments—the oscillator in the synthesiser—which is relatively controllable. Conceptually, such technique unveils a vital aspect of the musical liveness that is not solely rely on the accessibility of instruments from the performer's perspective.

Musical Gesture and mapping. Evidently, many audiences nowadays would not adopt the approach of elimination by ‘bracketing out' any non-musical associations—as well as the vision. Instead, they look for the cause of the live sound by analysing the musician's gesture about the sound regarding live performance. Moreover, the technological improvements in the last decades allow musicians to engage numerous ways to enhance or shape music. For instance, (STEIM) Studio for Electro-Instrumental Music in the Netherlands has been researching on the applications of digital technologies by musicians within the electronic music paradigm. They reclaim ‘touch is crucial in communicating with the new electronic performance art technologies' ("WHATS STEIM," 2016) out of the formalistic and overwhelming use of computer technology.

In *Seeress*, the body gesture is an important element in which it is one of the ways that the audience get to understand what is happening on the stage. It is a relatively complex situation as the presence of the visual elements than the set-up of three others interviewees. Nederberg's movement and gesture play a role not only to create a dynamic feedback but also to notify the audience the relation between the sound and her ‘playing'. It is similar to a violinist moving his/her finger on the string, where the sound is ‘mapped' from the performer's gesture to produce the vibrations. Generally speaking, the process of constructing the linkage—in electronic music—between the input and the output is called mapping. In other words, the mapping is a translation of gesture into sound. However, even the performer applies an explicit mapping method; it might still be problematic that the cause and effect of the sound are not as obvious as traditional instruments while the acoustic instrument has ‘greatly superior interaction capabilities than today's state-of-the-art real-time processors' (Hunt, Wanderley, & Kirk, 2000). The design of electronic musical instrument complicates the gesture translation to sound because it allows the separation of sound and control (control interface, sound synthesis and the output from loudspeakers. According to Fels et al., “this physical separation requires an effort on the part of

the designer to avoid the corresponding cognitive separation" (Fels, Gadd, & Mulder, 2002). The 'expressivity' (ibid.) elaborated through mapping is vital to all kinds of musical performances while Hunt et al. state:

> "the emotional response elicited from the performer is shown to be determined to a significant degree by the mapping. Whereas the input devices establish the physicality of the system and the synthesis methods govern the sound quality, the mapping somehow affects how the player reacts psychologically and musically to the instrument." (Hunt, Wanderley, & Paradis, 2003)

While Nederberg's gesture feedback instrument involves digital sound synthesis and explicit performative gesture, she claims, 'the sounds are not mapped at all, which is the point of working with feedback. I am fascinated with the idea that the sound is already there, whether or not I am present. When I approach the instrument, the sound appears' (Nederberg, 2017). In fact, her approach is neither *explicit* nor *implicit* mapping according to Hunt et al. (2000). There is no explicit relationship between her gesture the sound synthesis parameters or direct use of neural networks—implicit. Rather, Nederberg 'intervenes'—Nederberg prefers to use the word relate(s)—the sound generated from the Max/Msp patches for the processing of sound. Even though her gesture is partly restricted by the patches, which guide her actions, she could still improvise other gestures to shape the sound on top of the 'prepared' movements that are necessary to play the instrument. Nederberg strategically embodies herself, to actively approach the sound radiated from the loudspeaker and extend the timbres through her 'non-mapping' gesture, which *fluidise*s the previously suggested separation to be dissolved by meaningful gesture in nowadays electronic music performances.

In contrast, Carroll's gesture focuses more on the control interface (i.e. Knobs and faders) connected with the laptop to operate the programme, and he occasionally plays with the tube length to produce different harmonics via feeding the output back to the system. Yoshikawa and Sun do not engage with gesture explicitly. Yoshikawa adjusts the length of the cable of the contact microphone on his right hand to create different bouncing frequency, but it is not obvious to the audience.

Robustness. This term appears among Yoshikawa, Carroll and Nederbergs' response when they describe their experience in playing with loudspeakers. Yoshikawa and Carroll discuss the robustness of the speaker from its physicality to its sonic characters while Nederberg and Sun concern more about the frequency response in relation to conceptualising their piece. From the broken Yamaha MSP7 to HS5, Yoshikawa claims that the HS5 is much more robust and it never breaks since he bought it for his performance. Alternatively, both tweeter and woofer—the cone— from the MSP7 malfunctions several times that he is forced stop playing during the concert. In fact, the woofer—6.5-inch and 5-inch respectively—for both MSP7 and HS5 are made of polypropylene (PP). However, it exhibits different result on Yoshikawa's set up that technically speaking, the robustness of the loudspeaker is indeed affected by various parameters such as the crossover design, the amplification function—for active loudspeaker—and the frequency response. According to the review of the MSP7 on a popular website for music recording technology, Sound on Sound states, “This particular tweeter is capable of working up to 40kHz and is driven by what Yamaha describe as ‘a powerful magnetic circuit’, with the aim of providing a fast response for the accurate reproduction of transients.” (White, 2007) It might explain the malfunctioning of the MSP7 concerning the frequency response that the HS5 Yoshikawa is currently using is less sensitive to the unpredictable feedback effect determined quite much on the transients.

Correspondingly, Carroll also highlights about the robustness as a concern of loudspeaker performance that the speakers he uses have a higher chance to be torn down. One technical difference of Carroll from other three is that he plays with exciter which the driver does not has the diaphragm. In most cases of performing with feedback on exciters, it is comparatively significant to find a good quality amplifier to match with the technical detail of the exciters. Such combination has a promising electrical circuit protection to overcome the excessive, yet unpredictable output signal—and this is also why many musicians engage with feedback, especially for noise music. On the other hand, Nederberg claims that the reason for selecting a specific loudspeaker models from Genelec “because they are robust dynamic and have a good frequency response” (Nederberg, 2017).

5 Conclusion

This research starts from discussing the black box phenomenon in the field of new media arts. It appears the subject of investigation in this research, namely the loudspeaker, shares very much the properties of a black box even though the loudspeaker is the only way to bring forth the musical idea in live electronic music production. The separation of the sound output from the sound generation process with the modular nature of digital music production has further concealed the existence and the role of this important device while it has consistently been made transparent. While one of the aims of this research is to explore how the sound produced by musician is materialised through the loudspeakers and its relationship with the digital instruments for live sound processing, it seems the mobility of these instruments—including laptop—that benefit from the mass production of semiconductors with low economic value does not favour a relatively authentic sonic result for live electronics. Rather, it enhances the variety of sounds and performance gesture with innovative interface designs for the virtuosity. There is still a lapse, which musicians might face a sonic result that is different from their expectation and compromise in different music venues. Although the pursuit of a high fidelity listening from the loudspeaker is proven to be endless, for example, the hi-fi fetishism for home audio, one should not ignore the fact that he or she is *listening* to the loudspeaker. It seems that it is not valid to apply the idea from Eck (2017) that "there should be no significant difference in the experience of listening to a symphony by Beethoven at home through a hi-fi system to that of listening to the same symphony in a concert hall performed by an orchestra." (p. 38). At least, from the listener's point of view, one needs to be aware that the experience is mediated, and that it has a possibility to be shaped by the loudspeaker.

By addressing the issues about listening live concert with the loudspeakers, this research has revisited the functionality of the loudspeaker and its values for music performance and to a larger context how loudspeaker has been integrated into our lives silently. According to the electromagnetic principle, the electroacoustic characters of the loudspeaker are reviewed through its transformation of the signal from sound to electrical signal and vice versa. By explaining the term stereophonic, which originated from Greek, the distinction between monophonic and stereophonic is explained followed by the examination of the internal mechanism of the loudspeaker. Different types of drivers and the distribution of frequency are reviewed to provide an overview of what is inside the black box. By sharing a similar mechanism, audio transducers

and exciters are mentioned, which they produce sound by resonating with the material attached, to provide further information of how a loudspeaker is hidden from our daily life. Then, Cage's first experiment of electronic music, namely, *Imaginary Landscape(s)*; Schaeffer's theory of *musique concrete* and the diffusion system *cybernéphone,* which execute the idea of acousmatic music are reviewed based on the musicians' artistic practice. The examples demonstrate how the loudspeakers are exhibited on the stage from the mere use of studio production and telecommunication. Besides, modern applications are included, and new technology such as the bone conduction transducer is mentioned to offer an overview of the current development of the loudspeaker.

As discussed, it is vital not to exclude the discussion of the audiences' reception on a semantic level where different modes of listening are reviewed, which serves as a guideline of approaching live electronic music. The musical liveness is also discussed, not only from the musical practice but also the mediatized culture from what Auslander has illustrated. The musical liveness interrogated by Croft has proved the quest for a fine-grained responsiveness between the performer and the digital musical instrument, whereas Emmerson interprets the liveness in a larger context in which he discusses the way how a musician generates new musical ideas from both the musical and extra-musical models. For Emmerson, a live concert is not limited by itself. Rather, he revisits the nature of contemporary music performance in relations to technology, placing the issues and questions "before composers, performers and listeners" (2007, p. XV) to extend our perspective.

The results generated from the four interviewees are interpreted based on the theories about musical liveness. According to the distinctive practices from each interviewee, the results cover a broad range of discussion from the practical side and the ways how each of the interviewees conceptualises their performance. Of course, the findings are not meant to represent the entire field. Instead, this data contributes as segments to map the field. Besides, it provides insights to other researchers with a similar area of interests, hence to gradually compose a larger picture, bridging the academia and the art world.

By following the requirement of the master thesis, the method chosen in this research leans on the science models that tends to explain the existing phenomena rather than generating new material from them. Such methodological approach requires the behaviours of being scientific objective so that the claims and results are not influenced by personal interest and bias. As stated

at the beginning, other than being a research myself, I also participate as a musician in the field that I am investigating. Thus, it is comparatively critical that the research process could be remained completely objective, so as the research intention. As Emmerson (2007) differences between the science models and the models found in musician's practice, which the latter "is turned [from the entire edifice of the 'the model and analog' structure] on its head and used to create something new" (p.42). Therefore, such model is generative that musician does not treat explaining the 'unknown' as the process. Although, I do not mean to argue for artistic research[30] —while certain scholars have been doing that. Rather, the approach of artistic research might be an alternative way for this research regarding the way of producing new knowledge, which one could actively engage with the field with much less distance.

Last but not least, some of the data are not explicitly displayed in this research, which it is useful for further studies. For example, as mentioned by Yoshikawa, he treats his performance as a social event that the concert is only part of the happening. Other than preparing gears, he also prepares meals for the audience and the musician he invites. In fact, that is how I approached him with this interactive dynamic. Apparently, one could study the consequences of a music concert from a social perspective while there are certain interactions happening within. As Eck has mentioned, the social activities are usually relocated to the large foyer between the concert hall and entrance by the architectural design in the past to ensure the performance is not distracted by it (2017, p.10). Similarly, Helmreich (2015) explains how the field of sound studies investigate these transductive events in relation to the "social, political and economic conditions surrounding and suffusing technoscientific practice" (p.224). That is to say, for live electronics, there is much headroom for such discussions to explore through the lens of social interaction.

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Footnotes

[1] The situation of a percussionist playing a drum solo in a concert hall is different from a turntablist deejaying a mixtape of drum tracks in terms of the set-up of the instruments. The sound amplification fro the percussions is complementary to enhance the dispersion of sound, whereas the sound reinforcement system is essential to the turntablist's performance due to the technical aspect of the instrument design. The latter need an individual device for the sound output while an acoustic instrument materialise the sound from itself.

[2] Wessel and Wright (2003), the developers of the renowned OSC protocol (similar to MIDI as a communication between devices), is a computational language mediating between the musical interface and the computer. The authors propose an intimate musical control interface with higher responsiveness.

[3] See video link: http://jasperfungty.com/?p=471

[4] See video link: https://www.youtube.com/watch?v=6ZxxuDNQuMQ

[5] A magnetic guitar pickup is a device that pick up the mechanical vibrations generated from the strings and transform them into electric signals. The signals are then sent to a guitar amplifier to produce musical sound through loudspeaker.

[6] Dynamic microphone has the same principle of a dynamic loudspeaker as mentioned in Chapter one, whereas a condenser microphone has two extremely sensitive charged plates as the diaphragm inside the microphone capsule. The audio signal is created as the sound wave alter the distance between two plates and hence result in a change of electrical capacity.

[7] The term acousmatic and the concept is derived from the use of curtain by Pythagoras during his seminar, which he asks his fellows to focus on his speech by the suppression of the vision.

[8] Audio crossover is common in audio applications. It is a type of electronic circuit that split up an input audio signal into different frequency range. The crossover circuit in the speaker usually two-way, dividing the audio frequency into high and mid/mid-low and send to different drivers respectively

[9] Faraday's law of induction is the basic rule of electromagnetism forecasting the phenomenon of electromagnetic induction, which electromagnetic force is produced when a magnetic field passes through an electric circuit.

[10] See website: http://clarksynthesis.com/clark-synthesis-products/tactile-sound-transducers/

[11] See website: http://www.feonic.com/

[12] Bonnie Bird is a modern dancer and teaches dancing. She is a close friend of Cage.

[13] Technique such as *Klangfarbenmelodie* (Sound-colour melody in German) which split a melody between two or more instruments

[14] For example the very famous work *Prélude à l'après-midi d'un faune* (Prelude to the Afternoon of a Faun)

[15] In fact, Henry is 'expelled' because his composes many cinema and theatre works that go against with Schaeffer's concept. But Still, Pierre Henry remains his reputation nowadays by his unique composition approach. The film *The Art of Sound* (2007) is a documentary about Henry's theory of concrete music. See link: https://www.discogs.com/Pierre-Henry-The-Art-Of-Sounds/release/7220627

[16] Different modes of listening will be further discussed in chapter 3

[17] Another similar invention to the *Phonogène* by the time is the Morphone, which the machine consists of a record/erase head and several play head of magnetic tape so that delay and gigantic reverberation is created when manipulating the loop of the tape. Manufactories in the early period produce the machine with all magnetic heads fixed while the later ones allows to adjust the distance of the heads to create more complex sound. One of the notable analogue tape delays is manufactured by Roland in 1970s, namely, Space Echo RE-201. Taiwanese pioneer of noise music WANG Fujui uses it for his performance while Roland produces a digital version as well. Japanese manufacturer Hawk's 5-head echo unit and Dynacord's Echocord Mini Tape Echo from Germany are other high-end tape echos. Recently, the Danish made Replicator guitar effect by T-Rex allows guitarist to enjoy the true analogue tape delay sound while this compact box replicate the mechanical design from pervious busy units.

[18] See website: http://zungleinc.com/

[19] Retrieved from TEDxIndianapolis talk titled The difference between hearing and listening by Oliveros.

[20] A sensuous bias prioritise vision among others in Western cultures. This phenomenon could be traced back to the renaissance immersive doom painting. Media theorist Marshall McLuhan also argues the primacy of vision in terms of humans' way of knowing by stating 'Telephone is a cool medium, or one of low definition, because the ear is given a meager amount of information. And speech is a cool medium of low definition, because so little is given and so much has to be filled

in by the listener' (McLuhan, 1974, p.22-23). See also '*From the Empire of the Gaze to Noisy Bodies: Foucault, Audition and Medical Power*' (Siisiainen, 2008)

[21] The term is interchangeable with audience, however, listener could refer to both performer and audience because listening is the process circulates within a live musical event, formulating a feedback loop between the musician and the audience through technological mediation (i.e. Loudspeaker)

[22] Chion was also a member of *Groupe de recherche musicale* (GRM) for five years starting from 1971

[23] López has been executing his concepts in the form of concert, which he does real time manipulation of sound with participators blindfolded in a blackout theatre. During the performance, the audiences sit with their eye facing away from López in a round shape, which López stands in the centre of the circle, manually manipulating the mixer to create distinct sound effects of his field recording samples. López writes about his concerns about musical performance in the article 'Against the stage' (2014).

[24] The band's first debut self entitled album, released in 1989, is recorded underground at Fort Worden Cistern in Washington, which later renamed as Dan Harpole Cistern and is famous for the 45-second long reverberation. The album is done with location recording and later edited in the studio.

[25] The futurist Manifesto published by Luigi Russolo in 1912 speaks about multiplying the use of sound by extensively using the noise from the machinery, challenging the traditional musical practice at that time. in

[26] The piece is presented in the 5th anniversary of October Revolution, strongly supported by the government during the time to celebrate the victory of the revolution

[27] He has performed the piece at NIME 2014 in London at Club XOYO with performing artist/ Dancer Rebecca O' Brien

[28] Dirty Electronics is John Richards's current project that he travels and perform with his DIY miniature synthesiser boards in different places. It is similar to the idea of the analog modular synthesiser. These boards could be connected with each other that form a modular system or be played individually. He conducts workshops, teaching participants to hand made these electronics boards while later they perform together with Richards. He treats the process of devising the instruments as part of the performance as a shared experience and social interaction.

Richards's another article 'Getting the Hands Dirty' (2008) explains his intention of making electronics 'dirty'.

[29] As quoted in Seth Kim-Cohen's *In the blink of an ear: towards a non-cochlear sonic art* (2009) from an interview in ParisTransatlantic Magazine, on July 22, 1998

[30] Henk Borgdorff's '*The conflict of the faculties: perspectives on artistic research and academia*' (2012) concretely argue for the prospects for artistic research.

Attachments

All original materials for the interview could be found online at the link provided below:
https://drive.google.com/open?id=0Byo7EX2Oq0tGVzhVY3FVVS1qSFU

List of attachments:

1. Carroll_interview_170421.pdf
2. Nederberg_interview_170413.pdf
3. Sun_interview_170417.pdf
4. Yoshikawa_audio1.WAV
5. Yoshikawa_audio2.WAV
6. Yoshikawa_audio3.WAV
7. Yoshikawa_audio4.WAV
8. Yoshikawa_demonstration_video.mp4
9. Yoshikawa_interview_transcript_170501.pdf