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The *meta-instrument* as compositional technique: Strategies of the current musical creation

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The aesthetic paradigm shift after the Second World War inspired the emergence of new expressive possibilities and the development of compositional techniques on the timbral use of instruments, changing the relationships and hierarchies that had previously existed among them. Additionally, the role that technology has played in recent years has clearly influenced many creators when composing their music and changing the sound possibilities of familiar classic instruments while encouraging the creation of completely new ones. A new lexicon to define the same musical reality appears out of the development of these facts: the *meta-instrument*, a technique born from the idea of merging timbres in an autonomous entity that acts beyond the sum of its parts and produces an acoustic illusion in listening. Coming from different perspectives and yielding varying results, composers such as Giacinto Scelsi, Helmut Lachenmann, Chaya Czernowin, Mark Andre, José María Sánchez-Verdú and Raphaël Cendo have turned their gaze toward this strategy to solidify their musical thought. Moreover, the digital revolution, whose influence on some aesthetics and current trends is already apparent, has opened up a space not without controversy that seeks to redefine, or at least expand, the classic definition of composition and even the very idea of music itself. One way or another, listening is placed at the center of a debate to question, once again, the essential aspects of what it means to be human.

The concept of *meta-instrument*, a lexicon that has appeared in the last years in various forms to refer to the same musical reality, starts with the idea of an entity that operates and is conceived as more than the sum of its parts or components. The prefix *meta* addresses its original Greek etymology and stands for a beyond, an after, a higher or second-order kind, that is, something achieved only by transcending the individual sum of the parts. As for *instrument*, it is here referred to as a tool, device or object used to achieve that *third thing*[1]. Therefore, a *meta-instrument* is a compositional technique developed in order to reach specific expressive and structural goals.

Attending the disambiguation of the same concept in its different forms, we can categorize the above described into three definitions:

1. A *virtual instrument*[2] composed by a particular combination of other instruments. More precisely, its result consists on the fusion of different timbres that, mainly by means of extended techniques, creates a sonic illusion in our perception.
2. In the field of Music Theatre, a *meta-instrument* refers to the coherent integration of the elements music, text, movement, light, space and use of objects. The transdisciplinary assemblage of the previous elements would open a *third space* which would result as more than the sum of their disciplines.
3. A third disambiguation refers to a physical instrument whose body, classical use and technical possibilities have been extended, normally by means of technology or new handwork constructions.

1. The *meta-instrument* in the literature Review of its definitions

In the recent literature various musicologist and composers have mentioned the term *meta-instrument* or any of its synonyms, (*mega-instrument, hyper-instrument, composite-instrument,* etc.) in order to refer to the same musical strategy. In this sense, the definition of *meta-instrument* appears in particular books, lectures and websites adopting different meanings, one of which is referred to the fusion of instrumental parts and the other to an extended use of classical instruments mainly by means of technology. The already mentioned *third space* that deals with Music Theatre has not appeared as field of study in this sense yet, which gives our research an important impulse and motivation facing future investigations.

1.1. The *meta-instrument* as fusion of timbres

As for the first approach, it is in the 19th Century when the first Treatise of Instrumentation written by a composer appears as discipline to study and reflect on the orchestra as musical field, as existent and established reality. We are referring to French composer Hector Berlioz and the fact that the first third of the 19th Century implied the start of Orchestration as *science* itself, a step forward in the consciousness of its value as discipline. So far the instrumentation of big scores was an opened topic, to the extent that some performances changed their scoring from one concert to another. The *basso continuo*, indeed, is an extreme case in which timbre, in its basic conception, is normally not considered as structural musical parameter. A harpsichord, a theorbo or an organ could play the same part, changing clearly the sonic result of the same piece. However, it has to be pointed out that many baroque scores specify concrete instruments in charge of the *basso continuo*. Some reasons why they are specified have to do with the text with which vocal repertoire deals, whether it is religious –the case of some Cantatas written by J. S. Bach– or profane –various Händel's operas or oratorios. A representative example is the *Cantata BWV 12* by Johann Sebastian Bach, in which the composer demands an organ as *obbligato* part for the realization of the continuo. The biblical text expresses a great pain and sorrow and the German composer reinforces this *affetto* by means of an instrument capable of holding the sound after being played.

But not only timbre plays a neutral role in Early Music. Robert Schumann's *Drei Romanzen op. 94*, originally written for oboe and piano, was published also for violin and piano, and even for clarinet and piano. Although the German composer did not wish his piece to be published for other instruments than the original ones, this serves as a representative example of how timbre, in its identification dimension, still played a "neutral role"[3] during 19th Century. This signified that the consciousness of timbre as independent parameter was far from being an autonomous and structural element. Timber was rather an associative parameter: "[…] the function of timbre was primarily related to its identity in addition to being charged with certain effective and symbolic characteristics. The identities of Western instruments are standardized, investing them with a certain neutrality that allows the construction of pitch hierarchies that are unperturbed by differences in timbre of the instruments."[4]

In this sense, Berlioz´s *Grand Traité d´Instrumentation et d´Orchestration* implies a historical reference since the consciousness of the orchestra as discipline and, perhaps more important, the relation between its instruments, started to constitute a reflection on the ensemble as stabilised reality: "Hector Berlioz writes in his well-known Treatise on Instrumentation that the Orchestra should be consider by composers as a big instrument. Metaphorically speaking, the conductor as its performer and the composer as the architect of this Mega- or «Meta-instrument»."[5] The physical dimension of the orchestra during the 19th Century, that is, the considerable big amount of musicians playing at the same time, helped also to constitute that sense of unity or big metaphorical instrument.

There has to be more than one century later when a new optic on the constitution of the classical orchestra allows new and imaginative combinations and the abandon of the original Berlioz's idea of the instrumental groups as fixed elements. Emmanouil Vlitakis, who has dedicated a deep study to important orchestral pieces of the second half of the 20th Century, concludes by questioning this very fact: "Is the idea of instrumental groups still current or are the boundaries broken up, in which the Orchestra functions as an enormous «Hyperinstrument»?"[6] The aesthetical challenges that took place in Europe after 1945 opened a new space of technical compositional development and new possibilities concerning instrumental combinations within a classical symphonic orchestra. One crucial element that clearly contributed to the conquest of those new acoustic spaces is the so-called 'extended technique'. With the appearance of peripheral sounds, all grades of noise and even the absolute silence, music conquered the *sounding-total*.[7]

However, the first approaches in that sense did take place already before World War II, serving as a pool of ideas or rather as a potential to be exploded. A representative example that illustrates this idea is to be found in Bartok's *Music for percussion, strings and celesta* (1936). In the following excerpt, a unified glissando-gesture is composed of the harp, piano and second group of strings. The fast tempo and rapidity of the musical material contribute to cohesion the instruments taking part on in and reinforces the sonic illusion through its fugacious character.

Figure 1. Béla Bartók. *Music for strings, percussion and celesta, II Movement.* (Rehearsal mark 470). Boosey & Hawkes.

Another factor that reinforces his attempt to create a sonic illusion is confirmed in the following example, in which the contrabass plays the glissando gesture in absence of the piano and harp.

Figure 2. Béla Bartók. *Music for strings, percussion and celesta, II Movement.* (3 Bars after rehearsal mark 500). Boosey & Hawkes.

The title of the piece, *Music for strings, percussion and celesta*, is a clear reflection of how the Hungarian composer groups *a priori* different instruments in one same family. The ambivalence of the piano construction and its idiosyncrasy, on the one hand considered a string instrument since the material that produces the sound is precisely a series of strings of different lengths, and on the other hand, the fact that the mentioned strings are hit as it happens in percussion instruments, opens a space of discussion in which this instrument changes its role during the piece.

The same principle is evident in the score of *Klangschatten – mein Seitenspiel* (1972) by Helmut Lachenmann, in which the 48 strings and three grand pianos constitute the sound-corpus of the piece and function as a big resonance body. "The strings, instead of sounding, are 'muted' in a characteristic way."[8] In the description of his piece, Lachenmann mentions 'string' as global term to refer to both instrumental groups, a proof of his orchestral and compositional strategy while facing the relation between the 48 strings and the three grand pianos. As a matter of fact, the whole dramaturgy of the first section in *Klangschatten* is constituted by impulses organized in a homophonic –and also heterphonic– dimension, reinforcing the sensation of sonic and temporal unity and cohesion between the mentioned instruments.

In this sense, a similar strategy is to be found in his piece *temA* (1968) for flute, voice and violoncello, where the difference between the instrumental groups is even much more accentuated. Throw the 'thematization' of the breathing as main element, a whole dramaturgy takes place throughout the piece and distributes the so-called *Strukturklang* between the three instruments. The sonic result is a balanced fusion belonging to the same category of noise, at some points to the extent that none of the instruments are recognizable timbrically speaking or, at least, not without visual help.

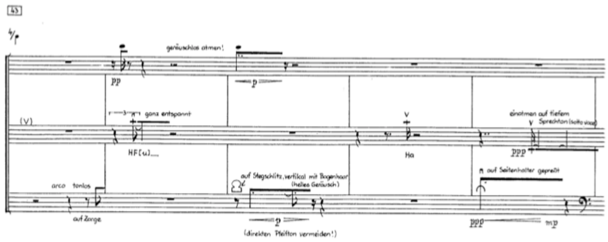

Figure 3. Helmut Lachenmann, *temA* (m. 43-47). Breitkopf & Härtel (Wiesbaden).

Israeli composer Chaya Czernowin, on the other hand, has worked likewise in some of her chamber music pieces. If the discussed scoring so far is composed of big ensembles and orchestra, now we are dealing with a much smaller group of instruments. This implies a new optic and challenge while analyzing her score(s) and discussing the role of the *meta-instrument* since the density of a big scoring reinforces naturally the sonic illusion created in our hearing.

In her piece *Die Kreuzung* (1995) for alto shô (or accordion), alto saxophone and double bass, the Israeli composer constructs a fabric in which the relations between the instruments call into a question and functions, metaphorically speaking and in words of the composer herself, as "a mystery which is both haunting and irresolvable". In order to evoke the same fragility and absurdity the piece is based on –after Frank Kafka's story with the same name–, Czernowin presents various levels of hearing in which the individual parts and the relationships between them open a space for our hearing to navigate across: "The three instruments are combined to become one composite instrument. For instance, the second part of the piece is constructed of 'etudes,' 'songs,' and 'dreams.' In each etude, the composite instrument works systematically on a specific technical difficulty."[9]

'Composite instrument' functions then as unity made up of the three different instruments and may be taken here as synonym for 'meta-instrument'. As a matter of fact, the Israeli composer mentions in her lecture at the 2018 edition of the Frühjarhstagung INMM in Darmstadt the term *meta-instrument* to refer to this very trio. On the other hand, another strategy takes also place and contradicts Czernowin's initial intention or, more precisely, completes it taking our hearing to the opposite pole of her instrumental technique: "[…] the new composite instrument ceases to exist, and where each member of the trio returns to independent play."[10] Therefore, we are looking at an ambivalent strategy that works as a pendular movement: sometimes the parts tend to melt in the *composite-* or *meta-instrument* while other times the individual plays a bigger role.

During a portrait concert[11] dedicated to Liza Lim, the Australian composer mentioned likewise the term *meta-instrument* to refer to her piece *The Heart's Ear* (1997), for flute/piccolo, clarinet and string quartet. A particular combination of the woodwinds with a very specific register on the strings, in which the hearing has difficulties to differentiate the individual parts, is described by Lim as "[…] a particular instrumentation, a *meta-instrument*"[12]. The poetic frame in which this technique takes place deals with Sufi poetry and, more specifically, with the work of Jeladuddin Rumi. The *meta-instrumental* strategy is framed in a kind of melodic approach, "a very brief fragment of a Sufi melody as way of evoking that gift-like quality of attention. To quote from another of Rumi's poems, the melody is 'like birdsong beginning inside an egg' […] I've thought of the piece as music that grows organically from this initial melody (the interior quality of a melody singing to itself) which 'pecks' its way out into a succession of musical spaces".[13]

Another important factor that contributes to reinforce the already mentioned sonic illusion in any of the previous cases is the dynamic balance. In several pieces framed in future investigations on the same matter, a demanding balance between different instruments is also crucial in order to create unified, homogeneous and compact sound objects in any of its variations. Examples of this fact could be found in György Ligeti's *Chamber Concerto for 13 Instrumentalists* (among other pieces by him), Luciano Berio's *O King* and, recently, in several works by José Mª Sánchez-Verdú.

The dynamic balance in order to reach a perfect assemblage of the different instrumental groups addresses Arnold Schönberg's instrumentation in *Farben*, where some musical processes taking place deal more with timbre and balance than with other sonic parameters. Nevertheless, this and other parameters are an opened topic for further investigations on the idea of *meta-instrument*.

In this sense, we can conclude that the *meta-instrument* as fusion of timbres is a compositional strategy that in the last decades has been used consciously by various composers with different results. The search for a sonic illusion, the dynamic balance and the structural relation between the individual instruments are the common elements that unify our concept and opens new questions while facing other scores from this point of view.

1.2. The *meta-instrument* as extended body

Since several decades the fast development of technology has allowed not only the constructions of instruments completely new (all kind of keyboards and synthesizers, electric guitars, devices such as the e-bow, etc., most of them defined by the use of loudspeakers as sound-producer), but also relevant modifications on the already existent. As consequence of that, new variations, extensions and hybrids between handwork and the highest technology have been constructed in order to explore novel sound possibilities.

The *Clex*, for instance, represents an extended conception of a classical contrabass clarinet. Clarinetist Emilio Molinari, together with Jochen Seggelke, Martin Suter and Daniel Debrunner, have developed a new model consisting of a dynamic-sensor contrabass clarinet which employees a motor in order not only to avoid key noise but also to get the perfect hole-disposition. Specific pieces written for this instrument, such as *Game* by Jorge Sánchez-Xiong or *Gravity's Rainbow* by Michael Pelzel, are a proof of the sound quality of this luxury –and not precisely cheap– hybrid between handwork and modern technology. In that sense, the idea of expanded instrument represents a good example of what a *meta-instrument*[14] means.

In line with the above, other classical instruments have been modified by means of technology in an attempt to perfection and explore new limits of the technical and expressive: "He built exquisite instruments for numerous artists, including […] Johnathan Impett's «Meta-Trumpet», a trumpet extended with ultra-sound position sensors, valve movement detectors, and additional switches".[15]

On the other hand, a different use of the term *meta-instrument* deals with the consequences of the digital revolution and the integration of the recently developed devices as instruments *per se*. Consequently, it ends by questioning, or at least amplifying, the concept of musical instrument itself. Since decades, the use of keyboards or other electronic devices have been normalize to the extent that many festivals, ensembles, commissions and premieres include hybrids of classical orchestral instruments and modern devices: "Today, this metaphorical instrument no longer merely consists of an orchestra, a piano, saxophone or tape recorder, but includes laptops, game-controllers, motion sensors, webcams, video-projectors, midi-keyboards, internet protocols, search algorithms […] This novel meta-instrument obeys a different kind of logic; it creates different fields of tension; it has different possibilities and different implications; it creates different material and asks new questions".[16]

The development and use of technology represents a fact that has clearly influenced compositional languages, as it did in other periods of musical History –the interest of Beethoven in expanding the piano register, for instance, or Edgard Varèse focus on percussion and other instruments.

In this sense, the first paradigm shift happened after World Ward II concerning timbrical composition is confronted nowadays with the current integration of technology in the classical scoring. We can observe this fact as a probable second paradigm shift that is making emerge new compositional languages and aesthetical (and also unaesthetical) expressions.

Resonance

Composer Mark Andre has introduced the concept of *meta-instrument* in two of his recent works, both for clarinet as main instrument: *…IN…* (2004) for bass clarinet and piano as resonator and *über* (2015) for clarinet, orchestra and live-electronics: In his work *…IN…*, the French composers speaks of his attempt to relate the material initiated by the bass clarinet: "Several strategies converge with respect to defining a «meta-instrument». First, the performer plays near a piano with the right pedal held down. Two microphones placed inside the piano amplify the resulting resonances. Fragmented 'traces' of the initial material create a polyphony based on an exhaustive (and obviously, resonant) fragmentation. Then, fragmenting and deconstructing the instrument's idiosyncrasies […], also produce other patent and perceptible polyphonic layers. Thirdly and lastly, the deconstruction of structure calculated by *Audioscript* and *Open Music* represent the third layer using 'structural traces'. All of the above contribute to defining a «meta-instrument» by rendering the initial material of «in-nomine» polyphonic, following synchronic phases of fragmentation and of massive deconstruction."[17]

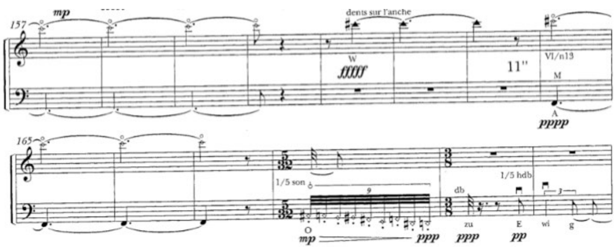

Figure 4. Mark Andre *…IN…* (m. 157-170). Éditions DURAND (Paris).

As for his piece *über*, a part of the orchestra functions also as enormous resonant body: "Throw the connection and combination of diverse sound sources with the different resonating instruments, Mark Andre builds a new *Meta-Instrument* of a superior order, in which the limits of the individual instruments and their corporality are vanished and apparently neutralized".[18] The clarinet's initial material functions here as a kind of mimesis, musically speaking, of the biblical wind quoted in Johann 3, 8, and associated symbolically to the Holy Spirit. In that sense, the *meta-instrument* adopts here a spiritual dimension that characterizes Mark Andre's compositional approach.

A similar case is the *Auraphon*, a resonant installation composed by a series of tam-tams and gongs whose body is excited by means of loudspeakers placed close to its surface. The *Auraphon*, conceived by composer José María Sánchez-Verdú and developed at the Experimental Studio of the SWR, has been used in several pieces – especially scenic ones– by the Spanish composer in order to create not only a sonic aura, but also a musical material capable of been melted with any other instrument or human voice. In fact, in his opera *Aura*, Sánchez-Verdú uses this installation to build, among other musical processes that also take place, a whole dramaturgy based on the tam-tam's and gong's resonance, as if it acted like a 'musical mirror': "The auraphone [sic.], with its five instruments, functions as a sort of 'meta-instrument' which soaks up all the other sources of sound. The 'auraphonist', who controls the relationships between the singers, instrumentalists and auraphone from the mixing console, advances to become the actual director of the musical events."[19]

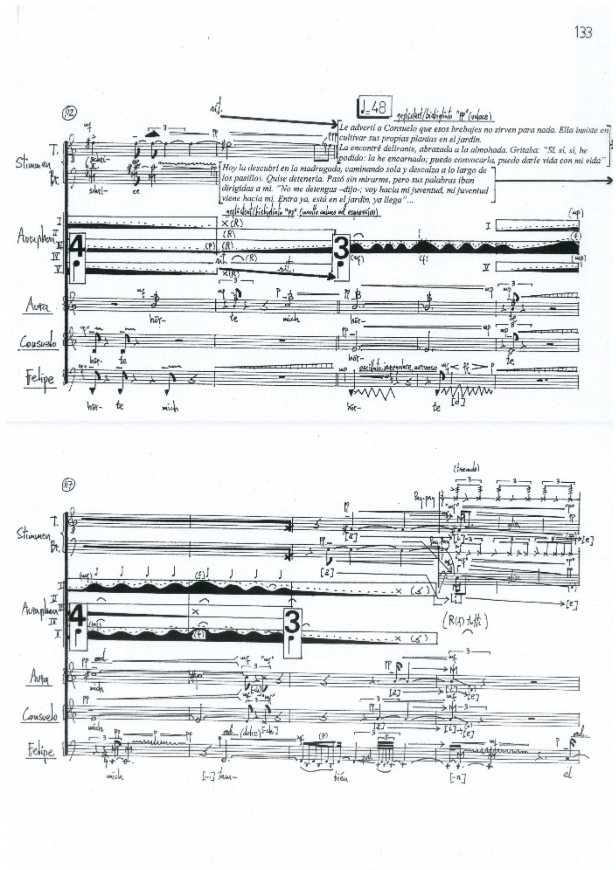

Figure 5. José Mª Sánchez-Verdú, *AURA* (m. 112-120). Breitkopf & Härtel (Wiesbaden).

Both composers serve as example of how particular installations and resonance constructions, as hybrid between orchestral instruments and the use of microphones and loudspeakers, have opened a world of possibilities concerning the conception of the classical scoring as resonating body.

In conclusion, the development of technology in the last decades has allowed new combinations between orchestral instruments and different devices in order to explore novel sounds and, with it, the development of compositional languages as in Stefan Pins', Mark Andre's and Sánchez-Verdú's cases.

2. Giacinto Scelsi and archaic landscape: *Okanagon*

After defining the general frame and some particular examples in which the concept *meta-instrument* appears, our idea focuses now on detail on a piece that serves as example of how this compositional technique functions. As discussed above, a *meta-instrumental* strategy can be now observed in diverse pieces of the chamber and orchestral repertoire of the last fifty years. In this sense, *Okanagon* is a score in which this technique shows structural consequences throughout the piece.

Okanagon (1968) for harp, double bass and tam-tam can be considered one of Scelsi´s representative works since the reduced and primitive nature of its material, among a temporal organization that deals with long periods of time, characterizes his compositional writing. As it also happens in other relevant pieces written in that period of time such as his *String Quartet n. 4* (1964), *Anahit* (1965) or *Konx-om-pax* (1969), Scelsi was focused on a search for a microscopic and qualitative sound, resulting from his experience improvising with the ondiola[20]: "Scelsi´s compositional method was quite unique: he would record his improvisations on a magnetic tape, subsequently entrusting the transcription to collaborators that would then work under his guidance. The score would then be completed with detailed instructions on its interpretation and measures in order to obtain the specific sound so meticulously researched by Scelsi".[21]

A first problematic appears while facing some of the works published by the Italian composer: the boundaries between composition and improvisation as different disciplines are not clear enough when his music is discussed; only a fine line separates them and statements referring to composition in a classical sense have to be discussed here in other terms: "The concepts Composition, Improvisation, Score, Piece, Artist demand extreme prudence by those who speak and write about Scelsi […] In the contextuality within his work they [the concepts] have to be questioned or challenged in order to extend the boundaries of a definition-space, or at least to let a time opened".[22]

Whether the score is result of a planed and detailed precomposition or simply the meticulous transcription of an improvisation, in the resulting piece only two materials of different characteristics are to be found:

Material A	Material B
Consisting of low impulses and different responses on harp, tam-tam and double bass. 	Percussion with fingers on the wooden body of the harp and double bass, mostly in a *hocket* form. 

Table 1. *Okanagon's* musical materials A and B.

Material A

The initial material consists of two basic sub elements, one consequence of the other: on the one hand a series of impulses on the lowest register of the three instruments, and on the other hand responses or resonances of diverse nature that, especially in the double bass part, act as decay. Both sub elements are not independent objects that sound one after the other, but rather they constitute a gesture in which they are interwoven. A bowed pitch would be played in the double bass part, for instance, after the harp had played that same pitch, so the resulting gesture is a joint of both initial sub elements that provides material A a clear continuity.

As for the impulses, a reduced number of pitches on the double bass and harp part, ignoring the octave changes, is as follows:

Eb – Ab – Db – G ¼ tone higher – C

Pitches Eb, Ab and Db function here as poles, while G ¼ tone higher plays the role of a 'disturbing' ornamental pitch and C is normally consequence of the low impulses. Besides, the three mentioned poles are separated by a perfect fourth, which addresses a basic tetrachord relation, also a factor that contributes to define the primitive approach of Scelsi´s music. Although this core of pitches constitute more than the 90% of the total amount of notes, peripheral pitches appear also rarely, especially in those moments where the inharmonicity reaches higher peaks:

C# ¼ tone higher – D ¼ tone higher – G (appearing only once)

In this sense, the general sensation while listening *Okanagon* tends to identify acoustically three main pitches as gravitational poles, indeed a very reduced number and a proof of Scelsi´s economy of means as discussed above. The relevant fact here is that the impulses on the double bass as well as on the harp are always played synchronically, even when there are inner rhythmical changes. This vertical conception reinforces the original idea of the *meta-instrument* as fusion of individual parts; however, something contradictory must be pointed out: the dynamic relations are at certain points in a clear unbalanced hierarchy since the harp takes predominance over the double bass with louder dynamics: *ff-f* and even *ff-mf* appear repeatedly throughout the first section. This predominance of one instrument can be understood due to the fact that a harp can play several strings simultaneously while a double bass is limited to only two. Besides, the lower range of the harp and the nature of its strings provide a louder resonance than the double bass. This can be the reason why Scelsi privileges the harp over the double bass in terms of balance, especially if we compare it to other sections that will be discussed later on in this same chapter.

On the other hand, another element can be considered to explain the dynamic differences between both instruments. The harp is unable to sustain its sound once produced, so in order to obtain a longer and louder response –that will be held by the double bass–, its dynamic would have been emphasized to achieve a more present resonance. The double bass, acting here as main response since it can hold notes by bowing, acts more as decay of the impulses produced mainly by the harp.

Figure 6. Giacinto Scelsi. *Okanagon* (m. 22-27). Editions Salabert (Paris).

Concerning the relation between the impulses on the tam-tam and the harp, also two ways of exciting the mentioned instruments, relate them not only from a sonic point of view, but also from a notational one: on the one hand the ordinary technique –normal sticks on the tam-tam and fingertips on the harp– and on the other hand a X notehead on the lower stave line indicating the use of a hard stick on the percussion instrument and fingernails or a metallic plectrum in order to pluck the harp’s strings.

Throughout the piece, the appearances of the hard stick tend to coincide with a high dynamic on the harp’s part – *forte*, *più forte*, *fortissimo* and partially *mezzo-forte*. Furthermore, the use of fingernails or plectrum on the later is normally reinforced with a noisy vibration on the percussion instrument, belonging to the sub element response; the resulting consequence is as follows: one of the two impulses of the harp is related to one of the two responses on the percussion, a *meta-instrumental* strategy that reveals how Scelsi approaches his composition relating timbrically the instruments before doing it through their morphological categories.

The responses of material A can be split in two different groups, both belonging to opposite extremes in a scale of harmonicity: on the one hand pure pitches or natural harmonics played in a traditional way, on the other hand a distorted sound resulting of an extended-technique: they consist on a metallic and inharmonic noise produced by the vibration of a tuning key shaking against the harp’s strings, and by the contact of a metal stick on the surface of the tam-tam –in the score, this technique is represented with a X notehead on the upper stave line. Both instruments, amplified through contact microphones, constitute a unity that makes our perception relate them rather than separate or split them into two different acoustical sources. A specific description of this resulting sound reinforces the idea of a balanced *meta-instrument* and is to be found in the performance notes of *Okanagon*: “The harp and the double-bass must be amplified with contact micro-phones […] balancing the sound with the respective potentiometres, but avoiding any stereophonic effect.”[23]

Despite this initial differentiation between the natural and artificial responses, a space between them will be acoustically filled throughout the evolution of material A, making the original opposite extremes more and more narrow. This strategy is possible thanks to a process that makes the initial natural resonance reach a much more inharmonic and harsher nature, as it will be discussed later. In order to achieve it, Scelsi builds bridges between the individual parts, that is, he relates not only the instruments in a vertical dimension, but also in a horizontal one. Therefore, the *meta-instrumental* strategy above mentioned proves once more that the relations between elements deal more with timbre than with morphological modes. A schematic representation of this idea can be observed in the following figure:

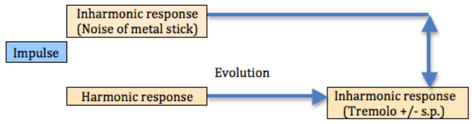

Figure 7. *Okanagon´*s evolution and relation between the different responses.

As for the second inharmonic responses reached after the evolution of the natural and harmonic ones, a particular element contributes to its transformation and development. The tremolo is the figure that initiates the mentioned process from m. 11 onwards, reaching gradual but irregularly a more relevant presence until the last bars of this first section –m. 65-83.

Notice how the first tremolo *sul ponticello stretissimo* on the double bass –m. 11– is vertically synchronized with the resonator of the harp, reinforcing the homogeneity and relation between both families of responses as shown in Figure 2. This *meta-instrumental* strategy is possible since the mentioned tremolo belongs also to the category of a low, inharmonic and noisy vibration, as it also happens in the harp and tam-tam part while playing with the resonators.

The different grades of this same gesture respond to a strategy that we can call *individualizing* and that spreads the initial idea of the material. In the case of the double bass part, at least three variations of the same gesture are to be found throughout *Okanagon*:

1. Tremolo on one single pitch.
2. Tremolo between two pitches, of which two subcategories can be differentiated:
   - 2.a. Ordinary distances (regular intervals such as minor or major second).
   - 2.b. Microintervalic distances (only quarter tones are indicated in the score).
3. Tremolo between double-strings and one pitch (generally dissonances such as micro-intervals and sevenths predominate).

As for the harp strategy, it is no coincidence that the same categories of tremolo are to be found:

1. Tremolo on one single pitch by the so-called *bisbigliando* technique.
2. Tremolo between two different pitches:
   - 2.a. Ordinary distances.
   - 2.b. Microintervalic distances (only quarter tones are produced by the initial scordatura).
3. Tremolo between several strings and one pitch (chords or clusters where minor seconds predominate).

This categorization of tremolos attending their pitches relations may us conclude the following: Scelsi´s strategy of the individual writing responds to a search for a sound-integration, homogeneity and compact musical result of the parts that crystallizes in different grades of a same material or sound-gesture. Notice how these relations take place throughout the piece and show not only the already mentioned grades of tremolos, but also a *meta-instrumental* strategy that relates them to the resulting noise of the resonators, including exact rhythms and even similar articulations such as accents:

Figure 8. Giacinto Scelsi. *Okanagon* (m.1, 71, 27 and 80), where different grades of tremolo are related whether between them or to the noise produced by the vibration of a metal stick in contact with the harp and tam-tam. Editions Salabert (Paris).

In addition, this joint resulting of a meticulous and detailed writing demands the performers an attentive listening while interpreting Giacinto Scelsi's compositional intention. It is important to point this fact out since the search for a coherent assembly of the individual parts shall reveal a new dimension that is required not only in this piece in particular, but also in Scelsi's music in general: "It is not enough when musicians are in contact only with each other, but the music itself is important, there the connexion must converge and that is where a paramount 'third'[thing] even arises, that only in this playing together can be created [...] One does listen. Not only to what the others play, but to the whole [music] and to what is required, and that does take place".[24]

This 'third thing', nomenclature which addresses the first lines of our research, refers to the idea of the sum of the individual parts as initial strategy in Giacinto Scelsi's work, that is, a musical conception that starts with a particular state of sound composed by interwoven elements, an imaginary landscape that places the hearing of the 'whole' in the centre of the acoustic experience. In *Okanagon*, the mentioned inharmonicity of the first material, the different lengths and dynamics that the impulses and resonance take form of, among the role that microintervals play, belong to a series of parameters that constitutes and defines the richness and complexity of this *meta-instrument*; in other words, its evolution throughout the piece is only possible thanks to the diversity of its parameters.

Therefore, the *meta-instrument* cannot be categorized here only by attending one element and is, as consequence, a proof of the ambiguity and richness Giacinto Scelsi's resulting music: "I think that concrete states of sound, that are very extensive or rather comprehensive, cannot be reduced to only one element, for instance the pitches… a sum of parameters, that cannot be defined, most likely represents and plays for the formal construction a kind of music and plays a bigger role than those classical parameters, in which music can be examined, analyzed. In this respect very precise tools have to be developed in order to make possible an Analysis".[25]

An irregular tendency of the initial material reaches its (first) climax after 27 bars: the maximal grade of dynamic (*ff*), inharmonicity –see cluster and dissonances in harp and contrabass parts, including microintervals on the low register that provides an extreme unclear and diffuse colour–, among the use of accents and tremolo in the contrabass part, constitute a clear peak within the first section in *Okanagon*. A second state of maximal distortion is also reached at m. 80, with similar characteristics but a higher range and a more complex response on the harp. A comparison between the initial state of material A and the both mentioned climax of the later can be observed in the following example:

Figure 9. Giacinto Scelsi. *Okanagon* (m.1, 27 and 80). Editions Salabert (Paris).

Notice also how the initial idea, constituted by an impulse-response gesture between the lower register of the harp and the *tenuto* bowed notes of the contrabass, remains intact despite of the mentioned differences above. It is a representative example of Scelsi´s material conception, characterized by a reduced and consequent strategy as it happens in other pieces of different scorings –see for instance his *String Quartet nr. 4* (1964) or his *Quattro Pezzi* (1959) in which a basic material suffers micro-transformations throughout the piece, normally reaching a much more distorted and complex nature after some minutes of slow evolution.

In a synthesized and simplified version, the tendency of the first material can be represented as follows:

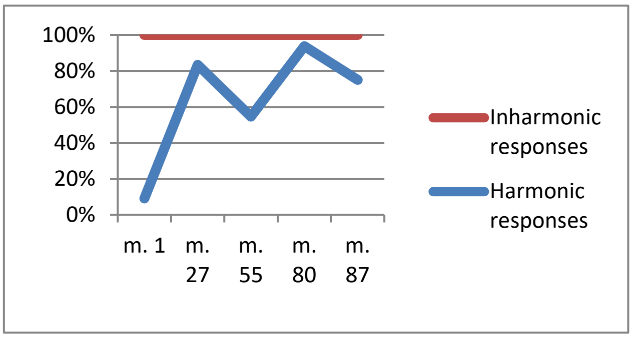

Figure 10. *Okanagon*´s evolution of Material A.

Material B

From a formal point of view, Scelsi splits both materials – and consequently the sections– not only by differentiating their nature, but also through a temporal pause that makes the piece 'breath' and changes abruptly its character: while the initial low impulses draw a stretched and slow architecture, now our perception is faced with a much more elemental and 'naked' nature, reinforced with a *Ritmico* indication.

A percussive action played with fingers on the body of the double bass and harp also shows a very particular technique, result of his experimentation and uncommon use of instruments: "[…] in order to obtain the specific sound so meticulously researched by Scelsi (dampers especially designed for the strings section, stringed instruments played like percussions, sound filters to distort the sound of the wind instruments, pre-existent recordings used to lead the performance)."[26] The first performance note referred to this second material asks the musicians to "balance as much as possible the sound result of both [contrabass and harp] instruments,"[27] once more a proof of Scelsi´s sound conception, in permanent search for a global balanced musical result. Besides, the "phrases" played by each instrument –referred here to a temporal organization of the inner structure of the material and not in a classical sense, that is, in terms of dynamic direction, distribution of the energy, reached accents and little culminations– take the form of the so-called *hocket*, providing material B an archaic continuity. Notice how the musical space between them is generally quite reduced, reached whether by a short superimposition or by avoiding long rests in-between:

Figure 11. Giacinto Scelsi. *Okanagon* (m.106-110). Editions Salabert (Paris).

Attending the evolution of its first state, and as it happened to material A, a non-linear tendency compresses and ‘soils’ the material by different means:

- **Tempo changes**: generally reached after transitions of tempo such as *affrettando*, they define a range between ♪=76 (♩=38) to ♩=120.

- **Inner rhythm**: the figure or figures that predominate suffer agogic changes, transforming the inner speed and sense of pulsation.

- **Time signature**: the different lengths of short “phrases” constitute a non-regular organization of the figures, making them unpredictable.

The three above mentioned elements contribute to draw a differentiated temporal dramaturgy in which diverse grades of pulsation produce in our perception an unpredictable but logical mechanic landscape. A representation of Scelsi´s strategy including all changes within the second material in *Okanagon* –m.90 to 159– can be observed in the following table:

Tempo	Inner rhythm	Predominating Time signature
♩=100	♫ ♬	3/4
affrettando	♬ (3)	Irregular changes
♩=120	(3)	2/4
♩=100	♬	2/4 5/8
affrett.	♬ (3)	2/4 3/4
♩=120	♫ (3)	2/4
♪=76	♫ ♬	5/8
affrett.	♬ (3)	3/4
♩=108	♫ (3)	3/4

Table 2. Representation of the tempi, rhythmical and time signature changes of material B in Giacinto Scelsi’s *Okanagon*.

In addition to the mentioned temporal strategies, also three elements contribute to revitalize material B. From a timbrical point of view, Scelsi differentiates between two types of percussive actions on the instruments double bass and harp: those that are produced by the fingertips –represented with a X notehead– and the ones resulting from the knuckles –notated as diamond shape notehead. Secondly, another factor plays a role in the construction of a diversified material, that is, the two different ranges in which Scelsi splits material B, resulting a higher and lower ‘pitch’ –a brighter and darker colour would be a more appropriate nomenclature here since the exact pitch resulting from the percussive actions is not specified neither in the score nor in the performance notes. Thirdly and finally, a specific dynamic factor helps to draw peaks in the architecture of material B: the accents irregularly distributed throughout this section contribute to maintain a permanent sensation of non-predictable temporal organization of the phrases.

Six of mentioned elements, fingertips, knuckles, high, low, accent and no-accent, constitute a matrix in which the Italian composer finds the revitalization of his original material and navigates while springing from one to another. Besides, the following matrix could be applied to each instrument, multiplying the actual result times 2. Although the resulting arithmetical possibilities are here exposed, it has to be warned that this preconceived material was way far from his compositional method and most likely consequence of his improvisations, as discussed at the beginning of this chapter.

	Fingertips	**Knuckles**
High	Very dominant	Less common
Low	Very present	Less common
	Fingertips	**Knuckles**
Accent	Common	Less common
No accent	Less common	Common
	High	**Low**
Accent	Common	Common
No accent	Very present	Very dominant

Table 3. Page Representation of the categories that define material B as well as its possible combinations.

A+B

At the beginning of the penultimate section -m. 171 to 189- Scelsi uses a very particular strategy, consisting on superposing material A on material B, the later privileged dynamically. The resulting architecture transforms both materials since their nature is now confronted and opens a new dialectics that has not been heard until this point.
The original continuity of material B is now transformed into a new articulated structure, consisting on a fragmentation of itself that interacts with the impulses of materi-

al A. In other words, the percussive *hocket* on the double bass and harp appears now as response to material A, creating a new interwoven texture, a musical entity that connects the materials initially separated.

Figure 12. Giacinto Scelsi. *Okanagon* (m.179-181). Editions Salabert (Paris).

It is remarkable that the low impulses appear under a *p-pp* dynamic range, which makes material B predominate in the foreground; only from m. 186 onwards, where a sudden *forte* barges, breaks this hierarchy and announces the coming last section in which only material A is briefly repeated.

Figure 13. Giacinto Scelsi. *Okanagon* (m.185-187). Editions Salabert (Paris).

The initial pulse sensation of material A, characterized by an accent-decay gesture, is now implanted on material B, transforming its rhythmical structure. The longer rests, inexistent in its original state, provide material B now a much more organic character, a 'breathing' sensation as it happened to material A. The result in our perception is a kind of 'contamination' or implantation from A to B, originally isolated and split from an architectonical point of view.
The resulting general architecture of *Okanagon*, after having analyzed and confronted its materials, is represented in the following table:

Section	A	B	Transition1 (=A)	B'	A'	Transition2 (B+A superposed)	A''
Measure	1-88	89-143	144-146	147-157	158-170	171-189	190-200
Duration[28]	4'30''	1'15''	5''	25''	35''	1'30''	1'

Table 4. Okanagon's sections and durantions in bars and seconds.

Despite of our categorization in minutes and seconds of each section, another point of view must be taken in consideration if we want to discuss the effect that Scelsi´s music produces in our perception. His compositions do not deal with a classical organization of time, but with a much more archaic approach that puts a primitive dimension of mankind in the centre of the musical experience. This has to do with the already mentioned long periods of time that result from his material organization: "We are used to concentrating our analyses on periods of time that may be measured in seconds; as soon as one tries to apply this way of thinking to any of Scelsi´s scores, the result is indeed rather poor."[29]

However, a non-quantitative measure of time would escape of our analysis and has to be expressed in other terms, referring more to images or poetry if one wishes to understand the deep and true intention of Giacinto Scelsi´s music. In more than one occasion, the Italian composer speaks even of "ritual" when referring to his music: "*Okanagon* should be considered as Rite and, if one wishes, as the heartbeat of the Earth."[30] In the performance notes of this piece, for instance, the scenic and visual dimension play also a role in his attempt to reach a mystic state while hearing it: "If possible also hide the microphones, instruments and players behind a large screen, adding in this way to the mystery of the ritualistic character of this music."[31]

These concepts of Rite and Mystery, here crystallized in the metaphoric image of the "heartbeat of the Earth", are clearly influenced by his interest for "Oriental mysticism and esotericism […] Oriental philosophies, Zen doctrines, Yoga and the subconscious mind"[32]. The conception of composition as ritual was a controversy in the post World War Europe after the big influence that Serialism and Structuralim had. With the course of the years new horizons appeared and the strict reaction against certain disciplines started to reduce their rigidity, allowing little by little other non-European influences to be accepted. However, Scelsi´s compositional language differs from other approaches that integrated this ritualistic character and orientalism such as Karlheinz Stockhausen.

Nevertheless, it is clear that a very personal search and method led the Italian composer develop his particular sound far from any academic standard, rule or aesthetic trend. This authenticity remains in his whole oeuvre, being *Okanagon* an exemplar piece that reveals a crucial fact in Scelsi´s music, that is, the relation of human being with the cosmos and universe, only possible after a qualitative search for the smallest detail, exactly as it happens in his music.

> Explorer les voies qui
> communiquent avec l´univers
> entier.
> Organiser l´attention
> sur un minimum d´espace.
> Cela dépend du soufflé.

Giacinto Scelsi (from *Poèmes incombustibles*)

In an attempt to define what the *meta-instrument* produces in our perception while listening *Okanagon*, we address psychoacoustics to frame all our analysis in one synthesized idea. The already mentioned long period temporal construction deals with a very particular role of our memory: the slowest known form of brain waves, called "theta waves", represent extreme proportions and time unities that take place throughout the piece.

In addition, the fact that the Italian composer considered himself a poet –*sono poeta* was his statement– and "not an Artist"[33], among his multifaceted skills crystallized in different artistic forms, contributes to reject any classical perspective when the reception of his music is discussed. A much more intuitive approach to the artistic fact defines with more precision his true intention while creating a piece of music: "His message obviously stems from a point where visual and acoustic notions are not yet separated, where the poetic world represents the dream-like expression of visions".[34] In this sense, it seems clear that the above analyzed elements, especially those that have to do with the reduced character of the material, define the primitive language of the Italian composer and how free of constraints it was.

Some conclusions concerning the *meta-instrument* in *Okanagon*:

1. The dynamic balance demanded through the performance indications, especially those referred to the noisy responses of material A as well as material B in general, confirms the search for a homogeneous and compact sound.
2. The coincidence of different categories –tremolos, harmonic and inharmonic responses, impulses and responses– points out that Scelsi would have worked meticulously on the timbrical relation between the instruments before privileging other categories (such as the morphological).
3. The initial sound-states are transformed through different processes, most of them having to do with temporal changes or accumulation of dissonance-inharmonicity, as it happens in other representative works of him.
4. A vertical conception of the material A reinforces the idea of the *meta-instrument*.
5. The superimposition of material B on A reveals a polyphony of *meta-instruments*, spreading its initial vertical-homophonic character.
6. The temporal strategy dealing with extreme long periods of time defines the effect of the *meta-instrument* in our perception, that is, a state of primitive, archaic and even mystic state of our senses. This fact, among the influence of Orientalism and other arts, is crucial to identify the *meta-instrument´s* differentiation in Giacinto Scelsi´s music while confronted with others.

Lastly, and in line with the above, a final question intends to reflect on the relation between Giacinto Scelsi´s archaic landscape and the challenges of our current society: "Maybe it is in Scelsi´s work, in the midst of our entirely secularized society, in the midst of traditional styles that almost exclusively stress the affective impact on the one hand and a professional avant-garde strongly determined by the intellect on the other hand, that we find the vague outlines of a musical concept that once ruled the ancient musical cultures […] This would explain the explicitly archaic effect of Scelsi´s music".[35] Certainly, the relevance of his music is a topic perhaps more current than never.

Conclusion

After reviewing the different definitions that the concept *meta-instrument* has adopted as well as the analysis of *Okanagon* from this particular perspective, we can conclude that this compositional technique has been a strategy used by various composers in order to express their musical language. Observing the grade in which the *meta-instrument* acts, at least three levels are revealed:

1. *Micro meta-instrument* (brief and sporadic fragments): Sciarrino, Lazkano, Lim, etc.
2. *Meta-instrument* as *momentum* (structures or sections): Ligeti, Lachenmann, Czernowin, etc.
3. Meta-instrument as compositional language (full works): Scelsi, Grisey, Andre, Sánchez-Verdú, Cendo, etc.

In an attempt to pose new questions and stimulate novel investigations, we leave the topic *third space* opened since the recent literature hasn't played a role yet in this sense. Likewise, some young composers have recently shown coincidences on this topic, confirming the current state of this particular strategy.

Lastly, and in an attempt to reflect on the possible symbolical meaning that the *meta-instrument* may have, we want to underscore the importance of a common hearing, a dynamic balance result of the radical necessity of 'the other'. This human dimension wants to face the challenges of a globalized world in which the concurrency and the individual development seem to need, maybe more than never, any kind of reaction.

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whose support my motivation would not exist: my father, Samuel Solís and Asís Márquez.

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[1] Various artists have used the ordinal number "third" in different expressions in order to point this same fact. In his lecture on April the 10th 2015 at the 69th Frühjahrstagung INMM Darmstadt, film director Edgar Reitz speaks of a "third thing" [*ein drittes Ding*] as concept to define precisely a unity which is reached when picture and music are combined together and that implies something different from the simple superposition of image and sound. Composer Manos Tsangaris, on June the 8th 2018 at the Münchener Biennale, mentions "third space" in a metaphorical way to refer to composition as synonym for the process of cooking, that is, of resulting a new element when different ingredients are combined and cooked together –the expression "third space" addresses here Stefan Prins' transdisciplinary work "Third space", premiered at the same Münchener Biennale.

[2] *Virtual instrument* is here referred not to sound-libraries, synthesizers or digital keyboards, but to the illusory result produced by the relation of instruments belonging to different orchestral groups. Sonic illusions will be discussed later on in this same chapter. For a further and detailed explanation see The Reality of the Virtual, a 2004 documentary film lecture by Slovenian philosopher Slavoj Žižek in which he speaks of "real effects produced, generated, by something which does not yet fully exist, which is not yet fully actual". An extended discussion on the lacanian concepts of the real, the imaginary and the symbolic would imply here an excessive and unnecessary explanation.

[3] Boulez, Pierre (1987): *Timbre and composition – timbre and language*. Contemporary Music Review, United Kingdom.

[4] *Ibid*.

[5] "Hector Berlioz schriebt in seiner berühmten Instrumentationslehre, dass ein Orchester vom Komponisten wie ein großes Instrument ansuzehen sei. Bleibt man im Bild, ist der Dirigent sein Spieler und der Komponist zu gewissem Grad auch der Erbauer dieses Mega- oder Meta-Instruments." Kreidler, Johannes (2005): *Instrument design*. Essay written after the lecture lagerhaus lectures, 14. 07. 2005, Freiburg. http://www.kreidler-net.de/theorie/instrument-design.htm. Accessed 17-Sept-2018.

[6] "Bleibt überhaupt das Denken in Instrumentengruppen erhalten oder sind die Grenzen aufgelöst, wobei das Orchester als riesiges "Hyperinstrument" fungiert?" Vlitakis, Emmanouil (2008): *Funktion und Farbe. Klang und Instrumentation in ausgewählten Kompositionen der zweiten Hälfte des 20. Jahrhunderts: Lachenmann – Boulez – Ligeti – Grisey*. Sinfonia 11. wolke, Berlin.

[7] "[…] el total sonoro." This term refers to the whole sound spectrum or range, from the already mentioned absolute sound to the pure noise. The concept has been introduced by Spanish composer Tomás Marco in several lectures and articles. See Marco, Tomás (2017). *Escuchar la música de los siglos XX y XXI*. Fundación BBVA, Bilbao.

[8] „[...] die Seiten, statt zu klingen, werden auf charakteristische Weise am Klingen gehindert. Natürlich konnte es nicht darum gehen, mit den so freigelegten Klangresten strukturell zu verfahren, als ob nichts geschehen wäre". Lachenmann, Helmut (1996): Musik als existentielle Erfahrung. Breitkopf & Härtel. Wiesbaden.

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[10] *Ibid.*

[11] 27th October 2016 at Hochschule für Musik Carl Maria von Weber Dresden.

[12] *Ibid.*

[13] Lim, Liza. (1997). Comment on their work *The Heart's Ear* https://limprogrammenotes.wordpress.com/2011/07/30/the-hearts-ear-1997/ Accessed 25th September 2018.

[14] Arroyo, Alberto. (2018). Generieren von Wissen in *MusikTexte 158:* 86, Köln, Verlag MusikTexte.

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[18] "Durch die Verbindung und Kombination verschiedener Klangquellen mit den unterschiedlichen Resonanzinstrumenten schafft Mark Andre ein neues übergeordnetes Meta-Instrument, in dem die Grenzen der einzelnen Instrumente und deren Körperlichkeit verschwimmen und scheinbar aufgehoben werden." Wilkening, Martin. (2017). *An der Schwelle des Hörbaren*. Program notes to the concert that took place on 11th September 2017 (20:00) in the frame of the Musikfest Berlin.

[19] Pöllmann, Reiner. (2010). *José M. Sánchez-Verdú's opera* AURA. Booklet of the CD with the same name. Co-Edition KAIROS Music Production & Fundacion Caja Madrid.

[20] The ondiola is an electronic instrument capable of produce microintervals. Sometimes named also *Clavioline* due to the commercial name it adopted on the Italian market, it is generally composed by a keyboard and an amplifier. A detailed description of the instrument has been shown in a documentary made by SCHISKE belonging to the Project *Giacinto Scelsi REVISITED* by Klangforum Wien in 2013.

[21] http://www.scelsi.it/en/biography/

[22] "Die Begriffe "Komposition", "Improvisation", "Partitur", "Werk", "KünstlerIn" verlangen von jenen, die über Scelsi sprechen und schreiben, äußerste Vorsicht in ihrer Verwendung. In der Kontextualität mit seinem Werk müssen sie sogar neu hinterfragt werden bzw. fordern dazu heraus, die Grenzen des Definitionsraums zu erweitern oder für eine bestimmte Zeit überhaupt offen zu lassen". Elfriede Reissig, *Dialoghi. Annährungen an Giacinto Scelsi*. Wolke, Hofheim 2015, p. 12.

[23] Giacinto Scelsi. Performance notes of *Okanagon*. Editions Salabert.

[24] "Es ist zu wenig, wenn MusikerInnen nur mit einander in Kontakt sind, sondern die Musik an sich ist wichtig, da muss die Verbindung zusammenlaufen und da entsteht dann sogar etwas Übergeordnetes "Drittes", das nur in diesem Zusammenspiel entstehen kann" [...] Man hört zu. Nicht nur darauf, was die anderen spielen, man hört af das Gesamte und auf das, was es braucht, und das gibt man". Elisabeth Harnik, *Dialoghi. Annährungen an Giacinto Scelsi*. Wolke, Hofheim 2015, p. 43.

[25] "Ich denke, bestimmte Klangzustände, die sehr umfassend bzw. parameterübergreifend sind, also nicht nur auf ein Element, zum Beispiel die Tonhöhe, reduziert werden können, die also eine Summe der Parameter, die man nicht genauer definieren kann, darstellen, spielen wahrscheinlich für die formale Gestaltung gerade bei so einer Art von Musik eine viel größere Rolle als diese klassischen Parameter, nach denen man Musik untersuchen kann. Insofern müsste man ganz eigene Werkzeuge entwickeln, nach denen man an eine Analyse herangehen könnte." Klaus Lang, *Dialoghi. Annährungen an Giacinto Scelsi*. Wolke, Hofheim 2015, p. 50.

[26] http://www.scelsi.it/en/biography/

[27] "N.B.: Equilibrare quanto possible la sonoritá dei due strumenti." (Scelsi, performance indication on *Okanagon*, m. 89)

[28] The duration here represented has been taken from the performance of the same piece released in the CD by KAIROS: *Giacinto Scelsi*. *Yamaon, Anahit, I Presagi, Tre pezzi, Okanagon*, Klangforum Wien – Hans Zender (1999).

[29] Hans Zender (1999): *Speculations about Scelsi*. KAIROS booklet from CD *Giacinto Scelsi. Yamaon, Anahit, I presagi, Tre pezzi, Okanagon*.

[30] Éditions Salabert (1999): *Giacinto Scelsi. Catalogue of the Works.*

[31] Giacinto Scelsi. Performance notes of *Okanagon*, Editions Salabert.

[32] http://www.scelsi.it/en/biography/

[33] Giacinto Scelsi, quotated by Elfriede Reissing. *Dialoghi. Annährungen an Giacinto Scelsi*. Wolke, Hofheim 2015, p. 12.

[34] Hans Zender (1999): *Speculations about Scelsi*. KAIROS booklet from CD *Giacinto Scelsi. Yamaon, Anahit, I presagi, Tre pezzi, Okanagon*.

[35] *Ibid.*

[Abstract in Korean | 국문 요약]
작곡 테크닉으로서의 메타 악기: 현행 음악 창작을 위한 전략

알베르토 아로요

2차 세계대전 이후 미학 패러다임의 이동은 새로운 표현의 가능성과 악기의 음색 활용에 기반한 작곡 기술의 발전을 이끌어내며 기존의 관계와 체계들을 전례없는 것들로 변화시켰다. 또한, 최근 수 년 간 선보인 테크놀로지의 역할이 완전히 새로운 어떤 것을 창조하도록 부추기며 음악을 작곡하거나 친숙한 고전 악기의 음색 변화의 가능성을 높이는 데 많은 창작자들에게 명백한 영향을 끼쳤다. 이러한 상황으로부터 출현하게 된 동일한 음악적 실제를 정의하는 새로운 용어, 메타 악기*meta-instrument*는 소리 각 부분의 총합을 초월하여 움직이며 청각적 환상을 만들어내는 자율적 소리 실체의 통합적 음색에 대한 테크닉이다. 지아친토 셸시Giacinto Scelsi, 헬무트 라헨만Helmut Lachenmann, 차야 체르노빈Chaya Czernowin, 마크 안드레Mark Andre, 호세 마리아 산체스-베르두José María Sánchez-Verdú, 라파엘 상도Raphaël Cendo 같은 작곡가들은 서로 다른 의도로 다양한 결과를 양산하며 그들의 시선을 이 테크닉으로 돌려 각각의 음악적 견해를 확고히 하였다. 더욱이, 이미 몇몇 미학분야와 현재 트렌드에서 그 영향력을 선명히 드러낸 디지털 혁명이 작곡의 전통적 개념 뿐 아니라 음악 자체에 대한 생각을 재정의하거나 최소한 확장시키지 않으면 안 될 논란의 공간을 열어 놓았다. 청취하는 행위는 인간 존재의 의미와 관련한 근본적인 의문사항이니 어찌되었든 이 논의의 중심에 있다.

A Study on the Changes of the Acoustic Sounds in Donoung Lee's *Butterfly Effect*(2015)

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This paper talks about the variety of sound changes in a live electro-acoustic music piece *Butterfly Effect*(2015) premiered in Lyon, France, on November 19th, 2015. This study carries out comprehensive analyses on the changes of sounds of the piece by examining the variables of its components. The path that various objects are connected to, and the types of parameters that control such objects in Max patches, which implement the electro-acoustic effects, are all analysed. Additionally, the change of the musical phenomenon by controlling the MIDI controller in real time is explored. The analytical results provide understandings of the role and meaning of the sound changes in this piece, and proves that the original meaning of the title "Butterfly effect" is reflected by the musical expression and developmental processes of the components in this work.

Prerequisites for the performance of the piece

Arrangement of musical instruments and equipment

This piece is performed by a single percussionist with a snare drum, a bass drum, and a marimba. Audio equipment includes a computer, an audio interface, a mixing console, a MIDI controller, 8 dynamic microphones, and 4 active speakers. Percussion, microphones, and speakers are arranged on the stage and in the auditorium as follows.

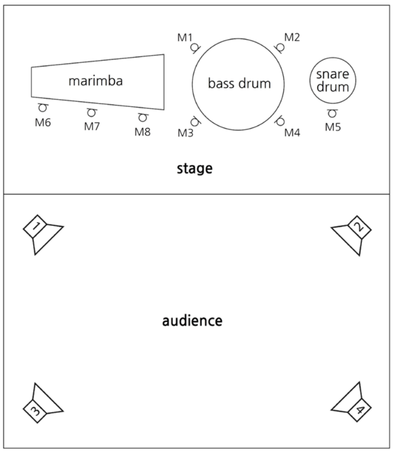


Figure 1. The arrangement of instruments

The following is a representation of the connection of the sound equipment and signal flow.

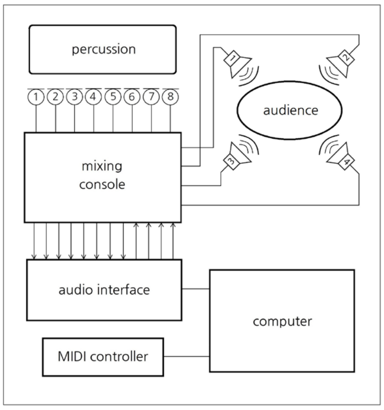


Figure 2. Signal flow

Running Max Patch

The Max patch of this piece is divided into 4 main files. The first patch, "ButterflyEffect_0_Lcontrol.maxpat," runs the program for each section of the percussion part. And it has a function to control the sound volume and parameters using the MIDI controller. The second patch, "ButterflyEffect_1_Main.maxpat," has the entire digital signal process and combinations of various effects, like sampling, looping, harmonizer, and reverberation. The third patch, "ButterflyEffect_2_Voco.maxpat," consists of two types of the vocoder effect, and the fourth patch, "ButterflyEffect_3_Spat.maxpat," consists of four types of the spatialization effect for the formation of surround sound.

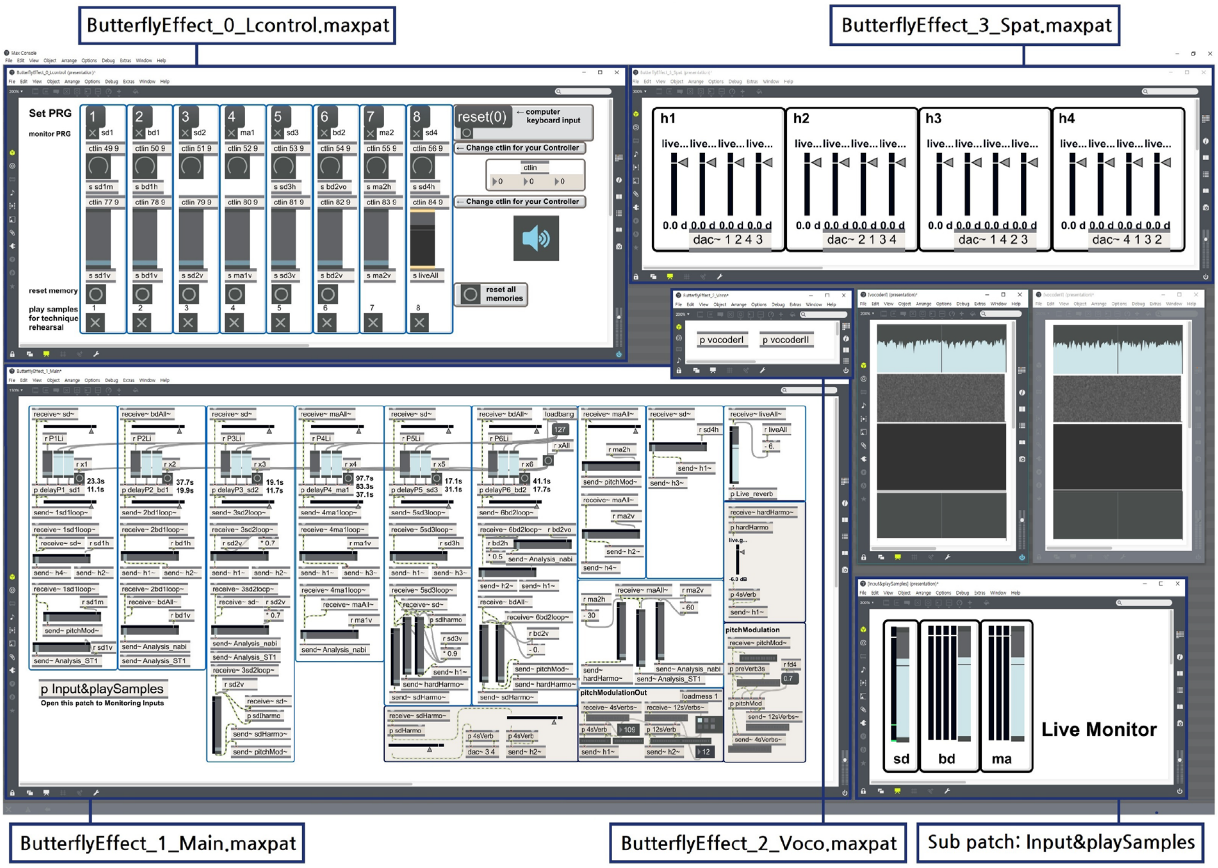


Figure 3. 4 The interface running on Max 7.3.5

Structure of the piece

Transformation and repetition from the structural point of view

The percussion part of the piece consists of 8 individual sections. The live sound of percussion is modulated into the electronic sound. To be specific, the acoustic percussion sound can be transformed into another pitch or the new tone. The modulated sound may appear in real time or after a delay. The electronic sound is programmed to repeat continuously until the end of the piece. The structural view of the repetition of the modulated sound can be understood in three aspects as follows.

① Formal consistency and uniformity

Repeating acoustic phrases plays an important role in establishing the uniformity. The electronic sound that was made in the beginning of the work consistently occurs in the whole of the piece. It provides a sense of stability.

② Increase of complexity

In this piece, the variety of electronic sounds is gradually increased. This work can reach a maximum degree of tension and complexity in section 7 since all the acoustic masses appear at once.

③ Relationship within context

It is difficult to precisely predict the exact start and end points of the repeated acoustic phrases since they are influenced by the variable of time which is the nature of a live performance. However, it can be found that when the timing of each sound is artificially controlled by increasing the volume via the MIDI controller, a special relationship of several acoustic layers is formed. Furthermore, the definition of musical context can completely differ depending on composition of several kinds of different sounds.

Figure 4 shows the starting and disappearing times of sounds. This figure shows how the concept of transformation and repetition is applied in this music piece.

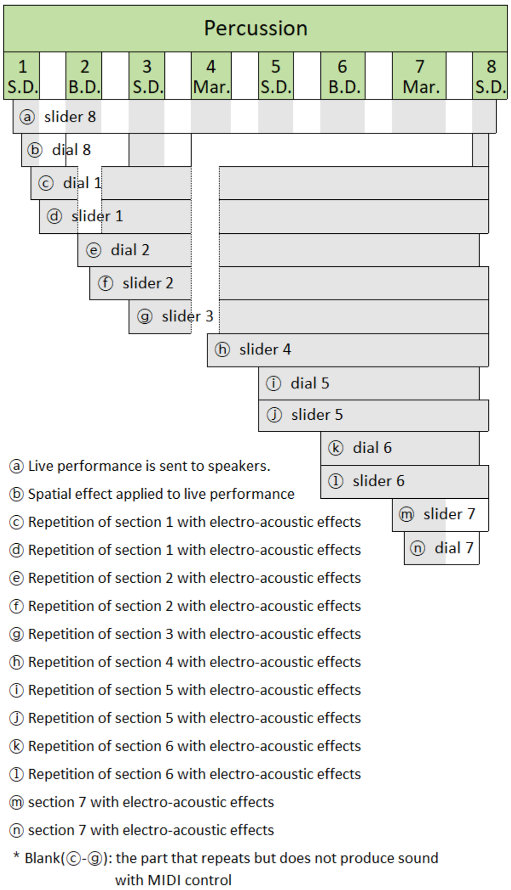


Figure 4. Configuration of the electro-acoustic layers

① Development process of dynamics

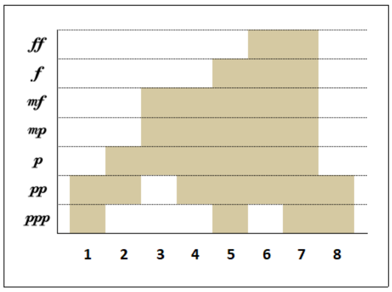


Figure 5. Range of dynamic of the 8 sections

② Development process of bpm and performance time

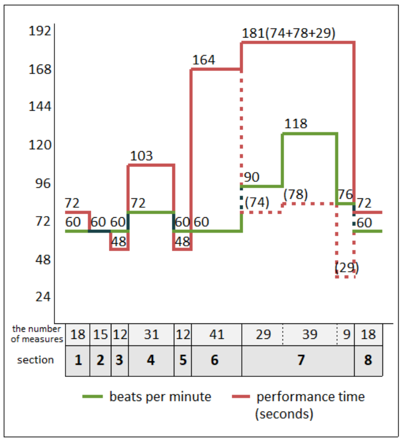


Figure 6. Development process of bpm and duration of the 8 sections

Structural features of the component development process

The structural features of the piece can be found in the process of development of various musical elements in the 8 sections. In the beginning, the elements have limited size, degree, number, and range. These components gradually expand and develop into the climax of section 7, and shrink and disappear in the last section.

③ Development process of electro-acoustic effects

There are different types of electro-acoustic effects applied to each section of the piece. The composer generates several sound effects by applying various parameters even when using the same modulation technique, and distinguishes by assigning a unique title to each path and patches of each sound effect.

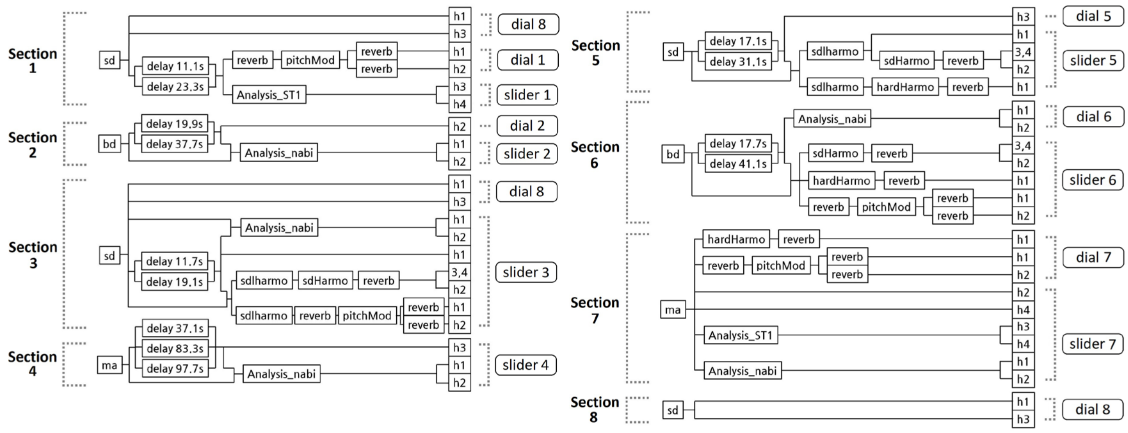


Figure 7. Development process of electro-acoustic effects applied to the 8 sections

④ Control process of MIDI controller

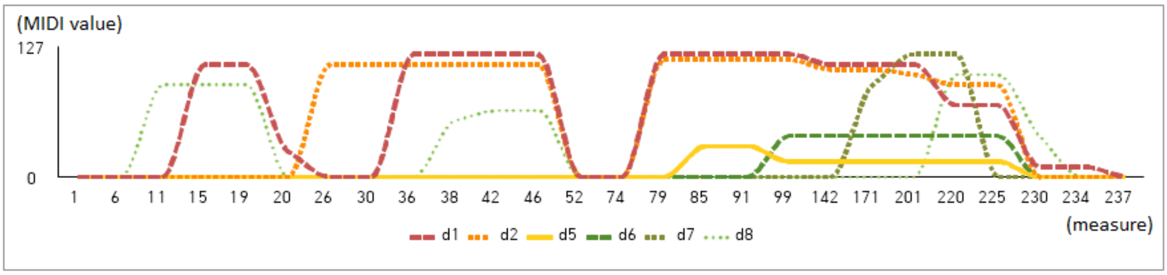


Figure 8. Control process of the MIDI controller in the entire work: 6 dials

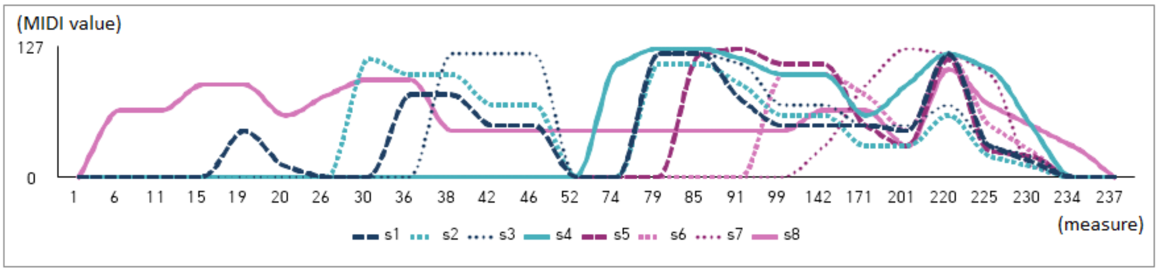


Figure 9. Control process of the MIDI controller in the entire work: 8 sliders

Specific aspects of sound changes in the piece

Sound changes according to the electro-acoustic effect realized by Max

① Sampling and looping

In this piece, the repetition of electro-acoustic is based on sampling and looping techniques. In the Max patch of the work, tapin~ and tapout~ objects are used to delay the reproduction of sound. The following is a patch with a delay of 23333 milliseconds (about 23.3 seconds) in section 1.

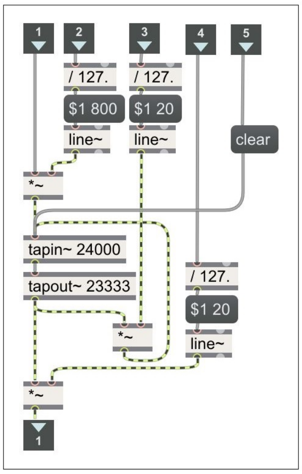


Figure 10. Patch for the delay effect "FBdelay"

The paths of the patch can be summarized in three ways. First, the sound of the percussion converted into a digital audio signal is connected to the outlet through the sampling process. Second, a signal that has passed through tapout~ is circulated back to tapin~. This makes it possible to reproduce the sound repeatedly. Lastly, the message box "clear" connected to inlet 5 functions to stop all execution of the following process by removing the input to tapin~.

② Spatialization

In this piece, the spatialization effect makes the sound panned throughout the four speakers located in the corners of the auditorium. It has function to form a new acoustic structure in space.

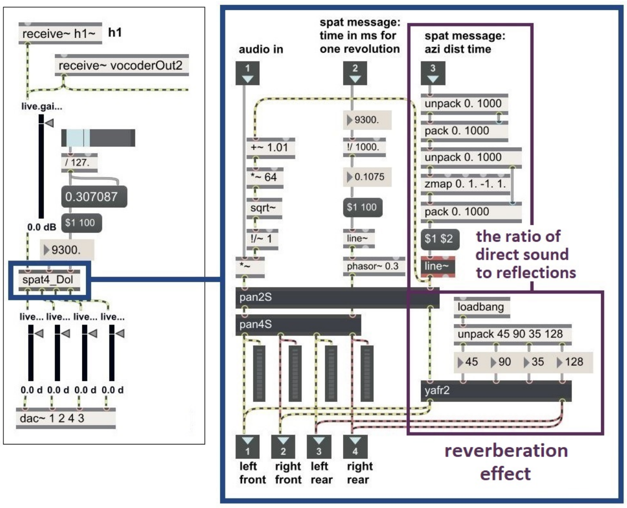


Figure 11. Patch for the spatialization effect "spat4_Dol"

In the patch, it can be observed that the audio signals connected to dac~ are output to the speakers in the order set in dac~. The four types of spatialization effect of the piece are as follows.

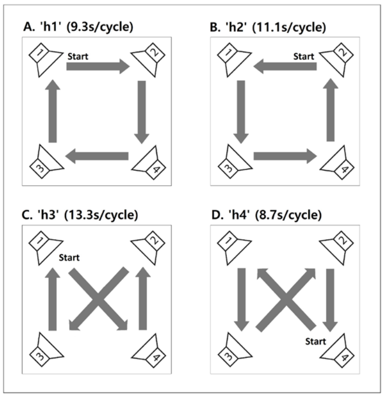


Figure 12. Path of sound movement by the spatialization effect

The following example shows the sound of the bass drum played in section 2 rotating counter-clockwise after 19.9 and 37.7 seconds, revealing the output to 4 speakers, by applying a combination of the delay effect and the spatialization effect.

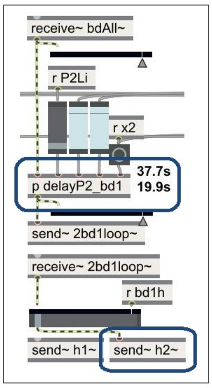
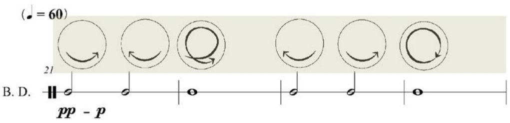
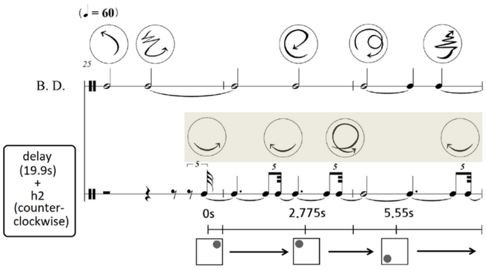


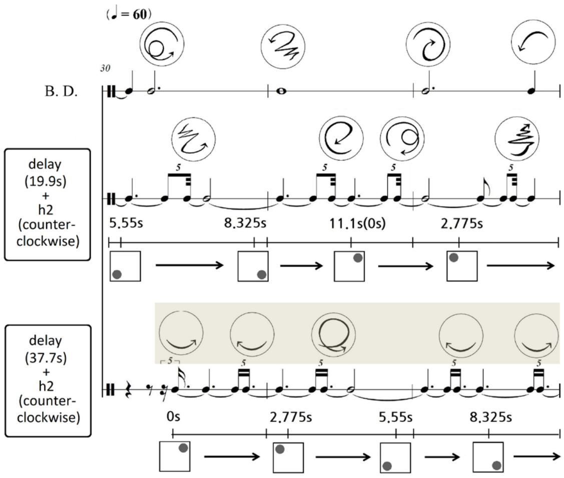
Figure 13. Combination of two effects applied in section 2



Score 1. Sampling initiation point in section 2



Score 2. Combination of two effects applied in section 2: 19.9s



Score 3. Combination of two effects applied in section 2: 37.7s

③ Harmonizer

The harmonizer effect builds a large chord by applying the number and type of input data in various ways during the process of changing the pitch of a specific sound. In the patches of this piece, a floating point number box is used to handle numbers below the decimal point, which makes it possible to achieve a microtone.

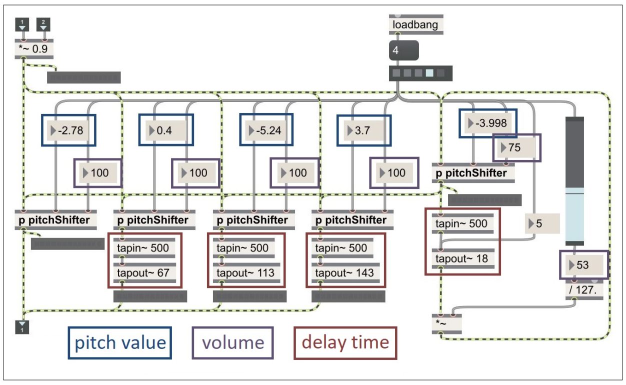


Figure 14. Patch for the harmonizer effect "sd1harmo"

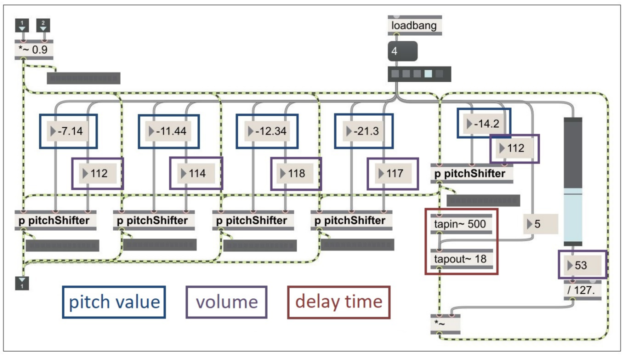


Figure 15. Patch for the harmonizer effect "sdHarmo"

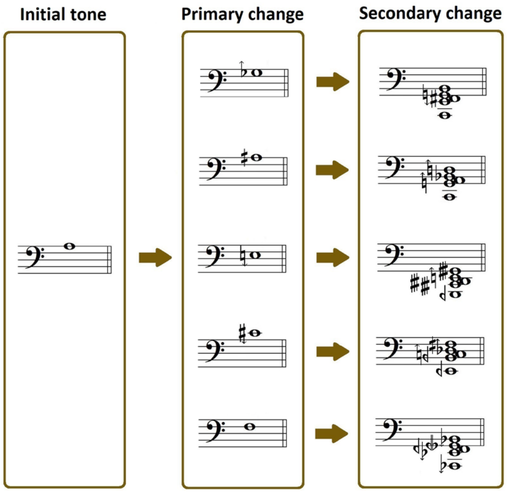
The harmonizer effect is used conjointly in section 3 and 5. An example is in Table 1.

The pitch change indicated in the following music sheet of Score 4 is obtained by estimating the average of the frequency generated in the section played by a snare drum at about 220 Hz, and converting the varying frequency with the harmonizer effect to the approximate pitch of the average rate.

When the same acoustic effect is overlapped, the acoustic layer may enlarge producing a richer sound, or conversely, the density may decrease creating a dull and faint sound.

	Pitch change of "sd1-harmo"	Primary change		Pitch change of "sdHamo"	Final result
0	-2.78	-2.78	im-medi-ately	-7.14	-9.92
				-11.44	-14.22
				-12.34	-15.12
				-21.3	-24.08
				-14.2	-16.98
	+0.4	+0.4	after 67ms	-7.14	-6.74
				-11.44	-11.04
				-12.34	-11.94
				-21.3	-20.9
				-14.2	-13.8
	-5.24	-5.24	after 113ms	-7.14	-12.38
				-11.44	-16.68
				-12.34	-17.58
				-21.3	-26.54
				-14.2	-19.44
	+3.7	+3.7	after 143ms	-7.14	-3.44
				-11.44	-7.74
				-12.34	-8.64
				-21.3	-17.6
				-14.2	-10.5
	-3.998	-3.998	after 18ms (feed-Back)	-7.14	-11.138
				-11.44	-15.438
				-12.34	-16.338
				-21.3	-25.298
				-14.2	-18.198

Table 1. Combination of "sd1harmo" and "sdHarmo"



Score 4. Pitch change resulting from the combination of "sd1harmo" and "sdHarmo"

④ Vocoder

The vocoder effect used in the piece is achieved by passing the resonant bandpass filters. The patch "VocoChan" contains 48 channels of filters with a wide range of 8 octaves from C0 to A7.

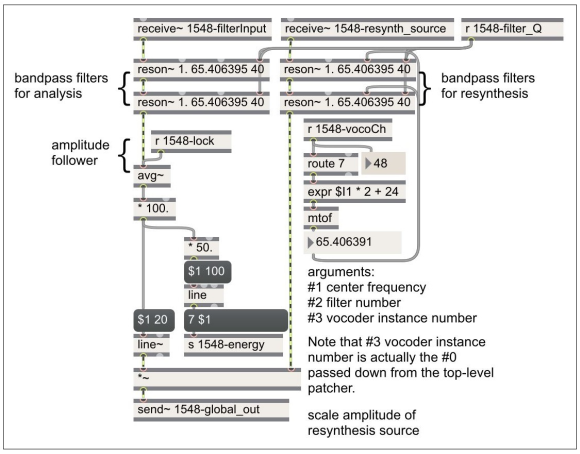


Figure 16. Patch for the vocoder effect "VocoChan"

The object itable, consisting of 48 scales on the x and y axis channels, can be used to set the parameters that apply to each filter consisting of 48 channels. Figure 17 is the object itable that allows visualization of the configuration of the parameters applied to each channel. In this piece, two types of vocoder effects are applied.

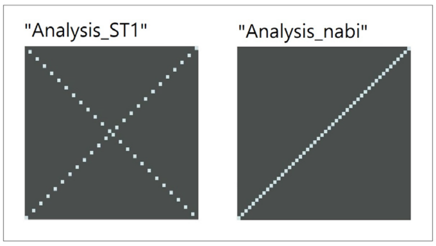


Figure 17. itable used in the piece

The form of the data table of the first vocoder effect, “Analysis_ST1,” is an X shape. The first input channel starts with the output channel of the lowest frequency and the second input channel starts with the output channel of the second highest frequency. Odd numbered input channels gradually increase and the even numbered input channels gradually decrease. From the 25th input channel, the odd input channels gradually decrease and the even input channels gradually increase.

Channel	Pitch(frequency)		Converted frequency (pitch)	
1	C0	32.703196	32.703196	C0
2	D0	36.708096	6644.87514	G♯7
…				
23	G♯3	415.304698	415.304698	G♯3
24	A♯3	466.163761	523.251131	C4
25	C4	523.251131	466.163761	A♯3
26	D4	587.329536	587.329536	D4
…				
47	G♯7	6644.87514	36.708096	D0
48	A♯7	7458.62016	7458.62016	A♯7

Table 2. Pitch and converted frequency of “Analysis_ST1”

The data table of the second vocoder effect, “Analysis_nabi,” is diagonal. The input channels from 1 to 48 have a 1:1 ratio with the output channels.

Channel	Pitch(frequency)		Converted frequency (pitch)	
1	C0	32.703196	32.703196	C0
…				
48	A♯7	7458.62016	7458.62016	A♯7

Table 3. Pitch and converted frequency of “Analysis_nabi”

⑤ Reverberation

The reverberation effect makes the resonance of the original sound. The patch presented below is based on the patch “reverb_example” provided by developer Randy Jones as an example file from Max.

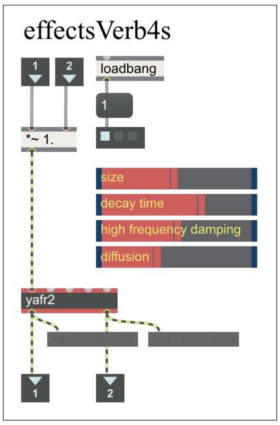
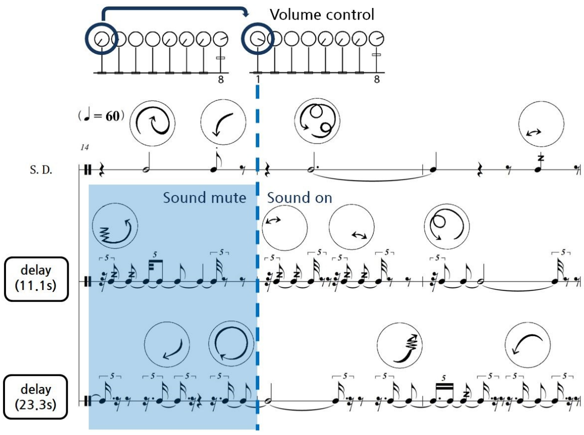


Figure 18. Patch for the reverberation effect “4sVerb”

In the patch, components that form reverberations consist of space size, decay time, high frequency damping, and diffusion. These four parameters are controlled by a horizontal slider object, and are subjected to various filter effects through the sub patch “yafr2” and sub patches “combineL” and “combineR” within it.

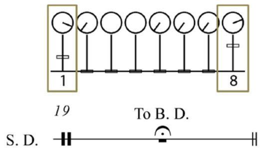
Sound changes according to real-time MIDI control

Audio input signals from the live performance and the electro-acoustic effects connected to the repeated signals acquired from sampling are not immediately executed because the volume is set at the lowest value in the patch of the piece. The role of the MIDI controller is to adjust the live.gain~ to increase the volume, so that each sound effect is processed and the sound is output to the speakers.



Score 5. Point where the sampled sound source appears in section 1

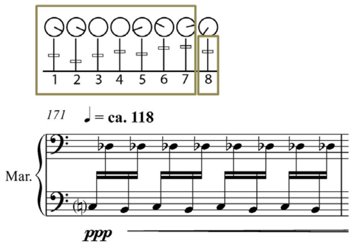
In this piece, the acoustic layer gradually expands as the modulated sound is added when the section changes. Observing the change of acoustic structure resulting from a mixture of each acoustics via real-time MIDI control is described as follows.



Score 6. Controlling MIDI presented in the rest period of section 1

Control device	Sound phenomenon
slider 8	(Audio signal is output to 4 speakers.)
dial 8	(Audio signal is connected to "h3" and "h4.")
dial 1	The sound source of section 1 - 11.1 and 23.3 seconds of delay - the harmonizer effect "pitchMod" - the reverberation effect - the spatialization effect "h1" and "h2"
slider 1	The sound source of section 1 - 11.1 and 23.3 seconds of delay - the vocoder effect "Analysis_ST1" - the spatialization effect "h3" and "h4"

Table 4. Acoustic phenomena in the rest period of section 1



Score 7. Controlling MIDI presented in section 7

Control device	Sound phenomenon
slider 8	Audio signal is output to 4 speakers.
dial 1, slider 1	(The previous sound effects)
dial 2	The sound source of section 2 - 19.9 and 37.7 seconds of delay - the spatialization effect "h2"
slider 2	The sound source of section 2 - 19.9 and 37.7 seconds of delay - the vocoder effect "Analysis_nabi" - the spatialization effect "h1" and "h2"
slider 3	The sound source of section 3 - 11.7 and 19.1 seconds of delay - the harmonizer effect "sd1harmo"+"sdHarmo" - the reverberation effect - the speaker 3, 4, and the spat effect "h2"
	The sound source of section 3 - 11.7 and 19.1 seconds of delay - the harmonizer effect "sd1harmo"+"pitchMod" - the reverberation effect - the spatialization effect "h1" and "h2"
	The sound source of section 3 - 11.7 and 19.1 seconds of delay - the vocoder effect "Analysis_nabi" - the spaialization effect "h1" and "h2"
	The sound source of section 3 - 11.7 and 19.1 seconds of delay - the spatialization effect "h1"
slider 4	The sound source of section 4 - modulation in real time - 37.1, 83.3, and 97.7 seconds of delay - the vocoder effect "Analysis_nabi" - the spatialization effect "h1" and "h2"
	The sound source of section 4 - 37.1, 83.3, and 97.7 seconds of delay - the spatialization effect "h3"
dial 5	The sound source of section 5 - 17.1 and 31.1 seconds of delay - the spatialization effect "h3"
slider 5	The sound source of section 5 - modulation in real time - 17.1 and 31.1 seconds of delay - the harmonizer effect "sd1harmo"+"hardHarmo" - the reverberation effect - the spatialization effect "h1"
	The sound source of section 5 - modulation in real time - 17.1 and 31.1 seconds of delay - the harmonizer effect "sd1harmo"+"sdHarmo" - the reverberation effect - the speaker 3, 4, and the spat effect "h2"
dial 6	The sound source of section 6 - 17.7 and 41.1 seconds of delay - the vocoder effect "Analysis_nabi" - the spatialization effect "h1" and "h2"
slider 6	The sound source of section 6 - modulation in real time - 17.7 and 41.1 seconds of delay - the harmonizer effect "hardHarmo" - the reverberation effect - the spatialization effect "h1"
	The sound source of section 6 - modulation in real time - 17.7 and 41.1 seconds of delay - the harmonizer effect "sdHarmo" - the reverberation effect - the speaker 3, 4, and the spat effect "h2"
	The sound source of section 6 - modulation in real time - 17.7 and 41.1 seconds of delay - the harmonizer effect "pitchMod" - the reverberation effect - the spatialization effect "h1" and "h2"
dial 7	The sound source of section 7 - the harmonizer effect "hardHarmo" - the reverberation effect - the spatialization effect "h1"
	The sound source of section 7 - the harmonizer effect "pitchMod" - the reverberation effect - the spatialization effect "h1" and "h2"
slider 7	The sound source of section 7 - the spatialization effect "h2" and "h4"
	The sound source of section 7 - the vocoder effect "Analysis_ST1" - the spatialization effect "h3" and "h4"
	The sound source of section 7 - the vocoder effect "Analysis_nabi" - the spatialization effect "h1" and "h2"

Table 5. Acoustic phenomena in section 7

The role and meaning of sound changes within the piece

The "Butterfly effect", which is commonly known to people as the idea that the flap of a distant butterfly's wing can still result in stirring up a tornado, is the theory that even the small change in initial conditions can have the significant impact on the overall result. The concept of "Butterfly effect" in this piece is revealed through two sides. The first is a musical depiction of several atmospheric phenomena; the small winds generated by the flaps of a butterfly wings to the strong typhoons. The modulation techniques are used to convert an acoustic instrument sound into an electronic sound and serve as a tool to represent an atmospheric phenomenon. The second is that the meaning of the word is applied to the composition and development method of the musical work. There are fixed and variable elements in the piece, and the variable elements including the parameters set in the program or data input by real-time MIDI control are presented differently within the fixed elements. Furthermore, it is difficult for the composer and the performer both to share a feature where accurately predicting the sound in every moment.

Formation of new tones

The composer configured the musical elements and materials of each section to symbolize some sort of phenomena, and tried to express the concepts of each section more realistically using the electro-acoustic effects.

Section	Instrument: special technique	Portrayal	Parameter
1 2 3	S. D.: Scratching B. D.: Scratching S. D.: Scratching	Small wind	Intensity, Speed, Direction
4	Mar.: Tremolo	The direction of wind	Range, Tempo
5	S. D.: Rim shot	Earthquake	Length, Dynamics
6	B. D.: Roll	Thunder	Speed, Thickness of acoustic
7	Mar.: Tremolo	Typhoon	Chord, Range, Tempo, Tension, Relaxation
8	S. D.: Scratching	Small wind	Intensity, Speed, Direction

Table 6. Musical portrayals of percussion for each section

The five electro-acoustic effects used in this work have the following roles and features.

Category	Electro-acoustic effect	Roles and Features
1	Sampling and looping	Repetition and temporal composition
2	Spatialization	Spatial composition
3	Harmonizer	Addition of chords adds thick-ness and depth
4	Vocoder	White noise is used together to create a unique tone.
5	Reverberation	Moderate sound is modulated to rich sound.

Table 7. The role and characteristics of the electro-acoustic effects used in the piece

In the part played using the scratching method, the electronic sounds express the small wind of the flaps of a butterfly. The sounds move and rotate at varying times through the four speakers during the usage of four different types of panning techniques.

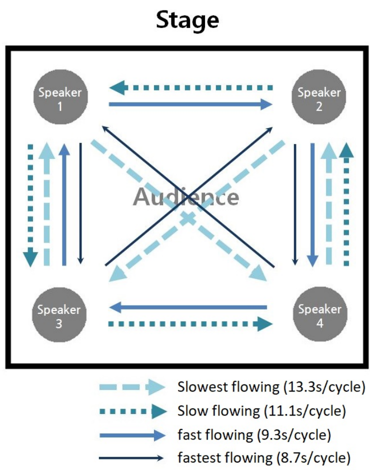


Figure 19. Flowing of electro-acoustic that simulates wind sounds

In section 6, where the bass drum is played with 4 mallets, depending on which part of the drum surface is struck, the direction of the thundering sound changes.

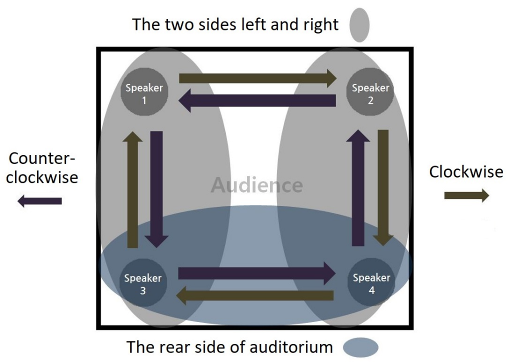


Figure 20. Spatial composition of electronic sound depicting thunder

Temporal reconstruction of sound

In this piece, there are four major factors that affect the way in which multiple acoustic layers are temporally relocated and constructed. First, the sound of percussion can be expressed differently whenever a piece is performed. This is entirely dependent on the tempo of the music. Several elements, like Tempo rubato, accelerando, ritardando, and fermata, may be played differently each time, thus the temporal length of the entire piece can vary, and the color of the music can vary. Especially in the genre of electronic music like this piece, which is played live as the music of the acoustic instrument and the electronic sound interact with each other, a small change in the speed of the musical instrument can have a significant influence on the entire music.

The second factor can also be explained in terms of improvisation. In this piece, the length of rest between each section can be freely determined by the artist and the sound controller, thus the composition of the sound that occurs directly following the rest can vary. For instance, some sounds that have been repeated continuously from the beginning may appear as the middle or last part of the sampled sound at the beginning of the next section depending on the length of the rest.

Third, the delay time setting directly affects the repetition of the electro-acoustic sound. If the delay time set in sections 1~6 is changed, the timing of the first appearance of the sampled sound can be altered.

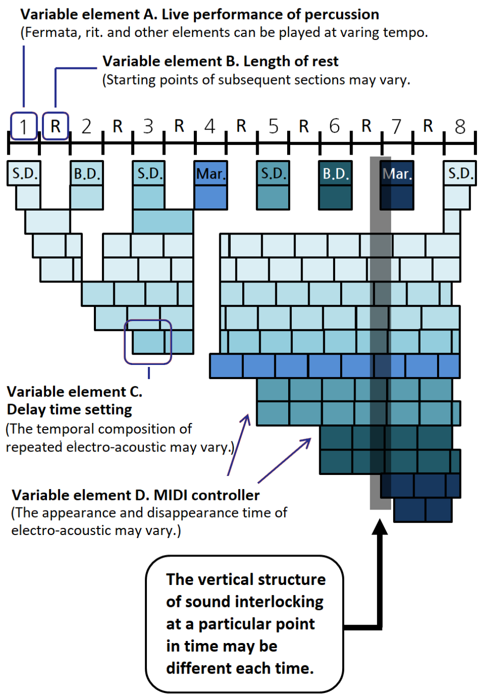


Figure 21. Temporal composition of sound depending on variable factors

Lastly, by controlling the volume in real-time through the MIDI controller, it is possible to construct a different sound by outputting or limiting the electro-acoustic sound at a desired point in time.

The figure 21 shows how the composition reproduced at any point during the performance of a music piece can be significantly changed depending on how the four variable factors mentioned above are set.

Spatial reconstruction of sound

In this piece, a variety of spatial arrangements are made while the electronic sounds move through 4 speakers. The method of setting panning is a factor that can make the spatial composition different. Even if the sound is structured identically, from the direction in which the sound is shifting and by changing the time for the 4 speakers to complete one rotation, the audience can perceive the position of the sound differently and accept it as a new musical phenomenon.

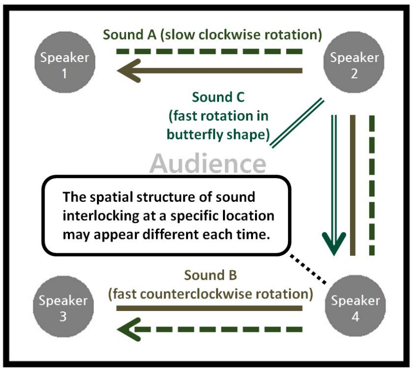


Figure 22. Spatial configuration of sound depending on variable factors

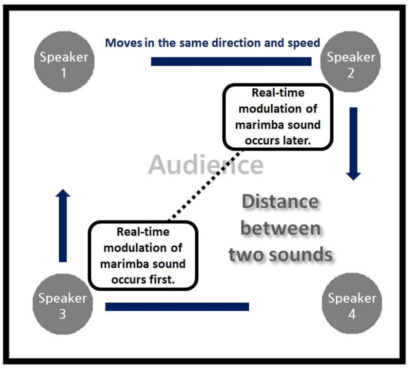


Figure 23. Spatial configuration of sound depending on variable factors

Secondly, even if the speed and direction are equal, a difference in time of electro-acoustic sound generation can make a distance between different sounds. Although the same panning effect is applied, the timing of MIDI controller is different, thus a change of sound movement occurs. For example, the marimba performance is modulated in real-time in section 7. However, due to the fact that the execution time of the 7th dial and the 7th slider are different, there is a difference in time when the electro-acoustic sound is generated by each control device. As such, the two sounds at different points at which sound modulation is performed via MIDI controller have a distance even if they are moved at the same speed and direction.

Conclusion

In this paper, the musical characteristics of the elements constituting the entire piece, as well as the overall process of sound modulation through electronic devices were studied in order to comprehensively examine all the acoustic possibilities that occur during the live performance of *Butterfly Effect*.

The matters discovered through the aspect of acoustic changes, specifically within this music piece, is that the acoustic phenomena figuratively reflect the meaning and theoretical background of the "Butterfly effect." First, the sounds of percussion instruments symbolize the physical phenomena that occur in the atmosphere, including the winds and typhoons, and are dramatically expressed through acoustic modulation. Moreover, numerous variable elements appeared in this piece give an influence on the spatial temporal result of the music. This process makes it possible to have a variety of or even perfectly different performances as it goes by. Consequently, the relation between this piece and the term "Butterfly effect" results in the application of the principle of unpredictability with symbolic meaning based on the artistic expression.

As a result, I could verify that the composer Donoung Lee opened a new form of musical possibilities by providing a various ways of combinations of sound effects as well as control of variable elements, and his creative usage of computer technology in diverse ways in this piece has developed the paradigm for acquisition of musical expressions that exist in this digital multimedia era.

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[Abstract in Korean | 국문 요약]
이돈응의 나비효과(2015)에서 나타나는 음향 변화 연구

김영선

이돈응의 《나비효과》(2015)는 스네어 드럼, 베이스 드럼과 마림바 이렇게 세 대의 타악기와 라이브 전자음향을 위한 작품으로 2015 년에 프랑스 리옹의 콩플루앙스 박물관에서 초연되었고 2016 년 서울국제컴퓨터음악제에서도 연주되었다. '나비효과'라는 용어는 "초기 조건의 작은 변화가 전체 결과에 큰 영향을 미칠 수 있다"라는 이론을 발표했던 미국의 기상학자 에드워드 로렌조 Edward Lorenz 가 1972 년에 "Does the flap of a butterfly's wings in Brazil stir up a tornado in Texas?"라는 강연주제를 사용하였던 것에서 파생하였다. 이 작품을 분석할 때 특별히 주목했던 점은 작품명인 '나비효과'라는 단어가 가지고 있는 본래 의미가 작품에서 어떻게 드러나고 있는가에 관한 것이었다. 이것을 세 가지 측면에서 살펴보았다. 첫 번째는 작품의 구조, 두 번째는 어떠한 음향변조기법이 적용되어 음향의 변화를 이루는가, 세 번째는 작품에서 가장 중요한 가변적 요소라고 할 수 있는 실시간 미디 제어에 따라 음향의 변화가 어떻게 이루어지는가를 파악하고자 한 것이었다. 이 세 가지 연구를 통해서 작품에서의 음향 변화의 역할과 의미, 그리고 작품명인 '나비효과'와 음악적 내용과의 연관성이 어떠한가를 확인해 볼 수 있다.

이 곡의 연주는 무대배치도에서 나타나듯이 세 개의 타악기에는 총 여덟 개의 다이내믹 마이크가 설치되고, 객석의 모퉁이에는 네 개의 액티브 스피커가 배치된다. 이외에도 음향장비로는 컴퓨터와 오디오 인터페이스, 믹싱 콘솔, 미디 컨트롤러가 사용되는데, 전자음향을 구현하기 위한 Max 패치는 네 개의 주요 파일과 여러 개의 서브 패치 및 abstraction 등으로 구성된다. 여기에 적용된 전자음향효과는 sampling 및 looping, harmonizer, vocoder, reverberation 과 spatialization effect 등이 있다.

작품의 전체적인 구조를 살펴보면 전자음향이 전개되는 방식의 가장 주요한 특징으로 '변형'과 '반복'이라는 요소를 들 수 있다. 타악기의 라이브 연주는 다양한 전자음향효과에 의해서 변조되고, 특히 샘플링 과정을 거친 전자음향은 작품이 종료될 때까지 지속적으로 반복된다. 이러한 현상에 대한 구조적 관점은 세 가지 측면에서 이해될 수 있는데, 먼저 형식적으로 일관성과 통일성을 구축한다는 점, 그리고 작품이 진행될수록 복잡성에 의한 긴장도가 증가되면서 후반부에 클라이맥스를 이룬다는 점, 또한 반복되는 음향이 어떠한 시점에 재등장하는가에 따라 음악적 맥락 안에서 질적인 변화를 가지게 될 수도 있다는 점을 분석할 수 있다. 구조적인 특징은 작품의 제목인 '나비효과'가 암시하듯이 정적인 분위기에서 시작된 작은 소리가 점차 두터운 음향층을 형성하는 과정에서 구성요소들이 전개되는 양상으로 나타난다. 다음과 같이 네 가지 구성요소에 주목해보았다. 먼저 타악기 파트를 살펴보면, 매우 조용한 분위기에서 연주가 시작되다가 셈여림의 범위가 점점 넓어지면서 일곱 번째 섹션에서 가장 큰 폭의 다이내믹을 이루고 있는 것 그리고 여덟 개의 섹션에서 섹션 별 마디개수와 빠르기, 연주시간이 점차 증폭되면서 변화를 이루고 있는 것을 확인해볼 수 있다. 또한 각 섹션마다 적용되는 전자음향효과의 종류와 가짓수가 다채롭게 구성된다는 점, 각 전자음향의 음량 값을 결정짓는 미디 컨트롤러를 실시간으로 어떻게 조절하느냐에 따라 음악적 줄거리도 흥미롭게 구성될 수 있다는 점이 파악된다.

Max 패치에 설계된 여러 가지 오브젝트들을 통해 전자음향을 구현하는 방식으로 음향 변화가 이루어진다. 먼저 tapin~과 tapout~ 오브젝트로 소리의 재생을 지연시키는 효과가 실행되고, tapout~을 한 번 거친 신호가 다시 tapin~으로 돌아가서 순환되는 경로를 통해 전자음향을 지속적으로 반복시키는 것이 가능해진다. 둘째로, 네개의 스피커를 이용한 서라운드 음향으로 소리가 공간적으로 이동하는 효과가 구현되도록 패치가 구성되었는데, 소리의 이동 경로는 위와 같이 다양하게 설정될 수 있다. 또 다른 음향변조기법인 harmonizer 는 어떠한 소리의 음고를

변경시키는 과정에서 입력하는 파라미터의 개수와 종류를 다양하게 적용하여 동시에 실행시킴으로써 결과적으로 하나의 거대한 화음을 구축하는 방식을 적용한 것이다. 타악기의 소리가 resonant bandpass filter 를 거친 후 같은 필터처리과정을 거친 화이트 노이즈와 재합성됨으로써 음색이 변조되는 vocoder 효과가 사용되기도 한다. 작품의 패치에는 장 2 도 음정으로 구성된 48 개 채널의 필터가 들어있어서 이것을 통해 특정한 음들이 완전히 새로운 주파수로 변환될 수 있다. 이외에도 소리의 잔향을 형성하기 위한 reverb 효과가 사용된다. 네 가지 파라미터가 연결된 슬라이더의 레벨을 어떻게 조절하느냐에 따라 잔향의 지속시간이나 음향의 강도가 다양하게 설정될 수 있다.

실시간 미디 제어라는 방식은 실제 연주시의 즉흥적인 행위를 통해서 창작과 연주라는 두 가지 개념을 동시에 포괄적으로 다룰 수 있다는 특징을 가지고 있다. 이 곡에서는 오디오 신호와 연결된 전자음향효과들에 적용되는 음량의 값이 최저로 설정되어 있기 때문에 live. gain~ 오브젝트를 조절하여 음량을 높여줌으로써 각 음향효과가 처리돼서 소리가 출력되도록 하는 것이 미디 컨트롤러의 역할이다. 작곡가는 미디 컨트롤러의 다이얼과 슬라이더를 조절하는 대략적인 시점과 정도를 나타내는 그림들을 악보의 곳곳에 제시하였는데, 미디 컨트롤러를 제어하는 과정은 매 연주마다 다르게 연출될 수 있음을 밝힌 바 있다. 섹션이 변경될수록 변조된 음향이 추가되고 중첩되면서 음향층이 점차 확대되어가는 전개를 갖추고 있다. 일곱 번째 섹션에서 가장 복잡하고 풍부한 음향 구조가 이루어지고, 마지막 섹션에서 미디 컨트롤러의 모든 조절장치들이 원점으로 돌아가면서 음향이 소멸되고 무대 위 악기의 음향만 남게 되면서 연주가 마무리된다.

작품 《나비효과》에 반영된 '나비효과' 현상은 두 가지 측면에서 드러난다. 첫 번째는 나비의 날갯짓에 의해 발생하는 작은 바람을 비롯하여 폭풍우나 강한 태풍과 같은 기상현상들이 음악적으로 묘사되어 있는 장면이다. 여기에서 어쿠스틱 악기의 연주를 전자음향으로 변조시키는 데 사용되는 음향변조기법들의 가장 중요한 역할은 새로운 음색을 생성하는 것이라고 할 수 있다. 둘째로 '나비효과'라는 단어의 의미 자체가 작품의 구성요소와 전개기법에 적용되는 현상을 발견할 수 있는데, 이 곡에서 여러 가지 변수들이 작용하여 매번 새로운 결과가 만들어지는 방식은 '시간'과 '공간'이라는 개념을 통해서 살펴볼 수 있다.

여러 개의 음향층이 시간적으로 재배치되는 방식에 영향을 미치는 가변요소로는 네 가지가 있다. tempo rubato 나 fermata 가 매번 다르게 연주될 수 있다는 점, 그리고 즉흥적으로 정해지는 휴지부의 길이에 따라 이어지는 섹션들의 시작 지점이 달라질 수 있다는 점, 또 delay time 에 따라 반복되는 전자음향의 시간적 구성이 달라질 수 있다는 점, 마지막으로 미디 컨트롤러를 제어하는 방식에 따라 전자음향의 등장과 소멸 시점이 달라질 수 있다는 점이 음향의 시간적 구성에 영향을 미치는 요인이다. 수많은 전자음향이 4 개의 스피커를 이동하는 동안 다양한 공간 구성이 이루어지게 되는데, 이러한 현상에 영향을 미치는 요인으로는 두 가지가 있다. 첫 번째는 소리의 이동 방향과 속도를 다르게 설정하는 것이고, 두 번째는 실시간 미디 제어로 음향의 발생시점을 조절하여 음향들의 공간적 거리를 구성하는 것이다.

본 연구를 통해서 《나비효과》라는 작품의 음악적 특징을 살펴보고, 음향장비를 통해 다루어지는 음향적 가능성들을 종합적으로 고찰해보았다. 특별히 이 곡에서 음향 변화의 양상을 통해 발견되는 사항은 작품에서 발생하는 음향 현상들이 '나비효과'의 의미와 이론적 배경을 반영하고 있다는 것이었다. 우선 대기 현상을 상징화하는 타악기의 소리는 음향 변조를 거침으로써 더 극적으로 표현된다. 또한 작품에 존재하는 수많은 가변적 요소들은 음악의 시공간적 결과물에 영향력을 발휘하여 매번 새로운 연주를 가능하게 한다. 결과적으로 이 작품과 곡명으로 사용된 용어 '나비효과'의 연관성은 예술적 표현에 근거한 상징적 의미와 함께 예측불가능성을 내포하는 원리의 응용으로 귀결된다고 볼 수 있다. 또한 이 작품은 작곡가가 다양한 음향효과들을 결합시키고 다루는 방식에 있어서 무수히 많은 경우의 수를 제공함으로써 가변적인 요소의 범위를 넓게 규정하였다는 점에서 새로운 음악적 가능성을 열어두었다는 결론을 얻을 수 있다.

Text-Painting as a Vehicle for Narrative in Contemporary Electroacoustic Composition

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Text-painting is an important compositional technique prominent in acoustic composition since at least the Renaissance. Text or word painting is commonly used in art songs or text-based compositions to augment the narrative of the text in the musical layer. As a creative process, this technique is studied primarily in acoustic composition analysis. In this article, I initiate a discourse on text-painting as a vehicle for narrative in contemporary electroacoustic music by examining its application in my own acoustic and electroacoustic compositions. This analysis reveals that text-painting serves as a powerful vehicle to carry narrative in electroacoustic composition, especially when the piece does not contain an explicit vocal component. Text-painting creates an image, linking the narrative to the music and improving the listening experience for electroacoustic compositions.

Text-painting is an important compositional technique that has existed in acoustic composition since at least the Renaissance period. Text or word painting is used in art songs or text-based compositions to augment the narrative of the text in the musical layer. Classic examples of this compositional technique can be found in *Winterreise D. 911,* a song cycle by Franz Schubert (1797- 1828) in which text-painting gives the audience a vivid musical image of the sung text.

In acoustic compositions, text-painting is "a compositional device that aims to represent in music specific images summoned by the text of a vocal work."[1] Text-painting is an important way to serve the audience or listener; a tool to understand the music. Lawrence M. Zbikowski explores the important placement of text-painting in the cross-domain mapping[2] — which "plays two important roles in musical understanding: first, it provides a way to connect musical concepts with concepts from other domains, including those associated with language; second, it provides a way to ground out descriptions of elusive musical phenomena in concepts derived from everyday experience."[3] The techniques of text-painting engage but are not limited to the musical parameters of melody, harmony, contour, texture, mode, modulation, word repetition, tessitura, cadence, and musical paralleling of the poem's scenes.[4] My concept of text-painting includes all of the above and also encompasses the use of vocal and instrumental timbres to recreate the scene from the text, a method I call sonic painting. My ideas align with the categorization of text-painting techniques found in the writings of Jack Boss. Boss suggests two general categories of text-painting techniques: structural text-painting and semantic text-painting where structural text-painting parallelizes the music and emphasizes the text's structure while semantic text-painting "reflects the meaning of the words."[5]

Because textual and spoken elements are already common in electroacoustic composition, I must clarify the specific nature of text-painting. The use of text or spoken elements as timbral material in an electroacoustic piece does not inherently imply the use of text-painting. For example, *I'm sitting in a room* by Alvin Lucier, as well as *It's gonna rain* and *Come out* by Steve Reich, each employ spoken texts as timbral and implicative agents but none of these pieces can be thought of as *setting* the employed text in the classical sense. Text-painting applies specifically to pieces that involve text setting in some capacity, or pieces that are story-driven in which case the text may not be set explicitly but rather motivates a narrative structure in the composition.

To my knowledge, past analytic papers on electroacoustic music do not view text-painting as an important aspect of the creative process and rarely acknowledge text-painting as a vehicle for narrative in electroacoustic composition. In this article, I initiate a discourse on text-painting in electroacoustic music by illustrating its use in specific electroacoustic and pure-acoustic compositions; specifically, by comparing two sets of my own pieces. Both sets consist of one acoustic piece and one electronic piece based on the same text. The first set is *Gu Yan Er* (*孤雁儿*) for soprano, clarinet, and cello and *Wu Ren Kan Ji* (*无人堪寄*) for cello and fixed media. The second set is the *Shan Shui* song cycle (*山水歌集*) for soprano and bassoon and *Shan Shui Remix 2017* for fixed media. In the comparison of these two sets, I examine the relationship between the application of text-painting in acoustic and electronic composition. From this I conclude that, even though the sound platform is different, there are no essential differences in the application of these compositional techniques. Text-painting can be applied easily in electroacoustic music and there are certain advantages due to the technology. Using technology results in a more direct, effective image for the audience than is possible in traditional acoustic music. Using examples of text-painting in my electronic pieces, I show that the technique can be applied in electroacoustic music to link the narrative of a poem with the listening experience.

Gu Yan Er is an acoustic ensemble piece for soprano, clarinet, and cello. The text of this piece is from a poem of the same title written by the most famous Chinese female poet, Li Qingzhao (1084 - c.1151). This poem is one of a series written to mourn the poet's late husband who died at an early age. The fact that she was never able to recover from his death sets the tone. This poem not only has a clear verse rhythm, but also contains musical references and onomatopoeia. The electronic piece in this set is *Wu Ren Kan Ji* for cello and fixed media. This piece is derived from *Gu Yan Er* in that the cello becomes the star of the show. The piece further develops the material by borrowing some of the melodies, sounds, and extended techniques from the original cello part. There is no vocal component, but the piece has the same narrative as the song and the music is completely driven by the text. The title "Wu Ren Kan Ji" (trans. "no one to give it to") is also derived from this poem.

On Plum Blossoms[6]

To the tune "a little wild goose" [7]

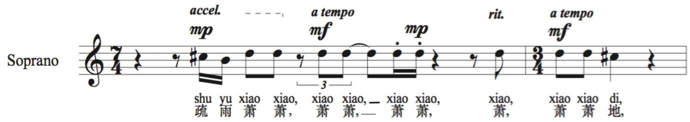
This morning I woke
In a bamboo bed with paper curtains.
I have no words for my weary sorrow,
No fine poetic thoughts.
The sandalwood incense smoke is stale,
The jade burner is cold.
I feel as though I were filled with quivering water,
To accompany my feelings
Someone plays three times on a flute
"Plum Blossoms Are Falling
in a Village by the River."
How bitter this Spring is.
Small wind, fine rain, hsiao, hsiao,
Falls like a thousand lines of tears.
The flute player is gone.
The jade tower is empty.
Broken hearted—we had relied on each other.
I pick a plum branch,
Heaven and earth,
There is no one to give it to.

The second set of pieces is the *Shan Shui* song cycle and *Shan Shui Remix 2017*. I will only use examples from the first piece of each cycle even though the techniques discussed persist throughout both compositions. *Shan Shui* is a song cycle based on three poems by Li Bai (701-762), who is considered one of the greatest poets in Chinese history. The three poems are all related to mountains (shan, 山) and water (shui, 水). Shan and Shui are important themes throughout Li Bai's poems. The piece I use as example is the first of the cycle: *Sitting above in Jingting Mountain (独坐敬亭山)*. *Between the Mountain and I* (*山吾间*) is the fixed media piece based on *Sitting above in Jingting Mountain.*

Sitting above in Jingting Mountain[8]

Flock of birds—
High-flying, away.
Lonely cloud—
Gone away, alone.
Looking at each other,
Not bored.
Only with
Jingting Mountain.

There are many ways to employ text-painting in a composition. One of the most common techniques is to play with words from the text. For example, a technique called word repetition – repeating and highlighting certain words – can quickly attract the audience's attention. My music demonstrates the application of this technique consistently across acoustic and electronic pieces. In *Gu Yan Er*, "Small wind, fine rain, hsiao, hsiao," (小风疏雨箫箫地) is a very interesting sentence that not only implies the depressed mental state of the poet and foreshadows the next sentence, but also features onomatopoeia: "hsiao, hsiao" is the sound of the fine rain hitting the ground. I repeat this word seven times in the song before proceeding to the next sentence to emphasize the moment (Example 1). In *Between the Mountain and I*, I apply the same technique, highlighting the words "not bored" (不厌) to emphasis the poet's fondness of the mountain (see recording, starting at 1')[9]. My use of word repetition here can be seen as an instance of Boss's "structural" text painting.

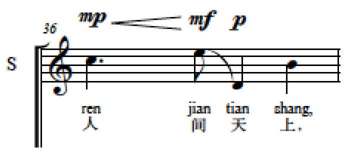


Example 1. word repetition on "箫箫"(hsiao, hsiao).

A second text-painting technique is to express unspoken facts of the text in the music layer. Poetry is a form of literature that often employs subtle implication. With multiple layers of meaning behind the text, the composer is left with a lot of interpretive and expressive space. Li Qingzhao was considered the master of "the delicate restraint" style (婉约派): in this poem she uses numerous subtle implications to express her sadness, depression, and the longing for her husband. The end of the poem "I pick a plum branch, heaven and earth, there is no one to give it to." (一枝折得，人间天上，没个人堪寄) describes her deep despair and the realization that her husband is gone and she will not be able to find another person that she loves so dearly. I took "heaven and earth" as the key words on which to apply text-painting.

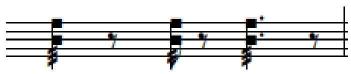
In *Gu Yan Er*, when setting the word "earth" (人间) and "heaven" (天上), I made a decision to write the melody *against* the natural contour of the spoken words and used a 9th, leaping from E down to D, to emphasize the drama. This moment is also accompanied by a sudden dynamic change from mezzo-forte to piano (Example 2). It is my intention to create a sense of unbalance and unexpectedness in order to indicate the poet's unbalanced mental state.

Clearly this is a critical moment of the poem which can be portrayed in a variety of ways, so I took the opportunity to create another interpretation in *Wu Ren Kan Ji*. Here, my reading of this final moment is not only that the world is in chaos for the poet, but that her sense of loneliness fills the entire space of the poem. To paint this interpretation, I employ a quasi call and answer between the cello and the fixed media with the same musical material, creating an echoing effect: the poet is all alone and even when she cries out to the world, all she can hear is her own echo (see recording from 10'). These expressions of deeper levels of meaning are instances of Boss's semantic text-painting category.



Example 2. 9th leaping and sudden dynamic change.

Sonic painting is another straightforward way of creating a convincing musical narrative by literally recreating the images described by the text in music or sound—paralleling the occurrences of the text organically. Boss calls this technique depictive text-painting, [10] a sub-category of semantic text-painting, which can also be found in compositions by Arnold Schoenberg (1874 - 1951). For this technique it is important to remember that the application of text-painting should not be focused solely on the vocalist singing the text. In *Gu Yan Er,* besides the repetition of the word "hsiao, hsiao" in the soprano, I use a brushing technique in the cello — palm of the hand dampening to mute the pitch while vertically brushing the strings — to mimic the sound of rainfall in the accompaniment, recreating the scene from the poem (Example 3). Similarly, in *Wu Ren Kan Ji,* I applied the same technique of text-painting in the same passage. In the electronic track, through the manipulation of cello sound by granular synthesis, [11] I was able to create a very convincing rainfall sound similar to the sound in the natural world (see recording, starting at 5'38''). The realistic sound of rainfall results in a deeper connection between the audience and the poem since this piece has no vocal portion to present the text. This kind of parallel between scenes in the poem and musical structure also gives the audience a sense of narrative time. At this point, the rainfall sound functions as a recreation of the poem's narrative as well as acting as a timeline marker, providing a more emphatic experience because the audience can have a physiological preparation for what's going to happen next. While text-painting in acoustic compositions may not be as clear or may need a certain imagination, here the audience has no trouble identifying the rain sound leading to a better association with the text. This is a clear advantage for electronic composition with respect to text-painting.



Example 3. brushing technique in cello.

There are other ways that I create realistic sounds relating to the natural world for text-painting purposes in electroacoustic music. In the example above, I use a brushing technique in the cello to recreate the rain in *Gu Yan Er*. I use the same technique in *Wu Ren Kan Ji*, but the result is quite different. After processing, the brushing sound is more like wind in the fixed media track. In the poem, the rain and the wind happen in the same scene: "Small wind, fine rain". In *Wu Ren Kan Ji*, this image is recreated fully by the technological extension (see recording, starting at 5'30'').

Digital sound manipulation also helps realize complex text-painting effects. In *Between the Mountain and I*, I use word repetition on the text "Flock of birds" (众鸟), and also process the word as it is repeating. This transforms into a new sound which mimics the sound of birds' wings flapping and eventually disappearing—a representation of the image in the next sentence, "high-flying, away" (高飞尽). This image was not possible with the sounds of acoustic instruments and voice in the original song. The continuous, smoothly transitioning sound effect hints at the power of sound processing for effective text-painting (see recording, starting at 13'').

Having the tools of technology to create and manipulate sound is already an advantage for electronic composition. With these tools, the composer's options for text-painting are multiplied. Composers and performers are always searching for ways of making new timbre out of old instruments, which has led to a profusion of extended techniques. However, there are limits to what physical instruments are capable of in terms of register, physical performing methods, and what performers are willing to do. Because of this, the cost of creating new sounds with traditional instruments grows higher and higher, while creating new sounds is a fundamental and accessible practice in electroacoustic music. In this sense, it is more economic to use electronic composition for creative text-painting. For example, looping is an easy way to achieve word repetition and sound design techniques help recreate natural sounds without the need to record an actual sound sample. The echo and birds "flying away" effects in my fixed media tracks disclose another advantage in electronic composition: spatialization, i.e. the possibility of creating a perception of distance when applying text-painting. This three-dimensional realm is not as easy to create in traditional acoustic music where musicians tend to remain in the same space as they play. In electronic composition, one can manage speaker placement and run sounds through different combinations of channels to create dramatic spatial effects.

As discussed above, text-painting serves as a powerful vehicle to carry narrative in electroacoustic composition, especially when the piece does not contain an explicit vocal component. Text-painting functions aid in creating an image, linking the narrative to the music, coherency, and improving the listening experience. Text painting is an important tool that electroacoustic composition can easily adopt from acoustic music and electronic media enables composers to create more realistic portrayals of the text and its meaning.

孤雁儿

藤床纸帐朝眠起，说不尽、无佳思。
沉香断续玉炉寒，伴我情怀如水。
笛声三弄，梅心惊破，多少春情意。
小风疏雨箫箫地，又催下、千行泪。
吹箫人去玉楼空，肠断与谁同倚？
一枝折得，人间天上，没个人堪寄。

独坐敬亭山

众鸟高飞尽，孤云独去闲。
相看两不厌，只有敬亭山。

List of works

Gu Yan Er (*孤雁儿*) for soprano, clarinet and cello, 2015

Shan Shui song cycle (*山水歌集*) for soprano and bassoon, 2015

Wu Ren Kan Ji (*无人堪寄*) for cello and fixed media, 2017

Shan Shui Remix 2017, 2017

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[1] Lawrence M. Zbikowski. (2002). *Conceptualizing Music* (Oxford: Oxford University Press: 17.

[2] For further reading on the concept of cross-domain mapping, please refer to chapter 2 of *Conceptualizing Music*. Zbikowski, *Conceptualizing Music:* 63-95.

[3] Zbikowski, *Conceptualizing Music:* 64.

[4] Brian W. Draper. (2012). "Text-painting and Musical Style in the Lieder of Fanny Hensel." [Master's thesis]. University of Oregon: 3.

[5] Jack Boss. (1998). "The "Continuous Line" and Structural and Semantic Text-Painting in Bernard Rands's Canti D'Amor." *Perspectives of New Music* 36, no. 2: 144

[6] English translation by Kenneth Rexroth and Ling Chung, edited by Tao Li. Please refer to the Chinese text in appendix.

[7] "Gu Yan Er" translates to "a little wild goose".

[8] English translation by Robert Kyr and Tao Li. Please refer to the Chinese text in appendix.

[9] Recordings of all the pieces mentioned in this paper can be found on taolimusic.com.

[10] Boss, "The "Continuous Line" and Structural and Semantic Text-Painting.": 144

[11] All sound samples in *Wu Ren Kan Ji* come from a cello.

[Abstract in Korean | 국문 요약]

현대 전자음악 작곡을 설명하기 위한 수단으로서의 텍스트 그리기

타오 리

텍스트 그리기는 적어도 르네상스 이후로 잘 알려진 어쿠스틱 음악을 작곡하는 데 중요한 기술이다. 주로 텍스트 혹은 단어 그리기는 예술 가곡이나 가사가 있는 작품에서 텍스트의 서술성을 보강하는데 사용된다. 이 기술은 창조적인 과정으로서 어쿠스틱 음악의 분석에 대한 연구가 주로 이루어진다. 이 글에서는 저자의 어쿠스틱 음악과 전자 음악 작품에 적용된 예를 조사함으로써 현대 전자 음악의 서술성을 위한 수단으로서의 텍스트 그리기에 대한 담론을 시작한다. 이러한 연구는 텍스트 그리기가 전자음악을 작곡할 때, 특히 명확한 목소리 요소가 없는 경우, 작품의 서술성을 담보하는 강력한 수단으로 기여함을 보여준다. 텍스트 그리기는 하나의 이미지를 만들어 그를 통해 이야기와 음악을 연결하고 전자음악을 감상하는 경험을 향상시킨다.

How do we listen?

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Situations of listening

> As I close my door and walk down the stairs, the motor-driven lock mechanism heralds a sequence of percussive metallic clicks, in counterpoint with my creaking shoes and, through their door, laughter from the neighbor's child. I'm in a space with stone floor and concrete walls. I stop, hold my breath, and wait for the reverberation tails of all three sounds to fade out. Silence is relative, and my attention is seamlessly drawn sounds from the outside: cars, birds, rustling leaves. I'm late.

In what ways do we listen to the soundscape? How do our concurrent activities, moods, and abilities determine the listening mode? What is it that allows us to experience arbitrary sounds in an everyday environment as elements in a musical composition?

> I am running through the rainforest along one of my favorite tracks that circles the hill: one hour outdoors activating muscles, bones, and ligaments. A heightened awareness of my heart: when running, I pay it due attention and gratitude. Suddenly I realize that for some time there has been music in my mind's ear – a motive, an ostinato, a chord sequence – and that I have had no awareness whatsoever of the forest sounds, or my footsteps, or breathing. Yet in the instant this observation emerges, the music evaporates, and all that I hear is exactly forest, footsteps, and breathing. The music remains as a trace in memory: a mental notation.

Why do ways of listening sometimes feel categorically different? Are there multiple parallel processing streams in our mind that compete for attention, as it were, knocking on the door to our executive control room? Or is what we call 'conscience' an emergent property, a mental scheme in temporary equilibrium: froth bouncing on streams of multiple parallel processes?

> The concert hall ushers didn't let me enter carrying a small backpack and sent me back to the ticket desk. I managed to return just in time for the performance to start. Sliding into the seat, I exchange a few words with my colleague about the theme printed in the leaflet. Lights go down: I switch off the phone and make myself comfortable in the chair. Two musicians enter the stage; the audience greets them with an applause that expresses recognition, expectation, and encouragement. We are in this together. Please tell us your story. They smile, inhale simultaneously, and attack in unison: pianissimo, an extremely high note – no, a tight minor second. Inexorably they bring on a crescendo to forte… Tartini on rampage… wild beating on everyone's eardrums. The audience writhes in awe.

The reader might recognize or recall similar situations of listening. There is an infinite range of such stories, yet it might be possible to describe the range of listening modes with a fairly small number of concepts. Occasionally consciously and most often not, we sense, perceive, and inquire the relations between three entities: the soundscape – the perceived acoustic environment; its constituent elements – the observed, implied, or imagined sources that produce the sounds we perceive; and ourselves. We have an innate capacity to evaluate sounds in terms of usefulness and danger. Listening is what mediates between the perceiving organism and its environment.

The first situation was about sounds and soundscape. We learn about our surroundings by dissecting its elements and identifying their respective sources. Some objects and other beings might be useful for us, and others harmful. Just as smelling helps us distinguish between edible and toxic plants, listening is ultimately a tool for survival. Sounds from sources far away do not normally attract our attention. As biological creatures, we have learned that faint sounds with low pitch, slow attacks, and low timbral complexity, such as a traffic drone, are generally harmless. By contrast, sharp attacks and high pitch, such as a locking mechanism, signal danger even if the sounds are faint. The second vignette was about the internal process of sonic imagination. The principle of homeostasis explains an innate tendency to adapt our attitude towards the surroundings so as to maximize our chances of utilizing objects and beings to our benefit. Some soundscapes are dense in signals about danger, pleasure, friends and foes. Most often these are essential, but occasionally our survival instinct is suspended and the soundscape is largely ignored, or even replaced by something entirely different, such as an imagined melody. This might only happen to us if the environment is known and considered safe. The third story described the transition from an ordinary environment to a highly focused and music-specific situation with expectancy and attention to sonic detail at the fore.

This paper reviews theories for modes of listening, in particular Paul Vickers' 'Aesthetic Perspective Space' (Vickers/ Hogg 2006; further discussed in Vickers 2013, Vickers 2017), and Kai Tuuri's taxonomy for modes of listening

(Tuuri et al. 2007, Tuuri/ Eerola 2012). It attempts a comparison between models, and sketches a way of testing experimentally two aspects of these models of listening, in the context of electroacoustic music and sonification.

Sonification and electroacoustic music

> Sonification renders data in sound to allow a human listener to detect and comprehend patterns and structures in that data, whilst a musician renders a musical score so as to make it audible and thus make perceptible the music's structure and even give clues as to the composer's and the musician's emotional states. We could go as far as to claim that a piano is a sophisticated auditory display machine… (Vickers 2006: 1-2; see also Kramer 1994)

Sonification is to music as visualization is to visual art: a strategy for explaining. Sound design is to composition as graphic design is to visual imagination: a method for making. It might be advantageous, in some cases, to listen to sonification as a form of electroacoustic music. This would allow us to apply analytical methods from contemporary musicology and through them, extract more meaning from auditory display, so as to be in a position to create more convincing and effective sonifications.

The Aesthetic Perspective Space (Vickers/ Hogg 2006) proposes an analytical tool that bridges auditory display and electroacoustic music. According to Vickers, it permits a kind of "typecasting" (Vickers 2017) of the activities of sonification and composition. Having a unified analysis method for a range of sonic artefacts from the fields of electroacoustic music (e.g. concert and multimedia compositions) and sonification (e.g. software earcons and system monitoring designs) facilitates interrogation of aesthetic and effectiveness. Vickers underlines that the principles of the former are applicable onto the latter. His primary concern lies with the design of auditory displays and the effectiveness of sonification for the discovery of meaning in data, and more generally for communication. He urges practitioners in the field of sonification to carefully study the principles of electroacoustic music composition, arguing that music and auditory display share important attributes: "it is at these intersections that dialogue and interrogation may take place.". However, he does not equate one with the other, noting that there are "artefacts present in each of music and sonification that are not present in the other… one such is the intellectual content of compositions." (Vickers 2006: 6).

Seeking to polarize, we might say that sonification is utilitarian, purpose-oriented, and aspires to serve science and communication, while electroacoustic music composition is hedonistic, pleasure-oriented, and aspires to serve art and experience (see Lindborg 2015 for a discussion). The opposition between the two archetypes (i.e. generalized concepts of sonic artefacts) is obviously a construction for the sake of facilitating analysis of real-life examples. There are manifold aspects not covered by the single dimension. Notwithstanding the conflation of multiple aspects, a polarization might help us understand how the conceptual extremes are connected.

In the Aesthetic Perspective Space (Figure 1), a continuous line connects two extremes poles, labelled 'Ars Informatica' and 'Ars Musica'. It spans the primary (horizontal) dimension of a conceptual space, reflecting the intention that a listener applies towards an auditory object: whether the intention tends towards information-extraction or towards artfulness-experience. The secondary (vertical) dimension maps to the opposition between what the listener perceives as abstract, or as concrete. This characterization of the sonic source material is labelled 'indexicality'. Vickers (2017) leans on Simon Emmerson's *Language Grid*, a framework that affords an analysis of electroacoustic music along two continuous dimensions: one describing the composer's perceptual attitude to the musical material, from 'Aural' to 'Mimetic', and the other describing the composer's action on the material, from 'Phonographic to 'Constructed' (Emmerson 1986; Fischman 2007; also Emmerson 2013-14). Emmerson defines 'mimetic' as "the imitation not only of nature but also of aspects of human culture not usually associated directly with musical material". (Emmerson 1986: 17). Within the context of auditory display, Vickers identifies sonification as a form of 'mimetic discourse', where 'indexical' is exactly the same as 'mimetical'. We might this speak of listening to 'concrete mimesis' in a situation where a sound object unequivocally denotes a physical source that is present in the environment, and listening to 'abstract mimesis' when a sound object associates with a non-present source or concept through metaphor. The association might be more or less graspable, hypothetical, or private.

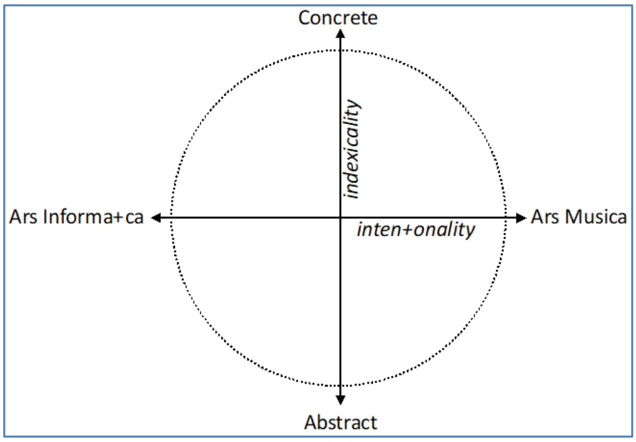

Figure 1. The outline of the Aesthetic Perspective Space, as a circumplex spanned by dimensions of listener intentionality and perceived sonic indexicality. After Vickers/ Hogg (2006).

Modes of listening

Turning the attention to Tuuri's taxonomy of listening modes, we will revise the approaches taken by musicologists building on the seminal work by Pierre Schaeffer. In *Traité des objets musicaux,* Schaeffer devised several toolkits for the analysis of sound. His journey of aural discovery and taxonomy was entirely enabled by access to technologies of recording and reproduction: first gramophone, then tape. With the *modes d'écoute* (listening modes, Schaeffer 1966: 112 ff.), Schaeffer made two dichotomizations pertinent the act of listening: firstly, whether abstract or concrete, and secondly, whether subjective or objective. He made explicit an inherent hierarchy by numbering them, as follows:

1. *écouter* (listen): objective/concrete *Causal* listening, taking sound as evidence;
2. *ouïr* (perceive): subjective/concrete *Neutral* listening, experiencing sound as raw material;
3. *entendre* (hear): subjective/abstract *Reduced* listening, attending to sonic qualities;
4. *comprendre* (comprehend): objective/abstract *Semantic* listening, attributing meaning to sound in context.

The first is the baseline, 'everyday-ish' mode. In *Causal* listening, we take sound as the evidence of action, or, to use a term from semiotics, the index of an event that is caused by physical objects in the present environmental context. By contrast, the third mode, *Reduced* listening, is when the perceiver focuses on the qualities of the sound in itself. Schaeffer described it as an 'unnatural' form of listening, a state of mind that can only be achieved through a high degree of dedicated attention and suitable training. By default, perceivers attribute a specific physical source to any sonic stimulus, and it is only through dedicated practice that people can de-learn this innate mental mechanism (cf. Schaeffer 1966: 95). Through applying *Reduced* listening, the 'sound object' becomes a phenomenological object. Thereafter, in the fourth mode, *Semantic* listening, meaning might be attributed. When shared, the sound object is no longer private, no longer merely a "laboratory specimen", but rather a "nonabstractable point of reference, related to a whole of greater magnitude than itself" (Schafer 1994: 274).

Michel Chion applied Schaeffer's scheme to analyzing the role of sound in cinema (Chion/ Gorbman 2009). The film 'soundtrack' traditionally consists of three quite different kinds of sound, that are designed by different techniques and teams of workers: Dialogue (produced by actors on location or with automated dialogue replacement, ADR); Effects (produced by Foley artists and sound designers); and Music (produced by studio musicians and engineers). To identify the corresponding and suitable listening modes for the three kinds of sound, Chion dropped the 'passive reception' mode (*ouïr*), and focused on the 'big three' (Tuuri 2012), namely the *Causal*, *Reduced*, and *Semantic* listening modes. Note that this tripartite division might be paralleled by the basic model of brain processing, which considers three levels: sensation, perception, and cognition (e.g. Mesulam 1998).

Chion's conception of *Causal* listening corresponds exactly to Schaeffer's first mode (*écouter*). Perhaps due to innate ecological listening principles, we spontaneously attribute auditory phenomena to causal actions (Chion 2009: 471). Because his preoccupation lies with film, and the power of sound to contribute to the filmic diegesis, both in physical and psychological terms, the *Causal* mode takes on a greater importance for Chion than what it did for Schaeffer. In *Reduced* listening, the subject deliberately separates the perception of the sonic phenomenon from any knowledge of its direct physical source. Only this specific attitude (which is quite Zen-like) allows the listener to fully perceive and appreciate the internal structure and qualities of the sonic object. Chion writes that "reduced listening has the enormous advantage of opening up our ears and sharpening our power of listening.…The emotional, physical, and aesthetic value of a sound is linked not only to the causal explanation we attribute to it but also to its own qualities of timbre and texture, to its own personal vibration." (Chion 2012: 52). Its application is not limited to electroacoustic music, as the reduced listening mode may also be willfully activated in other acoustic situations, such as when we strive to learn the details of pronunciation of a spoken language that is new to us. Semantic listening is defined by Chion (and Schaeffer) as a mode of perceiving sounds as signs with acquired meaning. He suggested that we may engage this mode of listening both at a conscious level, such as when selecting a rhyme for a poem, and at a pre-attentive level, such as when perceiving the meaning of a spoken language that we know.

The definition above of the 'big three' listening modes is rather loose, and most of the important observations made by Schaeffer and Chion is not sufficiently explained with such weak scaffolding. Seeking a more detailed framework for analysis, we turn to recent theories of music perception.

Music emotion

The field of music emotion research focuses on how affective responses are activated by music. David Huron (2002; further developed in Huron 2006) identified six psychological systems: reflexive (physiological), denotative (identifying sources), connotative (identifying properties), associative (arbitrarily acquired links), empathetic (understanding the other), and critical (self-monitoring).

Working from a slightly different perspective, Patrick Juslin and Daniel Västfjäll (2008; see also Juslin 2013) advanced an eight-component model (BRECVEMA) for music-induced emotion: brain stem reflex (reflexive), rhythmic entrainment (also reflexive, specifically for periodic sounds such as heart beat), evaluative conditioning (stimulus valence acquired through exposure), emotional contagion (pre-motor internal mimicking), visual imagery (crossmodal association and prediction), episodic memory (nostalgic recollection of a lived experience), musical expectancy (anticipation of specific features), and aesthetic judgement.

In the revised taxonomy of listening (Tuuri/ Eerola 2012), Tuuri directs the spotlight onto the connotative and denotative systems of auditory-evoked meaning-making. Connotative listening is pre-attentive, generating early associations between auditory sensation and previously experienced mental imagery and feelings. (Tuuri speculates that some aspects of connotative listening can become available to conscious attention through the technique of reduced listening.) As in the ecological approach to perception, these associations depend on perceptually invariant features of the sound, that is, statistically salient inputs yield emergent perceptual patterns. Tuuri then considers the perspective of embodied perception, which posits that meaning is created in two ways, through the organism's active corporeal and imaginative processes. In the first case, concepts emerge from the internal imitation of auditory sensation; simply put, when stimulated by sound, the brain's motor centers perform a 'mute production' to imitate the sound. In the second case, image schemes, formed over time by perceptual invariants, themselves produce concepts; that is the brain internally concocts thoughts through approximation and metaphor. As Tuuri writes, "action-relevant mental images arise upon emerging resonances of action-relevant values between… patterns of sensation and well-structured patterns of recurrent experiences" (145).

Importantly, both neuro-corporeal imitation and mental imagery are constrained by the environment within which the listening organism dwells, in terms both of natural and cultural (as in social) experiences. The central argument of enactive perception is that "perceiving is a way of acting… What we perceive is determined by what we do (or what we know how to do)" (Noë 2004). Despite largely focusing on vision, Alva Noé suggests that perception is more like touching than viewing, as touch is a more explicitly active way to engage with the environment. Touching is to embodied visual perception what vocalizing is to auditory perception: *homo faber* preceded *homo sapiens.*

This perspective leads Tuuri to formulate three components of connotative listening, each explained as a specific 'coupling' between sound and another phenomenon *X* through action (Godøy 2003). Action-sound-*X* couplings are schematically structured experiences that enable associations and projections of meaningful action-relevant mental images connecting our body with the environment. The first kind, action-sound-object couplings, emerge from experiences of manipulating objects. This would include a range of actions, from learning to pick up a ringing phone, to mastering a musical instrument. The second, action-sound-intersubjective couplings, are established through encounters with other human beings and interacting with them. This would include learning the semantic difference between sounds of laughter and crying, which might be acoustically close; the so-called 'mirror neurons' support a basic mechanism for empathy. The third kind, action-sound-habit couplings, refer to connotations that emerge from exposure to sound in social and cultural ecologies.

Processes of denotative listening happen immediately after the connotative action-sound couplings, and as a function of their output. Denotative listening is available to conscious control ('mode' indicates that it is something we are able to will). At this level, Tuuri defines largely the same mechanisms that Schaeffer and others had identified, but importantly, he refrains from any hierarchical arrangement, and places them on a spectrum between 'more source-oriented' and 'more context-oriented'. Thus, causal and empathetic listening are understood as more source-oriented, the latter being constrained by the socio-cultural environment. Functional listening answer questions about the purpose of a sound, and semantic listening attends to the meaning of sound by producing context-dependent metaphors. See Figure 2 for an illustration.

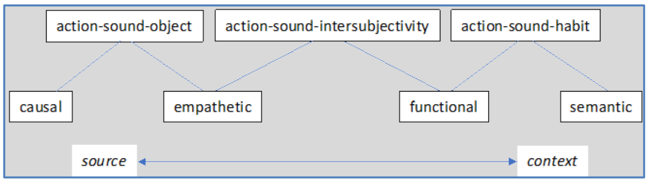

Figure 2. Associations between connotative (upper) and denotative (lower) listening modes. After Tuuri/ Eerola (2012).

Comparing models

This brief review cannot do justice to the complexity and details in the theories discussed so far. With Table 1, an attempt has been made to give an overview of the central concepts, and to suggest – in a deliberately simplistic fashion – their relationships. The table must be read 'squinting the eyes': please note that the layout does not suggest that concepts placed on the same row and level should be equated. They belong to distinct theories and are therefore well-defined only within their original framework. Despite being approximate, construing links between the psychological mechanisms might nevertheless facilitate observations, and further hypotheses.

What are we to make of all these intricate systems of psychological listening mechanisms that interact as we are going about our everyday activities of so many kinds? Electroacoustic music, as an art form, is perfectly attuned to describing, through concrete example and abstract metaphor, the interplay between inner mental imagination and external acoustic environment. Sonification aims to convey through the medium of sound essential information about internal and external processes that allow for interpretation and meaning creation/extraction. Can we build evidence for the theoretical predictions that the theories produce? Can we determine which listening mode, or perhaps listening attitude, that people favor when presented with sound or a soundscape? Should we measure physiological or brain activity, e.g. with MRI or EEG, or can we administer a self-report questionnaire? If we give test subjects a task at the same time, does it make the selection of listening mode more precise? What if the task is medium-centric, such as “explain your listening strategy as you determine whether this sonification signals danger or not”? Or if it is a distractive task that diverts attention away from what is being measured?

<table>
<tr><th>Schaeffer (1966)</th><th>Chion (2012)</th><th>Truax (2002)</th><th>Huron (2002)</th><th>Tuuri et al. (2007)</th><th>Tuuri/ Eerola (2012)</th><th>Juslin/ Väs tfjäll (2008)</th></tr>
<tr><td rowspan="2">ouïr</td><td rowspan="2">—</td><td rowspan="3">background listening</td><td rowspan="2">reflexive</td><td rowspan="3">pre-attentive</td><td>reflexive</td><td>brain stem reflex</td></tr>
<tr><td>kinaesthetic</td><td>rhythmic entrainment</td></tr>
<tr><td>écouter</td><td>causal</td><td>connotative</td><td>connotative (three action-sound couplings)</td><td rowspan="2">evaluative conditioning</td></tr>
<tr><td rowspan="4">comprendre</td><td rowspan="4">semantic</td><td rowspan="4">listening-in-readiness</td><td>denotative</td><td rowspan="2">source-oriented</td><td rowspan="4">denotative (causal, empathetic, functional, semantic)</td></tr>
<tr><td>empathetic</td><td>emotional contagion</td></tr>
<tr><td rowspan="3">associative</td><td rowspan="2">context-oriented</td><td>visual imagery</td></tr>
<tr><td>episodic memory</td></tr>
<tr><td>entendre</td><td>reduced</td><td rowspan="2">listening-in-search</td><td>quality-oriented</td><td>reduced</td><td>musical expectancy</td></tr>
<tr><td>—</td><td>—</td><td>critical</td><td>(context-oriented)</td><td>critical</td><td>aesthetic judgement</td></tr>
</table>

Table 1. Overview of listening modes in different theories and frameworks.

Drafts for two listening tests

Considering the Aesthetic Perspective Space, we might ask if it can correctly predict how people perceive sonic artefacts, on the one hand in terms of ‘music-ness’ or ‘informatic-ness’, and on the other, for their level of 'concrete-ness' or abstraction. When judging this, should they have access exclusively to the sound itself? Or should they additionally be presented with aphonic information, such as a text describing the production techniques involved, or the creative intentions? Vickers and Hogg (2006) had populated the Aesthetic Perspective Space with two handfuls of examples: some specific, some generic (referring to a composer/designer, or a style). In subsequent papers, Vickers (2013, 2017) included weblinks for most of the examples. It is not clear whether the distribution of these examples in the circumplex had been tested experimentally, or whether it is hypothetical. It might be feasible to conduct a listening test to explore how people interpret these pieces and sonifications; whether the median locations are close to those proposed by Vickers, and to what degree they agree (e.g. measure variance). Furthermore, a qualitative analysis of interviews (as in Lindborg/ Friberg 2015) with the test subjects might yield their evaluation strategies, and through that, a glimpse into their employment of listening modes.

The core point in Tuuri’s taxonomy of listening modes is the connection that he makes between mechanisms for connotative and denotative listening. Per definition, the former is pre-attentive and the latter reflects the listener’s consciously chosen attitude towards the sound object. This theoretical framework thus predicts someone's tendency to choose a specific listening mode, given the result of subconscious perceptual processing that immediately precedes it. We can assume that causal listening is activated when the subject is tasked to attend to individual sources (and where the soundscape as a whole is a distractor), and that semantic listening is activated through tasks attuned to the whole context (and where individual sounds act as distractors). The framework predicts that the preceding connotative process conditions the choice of denotative listening mode, and this is testable. For example, a dominant action-sound-object coupling facilitates causal listening, while a dominant action-sound-habit coupling facilitates semantic listening. A listening test could be designed by preparing priming stimuli of two kinds that correspond to those denotative mechanisms. Imagine that subjects are asked to apply a specific connotative listening mode throughout a block of forced-choice responses. Before each trial, they are exposed to a priming sound that activates one of the connotative mechanisms. The hypothesis is that response speed and success rate depend on whether the primer facilitates the requested listening mode or not. Stimuli and primers for testing the link between action-sound-object connotative processing and causal listening might be prepared from recordings of sport events, for example tennis: the subject is tasked to estimate the success of a hit (requiring a source-oriented coupling), while being distracted by crowd jeering (engaging a context-oriented coupling). Likewise, stimuli and primers for testing the link between action-sound-habit connotative processing might be created from recordings of soundscapes with differing degree of pleasantness, and the distractor is a single sound source within the soundscape (of the opposite valence). A starting point might be offered by previous research on the relation between individual sound sources and the whole acoustic environment (e.g. Lindborg 2016).

Future work will refine the experimental design outlined here, aiming to conduct listening tests that could shed light on Tuuri's and Vickers' theoretical work. It might also be feasible to design experiments that address specific cases where the theoretical predications can be falsified.

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[Abstract in Korean | 국문 요약]
우리는 어떻게 듣는가?

퍼마그너스 린드보르그

우리는 소리풍경을 어떠한 방식으로 듣는가? 어떻게 우리는 동시에 일어나는 행위와 분위기, 능력들로 청취의 양태를 결정하는가? 우리로 하여금 일상의 환경 속 임의의 소리를 음악 작품의 요소로 여기게 하는 것은 무엇인가? ... 독자는 유사한 청취 상황을 인지하거나 회상할 수 있을 것이다. 이러한 이야기는 무한대로 많은 영역의 것이겠지만, 꽤 작은 개수의 개념으로 듣는 양태들에 대해 설명하는 것이 가능할 수도 있다. 대부분은 그렇지 않겠지만 때때로 의식적으로 우리는 다음의 세 가지 실체를 느끼고 감지하고 이에 대해 의문을 가진다. 인지된 음향적 환경으로서의 소리풍경, 우리가 듣는 소리로 인해 관찰되고 암시되거나 상상하게 된 원천 정보가 되는 소리의 구성 요소들, 그리고 우리 자신이 그것이다. 누구나 유용함과 위험성에 관련하여 소리를 판단하는 타고난 능력을 갖는다. 듣기란 인지하는 생물체와 그 환경 사이를 연결하는 것이다. ... 이 글은 청취 양태에 대한 이론들, 특히 폴 비커스의 '미학적 투시도적 공간'을 살펴본다. 이는 전자음악과 소리화의 맥락에서 두가지 관점의 청취 모델을 비교하고 그들을 실험하는 방법을 보여준다.

Analysis of DualShock 4 as a Musical Instrument

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Sony's DualShock 4 can be used as an affordable and readily-available musical instrument that may not require an additional software to establish a connection with the computer. Despite the effortless connectivity via Bluetooth or USB, DualShock 4's number of functioning inputs varies depending on the applications and the communication method. The author analyzed and documented DualShock 4's mapping scheme for Max and SuperCollider in this article so that it may be served as a reference for composition and performance projects. While buttons and joysticks behave much like MIDI controllers, some distinct features of DualShock 4, such as the trackpad, built-in timer, and SIXAXIS, have unusual mapping schemes and ranges.

The PlayStation DualShock 4 is a convenient choice as an alternative controller for music as it complies with a USB HID Class specifications[1] and does not require additional software installation to establish a communication with Macintosh computers. Programs such as Max and SuperCollider accept over 50 channels of control signals from the device via Bluetooth or USB. This abundant control capacity has attracted electronic musicians since its market debut in 2013, but there has not been a comprehensive documentation of the working control parameters. This article serves to fill the gap by listing the range and type of *Elements*, an equivalent of MIDI Continuous Controllers, in the device. By doing so, the prospect users of Dualshock 4 may save time and effort in figuring out the parameters before delving into a creative process. The article is divided into three sections: The first section is about hardware and the software setup of Dualshock 4 for particular software. The second section is an analysis of usable *Elements*. In the last section, I list some detectable but unidentifiable data from the controller.

Hardware and Software Setup

DualShock 4 sends and receives signals according to the USB standards via both Bluetooth and Micro-B USB cable. I have tested the connections with both Macintosh running OS X 10.11.5 and PC running Windows 10 Home ver 1709. At the time of analysis, only the Macintosh computer established a working connection with the controller without an installation of a third-party driver. The connection availability was tested by running SuperCollider 3.8's *HID* UGen on both platforms. The SuperCollider in Windows detects Dualshock 4 using the same *HID* UGen but was not able to receive a data stream.

The method to establish a wireless connection between a Macintosh and a Dualshock 4 via Bluetooth is documented in various online sources[2]: First, put the controller into the discovery mode by holding the *PS* and the *Share* buttons. Then follow the standard procedure to connect a Bluetooth Device to a Macintosh computer. Once the connection is established, the computer is automatically paired with the controller everytime the devices are turned on.

The DualShock 4 is registered as a type of Human Interface Device (HID) to the computer. The output data from each component of the controller is routed via a separate channel of *Elements*, and most of these data are in the range of 0-255. This resembles a MIDI protocol for the Continuous Controllers, where each Continuous Controller number carries a stream of data ranging 0-127. The difference is that while the MIDI is understood universally among all MIDI devices, the availability of working *Elements* and corresponding *Element* numbers depends on the software and the connection:

- The *Element* assignment may change from an application to another. For example, the *Element* number 2 corresponds to the O button when using the controller with SuperCollider's *HID* UGen, while *Element* number 4 is assigned to stream the same data with Max 7's *hi* object.
- Some *Element* numbers differ between the USB and the Bluetooth mode. These *Elements* will be discussed in the next section.
- The connection via USB cable transmits more *Elements* than the Bluetooth connection. The detection of data from the motion sensors and the trackpad is only available when the controller is connected with a USB cable.
- Max7's *hi* object does not establish a connection via Bluetooth.

It should also be noted that the Dualshock 4's data output scheme is not applicable to other commercial game controllers. The Nintendo Wiimote share similar functions, such as motion sensors and multiple buttons, but it uses significantly fewer channels of *Elements*. Each button of the Wiimote controller is assigned to a single numeric value, and the sum of these values is sent to *Element* number 37 when multiple buttons are pressed. For example, pressing the circle and the triangle buttons together in Dualshock 4 will send a value of 1 in *Element* number 2 and another value of 1 in *Element* number 3, while pressing the buttons A and B simultaneously in Wiimote will create a single value of 3072, which is a sum of individual button values 1024 (A) and 2048 (B).

Input Method Analysis

Figure 1. Dualshock 4 Layout[3]

1. Digital Control

To use the manufacturer's language, the Dualshock 4 has a variety of Digital and Analog data input features. The distinction between the digital and analog in this context is more akin to the distinction between Note On/Off and Continuous Control in MIDI. The Digital buttons send an on/off messages or a value of 0 or 1. The Analog control sends continuously changing value between 0-255.

Control Surface	Element # in SC (Max: add 2)	Value Range
Square	0 (2 in max)	0 or 1
X	1 (3 in max)	0 or 1
O	2	0 or 1
Triangle	3	0 or 1
L1	4	0 or 1
R1	5	0 or 1
L2	6	0 or 1
R2	7	0 or 1
Share	8	0 or 1
Options	9	0 or 1
L3	10	0 or 1
R3	11	0 or 1
PS	12	0 or 1
Trackpad	13	0 or 1

Table 1. on/off buttons assignments in Dualshock 4

The table above lists *Element* numbers for all 14 Digital buttons in Dualshock 4. Note that the buttons L2, R2, L3, R3, and Trackpad have an additional function of sending continuous data via different *Element* numbers, much like MIDI aftertouch messages.

Because the *Element* number is specific to each software, the numbers detected with Max's *hi* object are different than that of the SuperCollider. For Digital buttons, the *Element* numbers for Max is greater than those of SuperCollider by 2. For consistency and efficiency, I will use the *Element* numbers detected by SuperCollider in the subsequent sections.

2. Analog Control

There are four visible buttons in Dualshock 4's directional pad, and the combination of those buttons adds an additional 4 directions. Unlike the triangle-circle-square-X buttons, all directional information is sent via one *Element* channel. In addition to the 8 directions, a value of 8 is sent when any of these buttons are released.

direction	Element # in SC	Value
up	18	0
up+right	18	1
right	18	2
right+down	18	3
down	18	4
down+left	18	5
left	18	6
left+up	18	7
release	18	8

Table 2. Directional Pad Assignment

The L2 and R2 are one-dimensional continuous controllers with a range of 0-255. Note that the L2 and R2 assignments differ in the Bluetooth and the USB mode. The L3 and R3, or the Analog Sticks, are controllers with two axes, with the horizontal and the vertical values assigned to separate *Element* channels. Their center position is assigned to value 127, but the incoming data sometimes jitter between values 126 and 130.

The sampling rate of the continuous control data for the above features is close to 180Hz in SuperCollider. This was calculated by running the code below that counts the number of incoming data from a specific *Element* number. Because of the unevenness of human movement, the exact sampling rate of the incoming data was difficult to calculate. I observe that the sampling rate differs from one *Element* to another in SuperCollider. In comparison, Max has uses one sampling rate determined by *poll* argument in *hi* object.

Control Surface	Element # in SC (Max: add +2)	Value Range
L3 x-axis	14	0-255 (left-right)
L3 y-axis	15	0-255 (top-bottom)
R3 x-axis	16	0-255 (left-right)
R3 y-axis	17	0-255 (top-bottom)
L2	20 in USB, 19 in Bluetooth	0-255 (release-push)
R2	21 in USB, 20 in Bluetooth	0-255 (release-push)

Table 3. L2, R2, L3, & R3 Assignments

```
(
SystemClock.sched(0,{
        var counter;
        counter=0;
        HIDFunc.element({
                    |...args|
                    counter=counter+1;
//target: element number 20
                    counter.postln;}, [20]);});
SystemClock.sched(1,{"Stop".postln;});
)
```

Figure 2. SuperCollider code for calculating the data sampling rate

The input parameters described so far are available in both Bluetooth and USB mode. The rest of the continuous data are only available if the controller is connected with a USB cable. Also, some data are not detectable in Windows.

3. Touchpad

Dualshock 4's touchpad can sense up to two physical contacts. With one finger on the touchpad, the controller can send the following continuous data. Unlike the Digital and Analog controls mentioned in the previous sections, the difference between the *Element* numbers in SuperCollider and Max is 1 for the touchpad.

Element number 48 is a timer/clock. When a finger touches and remains in contact with the touchpad, the controller counts values from 0-255. When the counter reaches 255, the value is wrapped back to 0 and continues to increase.

While *Element* 48 can be considered as an increment counter with automated trigger, *Element* 49 is a pair of manual increment counters. A counter ranging from 0-127 counts forward when a finger makes a contact with the touchpad, and a counter ranging from 128-255 counts forward when the finger is lifted off. The touch on/off counters resets to 0 and 128 respectively when they reach the end of their range. Since these two counters are essentially one control stream, the difference between on and off values are constantly at 128.

Touchpad Functions	Element# in SC (Max: add 1)	Value Range
timer	48	0-255 wrapped and continuing
on/off counter	49	0-127 for on, 128-255 for off
horizontal coordinate	50	0- ~1920, with 7.5 repetitions of 0-255
horizontal directions	51	0-255 Increasing: moving left. Decreasing: moving right (only in sc)
vertical coordinate	52	0-58 (top-bottom)

Table 4. Touchpad functions: one finger

Element 50, the horizontal coordinate of the touchpad, consists of a wrapped rotation of values ranging from 0-255. Instead of providing one continuous range of around 0-1920, the touchpad has 7 subsections with the range of around 0-255 and one subsection with around the range of 0-127. The reason for this approximation is due to the inconsistent and jittering values at the leftmost and the rightmost edges. In comparison, the vertical coordinate of the touchpad yields an exact range of 0 (top) to 58 (bottom).

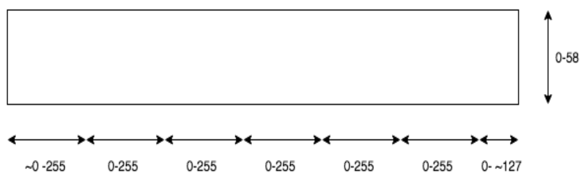

Figure 3. Numeric values of horizontal and vertical coordinates in DualShock 4 touchpad

In addition to the horizontal and vertical position detection, *Element* 51 sends a directional information of horizontal axis. A rotating value ranging 0-255 increases when a finger is moved to the left and decreases when moved to the right in SuperCollider. In Max, *hi* object decreases the value in both directions. The starting value at the moment a finger touches the touchpad seems random or perhaps related to an internal timer assigned to *Element* 48, but is irrelevant for detecting the finger movement directions. No element was found for vertical direction detection.

The five continuous control data on the movement and position on the touchpad are active when one finger is in contact with the touchpad. Additional four continuous data become active when the second finger is in contact. Their functions are similar, with two differences: 1. There is no separate timer 2. There is a vertical direction detector instead of a horizontal detector.

Touchpad Functions	**Element # in SC (Max: add +1)**	**Value Range**
on/off counter (2nd finger)	53	0-127 for on, 128-255 for off
horizontal coordinate (2nd finger)	54	0- ~1920, with subdivisions of 0-255
vertical directions (2nd finger)	55	0-255 Increasing: moving down. Decreasing: moving up
vertical coordinate	56	0-58 (top-bottom)

Table 5. Touchpad functions: 2 fingers

4. Timer

In addition to a timer in touchpad, there is another timer for general purpose. The *Elements* 19 and 25 in USB mode sends a timer with a range of 0-63 and 0-255 respectively. The sampling rate is faster than that of the touchpad's timer or L2/R2/L3/R3's continuous controller data. A high sampling rate timer is perhaps implemented for game command requiring timed actions, such as increasing the power of an attack by holding a button for few seconds, and this could easily be applied to control a musical parameter.

Timers	**Element # in SC (no avail in Max)**	**Value Range**
Timer 1	19	0-63 wrapped and continuing
Timer 2	25	0-255 wrapped and continuing

Table 6.

5. Gyroscope and Accelerometer

DualShock 4 uses a combination of accelerometer and gyroscope, trademarked as SIXAXIS by the manufacturer, to sense and measure the 3D motions of the controller. Given the trademarked name, I expected to find 3 channels of accelerometer data and another 3 channels of a gyroscope. My analysis could only find a few streams of gyroscope and accelerometer data, however. The mapping scheme of 0-255 value ranges is also different from that of other input methods in the controller. The subsequent table summarizes the types of control, corresponding *Element* numbers, and their respective range. I will use the roll-pitch-yaw scheme used in aeronautics and another 3D game controllers to categorize the control parameter types.

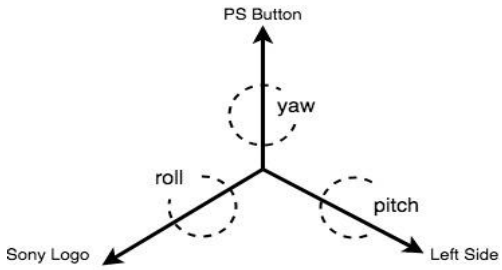

Figure 4. pitch, yaw, and roll position for DualShock 4. Axes are labeled with visible characteristics of the controller

Control Surface	**Element # in SC (Max: add +1)**	**Value Range (see Figures 5-7)**
Pitch accelerometer	28	0-127 & 128-255
Pitch gyroscope	36	0-32 & 223-225
Pitch gyroscope 2	38	0-32 & 223-225
Roll accelerometer	32	0-127 & 128-255
Roll gyroscope	32	0-32 & 223-225
Yaw accelerometer	30	0-127 & 128-255

Table 7. gyroscope and accelerometers

The allocation of the 0-255 range is particular for each *Element*. It is easier to visualize the value change using a diagram. As plotted in *Figure 5*, the incoming roll data through *Element* 36 decreases from 255 to 223 when the controller is rotating from position A to B. Note that the point A depicts the controller's normal position and C depicts the upside-down or flipped position. If the controller continues to spin from B to C, the value changes from 223 back to 255. The continuation of the spinning from the upside-down position to a normal position (C to D to A) yields a value change from 0 to 32 to 0. The values 0 and 255 are treated as an equal position in a similar way that the angles 0° and 360° in a circle are interchangeable. In a counterclockwise motion, values 0-32-0 are used when the controller is rotated from A to D to C, while values 255-223-255 are used for the C to B to A position change.

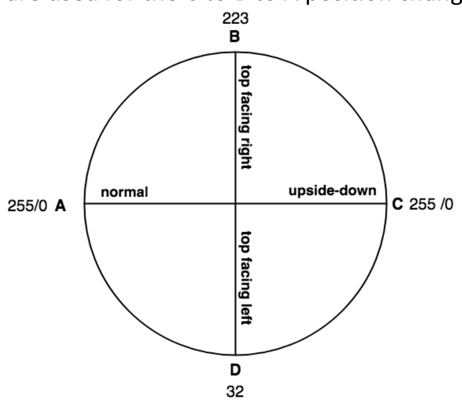

Figure 5. Roll data. Position A is a normal position where the controller's bottom with barcode is facing the floor. Position C is an upside-down position where the controller's bottom is facing the ceiling

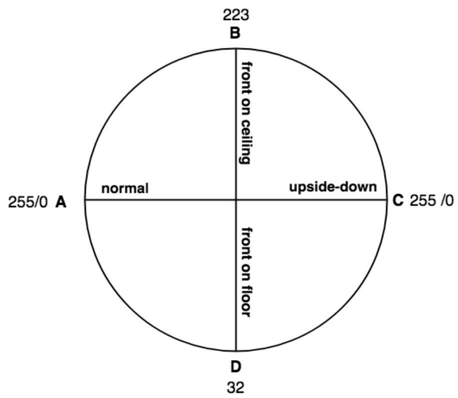

Figure 6. Pitch data mapping for Element 38, where A is the normal position, B is controller pointing the ceiling, C is the controller in an upside-down position, and D is the controller pointing the floor.

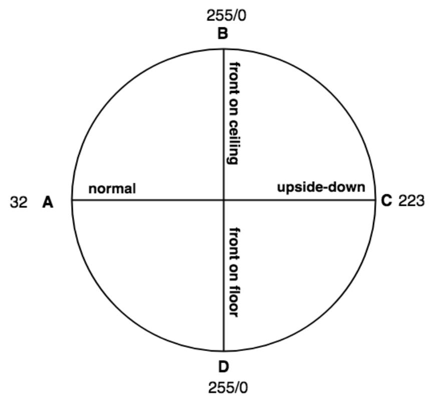

Figure 7. Pitch data mapping for Element 36

This mapping of the circular movement is also used for *Element* 36 assigned for the pitch position data (Figure 6). *Element* 38 is also allocated for pitch, but with 0 and 255 mapped to A and C (Figure 7). While two *Elements* are assigned to pitch value, I was not able to find an *Element* responsible for yaw rotation value.

The rotational values have lower resolution since they do not use values between 32-223 out of possible 0-255 range. In contrast, the acceleration data in the roll, pitch, and yaw use the full range. The acceleration increase in the clockwise motion (A-B-C-D-A) in the illustrated diagrams along the roll axis is measured as an increase in the values ranging from values 128-255 in *Element* 32, while the acceleration change in the counterclockwise motion (A-D-C-B-A) is measured using the values of 0-127. These mapping schemes are reversed, 0-127 clockwise and 128-255 counterclockwise, for pitch and yaw accelerometer, which are *Elements* 28 & 30 respectively.

Conclusion and Further Research

Using Max's *hi* object, one can see that a total of 1278 *Elements* are available in Dualshock 4. I was able to detect activities in *Elements* 1 through to 38, but not all of them were corresponding to input methods available in the controllers. *Elements* 24, 27, 29, 31, 33, 35, and 37 output streams of values at a rate that cannot be handled by SuperCollider running on my MacBook Air, as the incoming data caused the program to crash. This would not be a problem for Max since the rate could be quantized with the *poll* message in *hi* object, but I still could not find the relationship between incoming data and the available input methods. Perhaps some of these *Elements* correspond to the yaw position, but I was not successful in finding it.

The Elements 22 and 23 has a range that far exceeds 0-255 and do not react to any input methods available on the control surface. Such a large range of data may be needed for digitization of audio signal, but I could not find a proper method to test this hypothesis.

The Dualshock 4 controllers have been used in electroacoustic performances in various format by artists for its ubiquity, affordability, and flexibility. Using Max or SuperCollider's default objects to connect the controller is not a secret to those who seek the information. An external such as *zsy.ds4* for Max lets users even bypass the configuration of the controller in *hi* object and maps certain inputs more intuitively. Such easiness of usage comes with the limitation of the possibilities. The *zsy* externals come without some features that are only available in USB mode, namely the trackpad and the SIXAXIS features[4]. In addition, when Dualshock 4 is used in a performance, the artists often do not share the *Element* mapping used in their piece. The *Element-to-control-surface* mapping scheme is a technical aspect that do not need to be rediscovered every time a piece is made or performed. This article thus serves as a shortcut or reference to map the known parameters in the controller for those who wish to save time in the pre-composition and technical configuration stage.

As an example of a musical usage of the Dualshock 4, readers can download the SuperCollider codes and watch a video recording of *PS Quartet No.1*[5]. Various parameters of Karplus-Strong instruments are mapped to DualShock 4, and four or more performers create music as an ensemble by reading a graphical score consisting of commands common to PlayStation games. There is no need for installation of additional software other than the standard SuperCollider. There are separate .scd files for USB connection and the Bluetooth connection for the performers who do not wish to edit the code. I have also uploaded an scd file that contains a code that uses working *Elements* presented in this article[6].

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[1] "Tech specs | PS4 | PlayStation." https://www.playstation.com/en-gb/explore/ps4/tech-specs/. Accessed 6 Sep. 2018.

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[3] "File:Dualshock4 Layout.svg - Wikimedia Commons." 28 Nov. 2016. https://commons.wikimedia.org/wiki/File:Dualshock_4_Layout.svg. Accessed 6 Sep. 2018.

[4] "GitHub - larme/zsy.ds4: [zsy.ds4] is is a simple max patch to handle ...." https://github.com/larme/zsy.ds4. Accessed 6 Sep. 2018.

[5] "PS Quartet No.1 – for game controllers and computers | joo won park." 21 Dec. 2017. http://joowonpark.net/psquartet1/. Accessed 6 Sep. 2018.

[6] "DualShock 4 Controller Map for SuperCollider | joo won park." 6 Sep. 2018. http://joowonpark.net/dualshock-4map/.. Accessed 6 Sep. 2018.

[Abstract in Korean | 국문 요약]
음악 악기로서의 듀얼쇼크4에 대한 분석

박주원

소니 Sony 의 듀얼쇼크 4 DualShock 4 는 컴퓨터와의 연결을 위한 부가적인 소프트웨어 설치 없이도 손쉽게 구입하여 유용하게 사용할 수 있는 음악적 악기이다. 블루투스나 유에스비를 통한 용이한 연결 외에도 듀얼쇼크 4 는 지원 환경과 통신 방법에 따라 다양한 입력 기능이 있다. 저자는 이 논문에서 작곡이나 연주 프로젝트의 참고자료로 쓰일 수 있는 맥스 Max 와 수퍼콜라이더 SuperCollider 를 위한 듀얼쇼크 4 의 매핑 계획을 분석하고 정리하였다. 버튼과 조종간은 미디 콘트롤러와 매우 흡사하지만, 듀얼쇼크 4 의 특징적인 트랙패드나 내장 타이머, 식스액시스 SIXAXIS 는 특별한 매핑 계획과 범위를 갖는다.

Electroacoustic Music and the Sounding Body

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In the time before mains electricity was common, the boundaries of music were generally clear. Today, our musical horizons are expanded through music technology and music is no longer solely the product of physical gestures. No longer is music rooted exclusively in the body. Now, we have musical timbres that are otherworldly and that exceed the limitations of the human body. We also have generative music, made entirely by algorithm. Further, because of the ubiquity of recording technology, the distinction between everyday sounds and those of music has become increasingly muddled. The result is a sound world that would have been unimaginable only a century ago. Here I explore how and why our experiences of these newer non-body musical sounds might be different from those arising from traditional acoustic practices, which are more firmly rooted in physical gesture.

> Even in the cultured detachment of today's world, however, when we are listening to a concert of instrumental music, except where the texture is very dense or produced in a way which is novel to our ears, we are always very aware of the instrumental source of the sounds we hear. We might, in fact, go a stage further and notice that in the tradition of the virtuoso performance our awareness of the source and the performer's physiological, balletic, and dynamic relation to the source can become part and parcel of our aesthetic reaction to the concert experience. (Wishart, On Sonic Art)

As a composer and listener, I don't often contemplate just how or why the music we make is different, in essence, from what you might hear in a club, coffee shop, or a shopping center. The value of any body of music is ordinarily self-evident to its practitioners and fans. Discussions, in person and online, usually revolve around individual works or recordings and their specific characteristics. It is common to discuss how a piece might fit into the larger ecosystem of the genre in which the work is thought to belong. How does a particular piece succeed? How might it fall short? How does it compare or refer to previous work in that musician's output or to the music of others? How are certain genre expectations met or subverted? These are the types of questions usually considered when new recordings appear or in post-concert chats.

However, it is also useful to step back and consider several broader questions about what distinguishes our current musical practice. In what way might electroacoustic music be considered unusual or experimental (or not)? How do we derive enjoyment and fulfilment from it (when so many others do not)? An examination of such questions allows us to see better where we fit in the broader musical environment that surrounds us.

The Sounding Body

Long ago musical sounds were produced directly through the human body (the voice) or through an instrument, a mechanical transducer, activated by some exertion of the human musculature. There were a wide variety of such "transducers" that took various forms, but they all generally accomplished the same thing: they took energy from the human body and converted it into sound by setting some elastic object into vibratory motion. The hand hits an elastic membrane (a drum), the force of human breath blows a stream of air across a hole in a tube causing a vibration of air at the opening and this, in turn, excites the air contained in the resonant cavity (a flute), or perhaps a finger sets an elastic string into motion, through a plucking gesture and so on. Musical instruments are tools that translate body movements into sounding gestures and the musician's body has been omnipresent in music for nearly all of human history.

Further, in a traditional performance situation, listeners generally knew when the performance was underway and when it was over. The sounds of the singing voice or any recognizable musical instrument would instantly alert listeners that they were hearing what was intended to be understood as musical sound. Before electricity, music was generally produced with a comparatively small choice of acoustic instruments and voices. The limited and recognizable timbres as well as the common musical language and familiar performance cues and gestures all worked together to delimit that sound as music within a specific culture and time. Musical sounds, and musical performance were marked as separate from the ambient sounds of everyday life. The boundaries were clear. People knew music when they heard it.

Because we have a long history of listening to these musical sounds we learn to hear these sounds in relation to the bodies and events that produce them. As Don Ihde notes,

> Sounds are "first" experienced as sounds of things. That was the sound of the jackhammer with all its irritating intrusion. There, it's Eric calling Leslie now. That was definitely a truck that went by rather than a car. This ease that we take for granted and by which we "identify" things by sound is part of our ongoing ordinary experience. This common ability of listening contains within it an extraordinary richness of distinction and the capacity to discern minute differences of auditory texture, and by it we know to what and often to where it is that our listening refers. (Ihde 2007: 60)

Indeed, we tend to identify *all* sounds, traditionally musical and otherwise, in terms of the objects and events that create them. Independently, Vanderveer and Gaver both performed studies that asked people to describe everyday sounds using short phrases. They both found that people tended to describe the sounds they heard in terms of the objects and events that were the cause of the sound. Only when they confronted with sounds for which the sources were unknown did they resort to describing the intrinsic sensory qualities of the sound (Vanderveer 1979; Gaver 1988). Furthermore, Gaver noted that the accuracy of some of the identifications and descriptions were impressive with participants able to distinguish the sound of someone running up a flight of stairs with someone running down as well as the relative sizes of dripping water drops (Gaver 1993: 19).

As noted in the Wishart epigraph at the very top of this paper, this identification of the sound with its bodily source is likely a key part of our enjoyment of a virtuosic musical performance. This association is particularly strong for a musical instrument we are well acquainted with and able to imagine even if we ourselves cannot play it. We perceive that the body and the movements of the player are the source of the sound and are aware that those physical movements are intrinsically related to the nature of the musical gestures that we hear. In most acoustic music, the physiological gestures are transformed in a relatively direct manner into the morphology of the sounding gestalts we hear. The internal morphology of the individual sound events and shaping of musical phrases and groups usually shows a familiar and recognizable trace of the physical gesture that elicited those sounds and we therefore experience that music, at least partly, empathetically.

Until recently, nearly all music was firmly rooted in the body.[1] Music has long been associated with motor activity and with bodily gesture and the experience of music involved the perception of intentional and organized sequences of gestures as the cause of the temporally synchronous auditory signal. However, soon after the appearance of mains electricity at the very end of the nineteenth century, there came the electromechanical signal and the possibility of generating sound without much human energy at input or without using mechanical devices.[2] Further, the ubiquity of magnetic recording allowed for the storage of a signal as data on a magnetized medium. So, while a sound wave coming directly from a flute and a reproduced flute sound wave coming from a speaker has the same general acoustical nature, the process that elicited those sounds are very different. Trevor Wishart would say that these two sounds have the same *landscape*, which is to say that they have identical real or imagined sources (here, a flute) (Wishart/ Emmerson 1996: 139). Because that *landscape* is a traditionally musical one, the recorded flute sound is still easily recognized as music, though it has now become disembodied.

With electronics, sounds from the world, sounds not traditionally thought of as musical, can also become aesthetic entities for contemplation. When they do, the line between musical sounds and non-musical sounds is no longer clear and the boundaries between musical and non-musical territories are more easily crossed and more individually and idiosyncratically defined. No longer is there a broad understanding of what music is, what kind of cultural work it does, and what lies outside of its scope.

Combine this profound technological rift with some of the other changes that music has undergone throughout the past century or so. Performance conventions have broken down, metric regularity is no longer always certain, tonality has eroded, and uniform stable timbre-streams have broken apart. Further, traditional forms and teleological structures are no longer always adhered to. The borders of music become fuzzy.

In the art world, this confusion, of course, becomes fodder for many a smug cartoon of the rube who can't locate the boundary between art and everyday life. See the recent example of two teenagers who left a pair of eyeglasses at the San Francisco Museum of Modern Art only to have that confused as part of the exhibit (Mele 2016).

The same confusion has occurred in the world of music. With the arrival of electricity and recording technology, the variety of sounds now admitted into music is now vastly wider than ever before and music has become asynchronous and therefore disembodied. Recording technology has afforded the separation of the sound from any visual information, any physical event or gesture that might have elicited or initially accompanied that sound. But, with traditional musical instruments played in the conventional ways, we can still recognize the sound of a recorded performance as rooted in the body.

But now we have a whole universe of electronic music, which may be made up of musical gestures that closely resemble traditional acoustic musical sounds (warm string ensemble-like synth patches, synthesized drums and guitar string models) or comprised of more unusual sounds that may be completely dependent on electronics (starting with sine-tones, which are artificial in their extreme spectral purity).

Early on Pierre Schaeffer recognized that many electroacoustic sounds closely mimic real-world acoustic instrumental sounds while other sounds were truly new as these sounds are producible only through electronic means and are unlike sounds we experience routinely in the non-electronic world around us. To help distinguish sounds that are akin to typical musical sounds from the new and unusual electronically produced sounds he coined the term *facture*. In short, a sound exhibits *facture* if it is akin to a sound you already know from traditional acoustic music. If you can describe a sound as *flute-like* or *guitar-like*, it has *facture*. Sounds that do not have *facture* are often featured in science fiction films, for the obvious reason that they can seem unearthly and alien (Chion 2009: 219).

A useful expansion of Pierre Schaeffer's concept of *facture* is Denis Smalley's notion of *gestural surrogacy*. Smalley describes gesture as a sound that is elicited by a human agent through physical force (applying energy to a sounding body) to produce various musical or spectromorphological qualities (Smalley 1997: 111). He calls this linkage between physical motion and sounding result, the *energy-motion trajectory* (Smalley 1996: 84). Since the sounding gesture, the gestalt, is usually related to the physical gesture that produced it, listeners try to decode the source based on the spectromorphological qualities of the sound produced. Occasionally, there isn't an identifiable source. This sounds, thus far, much like Schaeffer's *facture*. However, Smalley add several new twists. He identifies various possible levels of disconnect between physical exertion and the resulting musical gesture. He calls this concept *gestural surrogacy* and outlines four orders, or degrees, of surrogacy within electroacoustic music (Smalley 1997: 112). The furthest from traditional music is *remote surrogacy*, which “is concerned with gestural vestiges. Source and cause become unknown and unknowable as any human action behind the sound disappears” (Smalley 1997: 112).

A full examination of these concepts is beyond the scope of this paper but their existence points to a unique category of musical sounds, a category absent from human music for centuries: musical sounds that only exists because of electronics. Further many of these sounds do not resemble the traditional sounds of music made by human physical gestures. For the first time in human history, we have the music of non-body. Music entirely generated by electronics or computer algorithm, synthesized, and played over loudspeakers. Music that could not have been made in the pre-electronic era. How do we understand that? And if there is an absence of body and we are no longer listening to and for bodily motion, what is it that we attend to?

Body, Mind, and Body-Mind

One of the most entrenched and pernicious ideas we commonly hold is the profoundly mistaken idea that a person consists of two separate entities, a mind and a body, in some way coupled together. This Cartesian mind-body dualism is so entrenched in our culture, so much a part of our language and thinking, that it seems impossible to dispel. Hence the prevalence of computationalism, the notion that your brain functions like a computer, which nowadays may seem compelling as metaphor but paints a problematic and incomplete picture (Epstein, n.d.; Piccinini, 2009). That the brain explains the mind and that the mind is what the brain does may have an intuitive appeal to it but it is not the entire story. Humans are fully integrated and deeply complex biologic organisms and we could no more live without a body than we could live without a brain. Further, body projection pays a key role in determining how the things we encounter in our world can be meaningful for us.3 We should remind ourselves of just how harmful this artificial mind/body division is if we wish to have a fuller understanding of human thought and meaning.

To undermine this body/mind dichotomy the philosopher and psychologist John Dewey coined the term body-mind to help us think more holistically and to remind us that what we call a body and what we call a mind are merely two aspects of a cohesive and inseparable whole.4 Of this problem Dewey wrote,

> The very problem of mind and body suggests division; I do not know of anything so disastrously affected by the habit of division as this particular theme. In its discussion are reflected the splitting off from each other of religion, morals, and science; the divorce of philosophy from science, and of both from the arts of conduct. The evils which we suffer in education, in religion, in the materialism of business, and the aloofness of "intellectuals" from life, in the whole separation of knowledge and practice—all testify to the necessity of seeing mind-body as an integral whole. (Dewey/ Sidorsky 2008: 27)

Humans are embodied creatures. We don't have bodies; we are bodies. Further, we have an environment that we interact with and it is this bodily interaction with the world that creates meaning for us. Dewey wrote extensively about the inextricable links between body, mind and environment and he felt that we must investigate the implications of our embodiment for perception, experience, understanding, feeling and reasoning:

> Since both the inanimate and the human environment are involved in the functions of life, it is inevitable, if these functions evolve to the point of thinking and if thinking is naturally serial with biological functions, that it will have as the material of thought, even of its erratic imaginings, the events and connections of this environment. And if the animal succeeds in putting to use any of its thinkings as means of sustaining its functions, those thoughts will have the characters that define knowledge. (Dewey/ Hickman/ Alexander 1998: 146)

If you make some simple phenomenological descriptions of your body and the way it interacts with the environment, you may observe what your resources are for making sense of the world around you and you might notice some recurrent mental structures and fundamental symbolic representations. Both Mark Johnson (Johnson 1987) and George Lakoff (Lakoff 1987), give these structures the name *image schemas* and the theory that is built around this notion of image schemas represents a rigorous attempt to relate conceptual structures to the nature of embodiment. Therefore, *image schema theory* most clearly investigates embodied cognition and the primary guiding principle of cognitive semantics, which asserts that conceptual structure is embodied.

Schemas are relatively abstract representations that are derived from the bodily experience of the everyday world around us, and Johnson proposes that one way that embodied experience manifests itself at the cognitive level is in terms of these image schemas. An image schema is "a mental pattern that recurrently provides structured understanding of various experiences, and is available for use in metaphor as a source domain to provide an understanding of yet other experiences" (Johnson 1987: 2–4).

Johnson argues that these image schemas provide the conceptual building blocks for more complex concepts and can be systematically extended to provide structure to more abstract concepts and conceptual domains-even mathematics. Johnson defines and explains dozens of these image schemas in his texts *The Body in the Mind: The Bodily Basis of Meaning, Imagination, and Reason* (ibid) and *The Meaning of the Body: Aesthetics of Human Understanding* (Johnson 2007). Here is just one image schema to show how they work, Johnson's description of what he calls the *container schema:*

> Because we must constantly interact with containers of all shapes and sizes, we naturally learn the "logic" of containment (for the CONTAINER schema). Containers have at least the minimal structure of a boundary, an interior, and an exterior. Through many experiences each day, we learn what the word into means, as we encounter the movement of objects as they pass from the exterior of a container across or through its boundary, finally coming to rest in its interior. We know, in a bodily way, that something that is inside a container is not outside it. We learn that if something starts moving within a container toward its boundary and eventually crosses over the boundary, then it is at least temporarily outside of the container. (Johnson 2007: 138)

We have this *container schema,* and we have what you might call *container schema understanding*. This fundamental image schema is a simple structure that we know via our embodied experience, and it has a specific logic and forms gestalts for us. It combines with other image schemas to create greater and greater levels of abstraction.

The body has and learns its own logic, such as the container logic above. These image schemas are learned automatically through bodily interactions with the world around us and they characterize the recurring structure of much of our sensory-motor experience. Consider, for example, how important verticality is for human beings. Generally, we are creatures that stand upright when we are awake, and this bodily experience creates a mental structure that influences how we experience the world. We have up/down orientation and because of the mirror symmetries of our bodies and facial features, we have left/right symmetries that we then project on to other things. If instead of being land-bound mammals characterized by erect posture, bipedal locomotion, and high-level manual dexterity coupled with larger, more complex brains, we were, say, shaped like crabs or Jellyfish and lived suspended in water or flying through the air, our bodily experience of the world, and the complex network of schemas we use to make sense of things, would be very different.

Johnson goes a step further; his radical claim is that sensory motor experience and meaning are central and form the basis of all meaning. Furthermore, higher cognition is tied to sensory-motor function. Johnson quotes Don Tucker:

> The brain evolved to regulate the motivational control of actions that are carried out by the motor system and guided by sensory evaluation of ongoing environmental events. There are no faculties of memory, conscious perception, or music appreciation that float in the mental ether, separate from the bodily functions. If we accept that the mind comes from brain, then our behavior and experience must be conceived of as elaborations of primordial systems for perceiving, evaluating, and acting. When we study the brain to look for the networks controlling cognition, we find that all of the networks that have been implicated in cognition are linked in one way or another to sensory, motor, or motiva-

> tional systems. There are no brain parts for disembodied cognition. (Johnson 2007: 99)

We use our perceptions and motor sensory experience of the world for basic structures and we then appropriate those structures for abstract thought. That is essentially Johnson's argument condensed to a single statement. I think that this has implications for our experience of music.

Mirror Neurology and Social Neuroscience

Recent work in cognition and embodiment has led to work in and the emerging field of social neuroscience. Work in social neuroscience helping us to understand how it is we are able to comprehend all the various communicative signals we encounter in our daily lives. Vittorio Gallese and his colleagues are investigating mirror neurology and what Gallese calls *embodied simulation theory*[5] and this may provide the critical link to our understanding of how we make sense of the actions and intentions of the people around us. The emerging picture suggests that the mirror neuron system provides a basis for representing infinite combinations of hierarchical structures and also provides a mechanism for mapping the movements and intentions of others on to our own motor system as means of understanding and anticipating the actions of others (Giacomo Rizzolatti/ Craighero 2004). This work, however, is still relatively new and not without its critics and detractors[6].

The investigations into mirror neurology started in the late 1980s and early 1990s, when neurophysiologists[7] at the at the University of Parma placed electrodes in the ventral premotor cortex of the macaque monkey to study neurons specialized for the control of hand and mouth actions such as taking hold of an object and manipulating it. During each experiment, the researchers allowed the monkey to reach for food and recorded the activity of single neurons in the monkey's brain. In this way, they were able to measure the monkey's neurological response to certain bodily movements. Unexpectedly, they also found that some portion of the same neurological areas also responded when the monkey merely observed a person picking up a piece of food (di Pellegrino/ Fadiga/ Fogassi, Gallese/ Rizzolatti 1992; G. Rizzolatti/ Fadiga/ Gallese/ Fogassi 1996) which suggests the presence of a type of neurological mirror resonance.

The next problem was how to confirm or refute the presence of mirror neurology in humans. It is not possible to study single neurons in the human brain without harm, so most evidence for the presence of mirror neurons in humans comes from brain imaging experiments using functional magnetic resonance imaging (fMRI). These have shown that the human inferior frontal cortex and superior parietal lobe are active when a person performs an action and when one sees another performing the same action. This indicates that these brain regions may contain mirror neurons (Iacoboni et al. 1999) just as found in the macaque monkey. This finding suggests that for humans too, the same brain regions are used for imagining actions and for performing them. Consequently, there is a physical connection in the mind between performing an act and observing the same act done by another, as well as merely imagining the act, remembering it or possibly even dreaming it (Nielsen/ Kuiken 2013).

This system is highly dependent on experience. Knowing how to do something well results in a better understanding of the performance of others. The same neurological network may be activated in response to observation as would be if the action were performed. Further, that activated is stronger if the action observed is one that the perceiver is familiar with. If I am proficient at performing a certain action then I will have a strong representation of that action in my own mind and I can use this strong activation in my own brain to make sense of other people's movements. For example, watching someone move objects with a pair of chopsticks might elicit a stronger neurological activation from the person who has extensive experience using chopsticks than from someone who never eats with chopsticks.

One study showed isolated movements by capoeira dancers and ballet dancers to novices and experts of both types of performance. The uninitiated were unable to distinguish, in isolation, the capoeira movements from the ballet movements. However, experienced ballet dancers and capoeira practitioners were able to tell, in the absence of other clues, which body motion was excerpted from each type of dance and further, produced greater neurological activity when presented with movements that they themselves had frequently performed. This indicates mirror neurological activity and that brain response to seeing activities is influenced by the level of acquired skill of the observer (Calvo-Merino, n.d.).

A similar study was performed with basketball with the added wrinkle that expert basketball players were able to predict with a higher degree of success if the shot would be successful, even if they did not see the trajectory of the ball in flight towards the basket. Experts only needed to see the shooting motion alone. Simply through observation of the shooter's motion up until the moment the ball is released from the hand, expert basketball players were able to tell something about the accuracy of the shot. Further, their predictions were quicker and more accurate than novices' and even those of people with comparable visual experience but less practice actually shooting the ball, for example coaches or sports journalists (Aglioti/ Cesari/ Romani/Urgesi 2008).

When reading about the mirror neuron system there is wide discussion about how language and action are supported by the mirror neuron system. In English we have several linguistic metaphors for conceptualizing the act of intellectual understanding. The two most common metaphors for understanding involve either *sight* or *grasp*. Metaphors of sight are frequently used in discussions of clarity. We use expressions such as, "I see what you mean," "shed some light" on a topic. Or we might say that "the lecture was murky," if we did not fully comprehend. We also use phrases with "grasp" to express how well we understood something. We try to "grasp" a point so we can "get it" or "get a handle" on an idea. We might say that notion we didn't fully understand was "beyond our reach."

As previously discussed, Mark Johnson's work includes a detailed discussion of how these metaphors work, cognitively speaking. He includes examinations of fMRI neuroimaging studies of subjects grasping objects, of people watching others grasp objects, and then of people merely hearing the word *grasp* both in a literal context and as metaphor (Johnson 1987: 165–170). Johnson notes that, "From a neural perspective, the conceptual metaphor hypothesis states that neural mapping is the basis for the conceptual mapping that constitutes a conceptual metaphor. Metaphorical mappings are physically realized in stable neural circuitry linking the sensorimotor system to other brain areas" (Johnson 1987: 167).

If there are conceptual metaphors, then there must exist neural connections between sensorimotor areas of the brain and other areas that are involved in thinking. It seems we not only activate the same neurological circuit to grasp something as we do when we observe someone grasp an object, or when we imagine it, but there is even activation when we also use the word *grasp* as a synonym for understanding. Johnson notes, "[t]he big question is whether our brains actually work this way. Do we use our sensorimotor neural circuitry for abstract reasoning, via metaphorical mapping structures? We do not yet know the answer to this question. However, there is at least some evidence from cognitive neuroscience for the plausibility of the embodied meaning hypothesis" (Johnson 1987: 167).

Music and Mirror Neurons

Human communication, whether it be spoken language, visual symbols, physical gestures, or a musical utterance, has at its root a bodily motion. Language and action have been described as being supported by the human mirror neuron system. If language and action both involve a deep coupling between the perception and production of hierarchically organized sequential information, might the perception of art also be mediated by the mirror neuron system?

The relationship between art perception and the mirror neuron system has been investigated, most noticeably by Gallese and his collaborators who have applied his theory to our enjoyment of film (Gallese/ Guerra 2012). It may be that appreciation of music is linked in the same way to mirror neurology and empathetic motor resonance and embodied simulation.

The work in this area is relatively new but it suggests further areas of inquiry concerning embodiment and listening. If the mirror neuron system is sensitive to auditory stimuli related to actions as stated in Molnar-Szakacs and Overy (2006: 236), what are the implications for soundscape composition if, for example, the sound of cracking peanuts or tearing paper does indeed ignite our brains in much the same way as actually cracking peanuts or tearing paper does (Gazzola/ Aziz-Zadeh/ Keysers 2006)? Further, what might be the relationship, neurologically speaking, between very similar activities? Does expertise and experience playing the guitar influence how we hear violin or piano music? What about arts in general? In a different context Pierre Bordieu noted that, "everything seems to indicate that knowledge and preferences tend to form into constellations that are strictly linked to the level of education, so that a typical structure of preferences in painting is most likely to be linked to a structure of preferences of the same type in music or literature" (Bourdieu/ Johnson 1993: 231). How would competency in literature translate into the appreciation of film? How about dance and music? Does a greater fluency in one area effect competency in another area or do these constellations of knowledge and preference arise form entirely from one's class, education, and habitus? Can one understand Kandinsky better by listening to Schoenberg?

It is clear that listening becomes emotion through a complex and dynamic interaction between auditory stimulus, attention, several cognitive networks, and neural systems, but just as in our basketball example above, the degree and nature of our musical experience modulates our understanding and experience of the music we hear. Even those with moderate levels of experience performing music exhibited enhanced musical responses related to emotion and reward (Chapin/ Jantzen/ Scott Kelso/ Steinberg/ Large 2010).

If the mirror neuron system provides a means by which listeners may experience music empathetically through motor resonance rather than by merely cognitively interpreting an internal representation, then what might this mean for music which is generated by algorithm and synthesized entirely without the intervention of the human body? Additionally, what if that music is made of sounds that are gesturally remote or exhibit no facture? Does the absence of traces of the body change how we experience this music? If the communication of emotion during listening to a musical performance is at least partially an empathetic process in which a listener feels the emotion communicated by the performer, what might this mean for music that doesn't have a human performer?

There is music that is clearly within the traditional frame, performed on known musical instruments and that produces gestures that are evocative of the physical motions that produced them. This is music of the body. This is music we may, at least partially, experience empathetically and through motor resonance. There is also music that is conventional in musical language and was initially performed on recognizable musical instruments but which through recoding technology becomes temporally asynchronous. While literally disembodied this music presents us little trouble and we have no problems recognizing what we hear as music. Further, we continue to hear the music as bodily performed and may still experience it empathetically. But now we have, for the first time in human history, the music of non-body. Music that was not produced by human bodily movement. How do we understand that? Is this music still mediated by the human mirror neuron system? And if there is an absence of body and we are no longer listening to and for body movement, what are we attending to?

It may be many years before we know the answers to many of these questions and if the current line of inquiry into social neuroscience will be provide the answers. Diverse listeners are attending in complex and sophisticated ways to an ever-growing nexus of genres of music and deriving enjoyment from them. I suspect that these different modes of enjoyment are related to the manner of production of the music, how deeply rooted these performances are in bodily motions, and how well listeners can discern those motions as responsible for the musical gestures they hear. The work in embodiment and social neuroscience suggests that when we listen to traditional music played in conventional manner, we are listing to bodies. What the Vanderveer and Gaver (Vanderveer 1979; Gaver 1988) studies both suggest that when we are listening to music which is not obviously tied to human gestures we experience those things intrinsically. Perhaps this is why so many composers endeavor to defamiliarize ordinary sounds, to encourage listeners hear them anew.

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[1] A notable early exception is the organ with its pneumatic system and elaborate array of large pipes. This allows for a music that in many ways exceeds the limits of the body both in terms of duration and loudness.

[2] Let us leave aside the semantic argument over whether speakers are mechanical devices, strictly speaking, the garden-variety dynamic cone speaker is mechanical as it produces sound waves through a moving voice coil (piston) and cone mechanism. Electrostatic transducers are also mechanical, while ribbon speakers, however do not have a voice coil.

[3] One fascinating example is pareidolia, which is a psychological phenomenon in which the perceiver responds to a stimulus, usually an image or a sound, by perceiving a familiar pattern where none exists. The most common examples are perceived images of faces in random images or in patterns of light and shadow or hearing indistinct voices in random noise such as that produced by air conditioners or fans. Since the quick perception of emotion through the recognition of facial expression is a key human survival skill, we have become virtuosic at reading facial expressions. Even simple stick figure faces and simply drawn emoticons are able to convey complex emotional information. We see faces on the moon, in clouds, in fossils. We see faces everywhere, even in places where there aren't any.

[4] Though this idea of a body-mind, with some variation, is found in many other places, from the work of Pierre Janet, Sigmund Freud and particularly Wilhelm Reich who developed it as vegetotherapy. It is also found in the Hindu and Buddhist concepts of Namarupa and in modern alternative medicine, holistic bodywork practices, and psychosomatic medicine. We don't need to trace all these appearances and variations of the concept or evaluate them, I merely point out that other traditions and practices have a more holistic concept of body-mind and that this idea isn't unique to Dewey.

[5] Briefly, embodied simulation theory builds on the implications of mirror neurology. It is in essentially a theory of social cognition, of how it is we understand others' actions, intentions, emotions, and sensations. Gallese states that "the fundamental mechanism that allows us a direct experiential grasp of the mind of others is not conceptual reasoning but direct simulation of the observed events through the mirror mechanism" (Gallese/ Keysers/ Rizzolatti, n.d.: 396). Further "Social cognition is not only thinking about the contents of someone else's mind … [o]ur brains, and those of other primates, appear to have developed a basic functional mechanism, a mirror mechanism, which gives us an experiential insight into other minds. This mechanism could provide the first unifying perspective of the neural basis of social cognition"(Gallese et al., n.d.:401).

[6] Here are just three critical looks among many ("A Calm Look at the Most Hyped Concept in Neuroscience - Mirror Neurons," n.d.); Hickok, 2009); de Bruin/ Gallagher, n.d.).

[7] Giacomo Rizzolatti, Giuseppe Di Pellegrino, Luciano Fadiga, Leonardo Fogassi, and Vittorio Gallese.

[Abstract in Korean | 국문 요약]
전자음악과 소리내는 몸체

케빈 파크스

전기가 일상화되기 이전 시기, 음악의 경계는 일반적으로 명료했다. 오늘날, 우리의 음악 경계선은 뮤직 테크놀로지를 통해 확장되어 음악은 더이상 물리적 행위의 결과로만 남아있지 않다. 신체에 독점적으로 기반한 음악이 더이상 아니다. 지금, 우리는 인간 신체의 한계를 뛰어넘는 초현실적인 음악적 색채을 누리고 있다. 또한 알고리듬으로 자동으로 만들어지는 생성 음악 generative music 도 갖고 있다. 더욱이, 녹음 기술의 편재로 일상의 소리와 음악적 소리 간의 구분도 갈수록 혼란스러워진다. 한 세기 전만해도 상상할 수 없었던 소리 세계가 그 결과이다. 여기서 저자는 이러한 새로운 비신체적 음악 소리를 경험하는 것이 기존의 신체 행위에 보다 견고하게 기반한 어쿠스틱 사운드를 청취하는 것과 어떻게 그리고 어떠한 이유로 달라질 것인가에 대해 연구한다.

PART II: Reviews

제2부: 참관기

We have the right to enjoy sound quality: Review of *Multimedia Music Performance – Synesthesia*

Cho, Jinok

This article discusses today's listening trends and author's attempts to the performance of a 24 channel loudspeakers orchestra in the concert, *Multimedia Music Performance – Synesthesia* played at *Incheon Robotland* on December 2018. It provides a brief history of technological development in our everyday life for recent decades and the consequent changes of our listening styles. The recent high-tech sonic environment looks more useful and accessible to higher-quality arts for people. However, the author points out that listening has been belittled and rather treated discriminatingly as much as the power of visual media and devices has evolved. Successively, he addresses that the duty of contemporary musicians would be to open audience's ears to really deepen pleasure in association with the stereophonic sound technology. In order to provide the optimal place to listening to music, the assumable interference like physical actions are limited. Also, the visual elements are set to be closely responsive to the sonic movements for the same reason. Listening should advance in line with seeing by employing actively any other media to enjoy routinely the good quality of sound.

좋은 소리를 들을 권리가 있다: 멀티미디어 음악展-공감각 참관기

조진옥

볼거리와 들을거리가 넘쳐난다. 우리 손 안에 다재다능한 컴퓨터이자 통신기기가 하나씩 들려있고, 말 한 마디로 음악을 켜주거나 보고 싶은 영상을 찾아주는 기계 속 친구도 구할 수 있다. 그럼 우리는 그 풍성한 양에 비례하는 좋은 질의 소리와 영상 콘텐츠를 소비하며 즐기고 있을까?

과거 각 집 거실마다 전축이라 불리던 커다란 오디오 세트가 있었고, 그 크기가 마치 부의 크기와 비례하는 듯 여겨지던 시절이 있었다. 1980 년대를 지나 1990 년대에 이르러 이러한 대형 오디오 시스템의 유행은 아파트 생활의 보편화 및 핵가족화와 맞물려 미니 콤포넌트의 인기로 변화했고, 다른 한 편으로는 커다란 브라운관 티브이TV 와 돌비 프로로직 포맷이 만나 5.1 채널 홈시어터 시스템의 유행으로 변화했다. 이 후 비디오 시디 및 레이저디스크 등을 거쳐 디브이디에 이르기까지 시청각 매체의 발달과 더불어 홈시어터는 승승장구 했으며 많은 가정의 거실을 차지했다. 이렇게 대략 1990 년대까지 소리재생 매체와 기기는 과거 일반 소비자들의 핵심 여흥 도구에서부터 시각매체와 긴밀히 결합된 형태로, 그 핵심적 지위를 동등하게 나누어 가지게 되었다.

그렇다면, 2018 년 현 시점의 시청각 콘텐츠의 소비행태는 어떠할까? 많은 사람들이 영화도 드라마도 강의도 음악도 단연 손 안의 작은 스마트기기로 보고 듣는다. '편의성'이 다른 모든 요소들을 압도한다. 이제 가정 거실의 핵심 가전제품은 오디오세트나 홈시어터가 아니고 대형 디지털 티브이다. 대다수의 사람들은 소리의 품질에 크게 신경쓰지 않게 되었다.

그럭저럭 티브이 자체 스피커로 만족하거나 작고 얇은 사운드바 정도를 연결하여 듣는 경우가 압도적으로 많다. 여섯 개 이상의 스피커를 거실을 둘러싸고 설치하여 입체감 있는 소리를 즐기던 홈시어터는 찾아보기 힘들다.

과연 그 동안 어떤 일이 있었던 것인가? 지난 이십 여 년 동안 영상 재생기기의 화질은 놀라운 발전을 거듭해 왔다. 디브이디의 해상도를 뛰어넘는 고해상도-HD 라는 단어를 들은지 얼마 지나지않은 것 같은데 FHD, QHD 를 거쳐 UHD-4K 의 해상도를 갖는 영상이 방송되고 있으며, 심지어 가전업계는 4K 콘텐츠가 보편화 되기 한참 전임에도 불구하고 이미 8K 해상도의 티브이를 내놓았다. 해상도 외에도 동그랗던 CRT 방식의 외형은 평평해지고 얇아졌으며 몰입도를 위한 곡선 티브이도 등장한지 오래이며 최근에는 돌돌 말 수 있는 화면까지 등장했다. 그렇다면, 같은 기간 음향 재생기기 및 매체는 어떤 변화를 했을까? 온전한 소리 재생매체는 CD 와 CD 플레이어를 정점으로 그 인기가 급격한 하향세를 걷는다. SACD, DVD-AUDIO 등의 차세대 매체와 기기로의 전환이 시도되었으나 처참히 실패하고, mp3 와 같은 손실압축 포맷의 스트리밍 음원에 그 자리를 내주었다. 이제는 소리를 담은 매체와 재생기기를 구입하지 아니하고 온라인에서 바로 재생하여 듣는 것이 일반화 되었다. 소위 말하는 음악의 소유에서 소비의 시대로 바뀐 것이다.

이 변화들을 콘텐츠 품질의 측면에서 요약하면, 지난 수십년 동안 시각매체와 기기가 발전에 발전을 거듭하는 동안 소리는 오히려 뒷걸음질만 친 것이다. 심지어 상당수의 사람들은 저음이 전혀 나오지 않는 작은 스마트 기기의 스피커로 음악을 듣는데 거리낌이 없다. 어린 시절 VHS-비디오 재생기와 5.1 채널 홈시어터 시스템으로 감상한 영화 '늑대와 함께 춤을' 속 버팔로 떼가 만들어 내는 생생한 저음은 이제 추억 속에만 존재하는 듯하다.

소리를 통해 자신을 또는 다른 무언가를 표현하는 작곡가에게 소리가 홀대받는 듯한 이러한 변화와 현상은 무척 아쉽고 섭섭하기까지 하다. 그러나, 손놓고 앉아있는 것이 예술가의 자세는 아닐 터, 소리에 더 집중하여 좋은 작품을 만들고 청중들에게 소리가 주는 즐거움을 알려야하지 않겠는가? 그러기 위해 나는 '라우드스피커 오케스트'라고 하는 많은 수의 스피커를 이용한 작품을 계획했다. 전자음향을 표현도구로 삼는 작곡가에게 되도록 많은 위치에 많은 수의 스피커를 배치하는 일은 표현의 가능성을 크게한다는 면에서 늘 설레고 즐겁다. 비록 그 과정이 체력적으로 다소 고통스럽더라도 말이다.

2015 년 1 월, <멀티미디어 음악극 - 수궁가>라는 제목의 작품을 무대에 올렸다. 여기서 소리꾼과 고수라는 전형적인 판소리 편성에 대금주자를 더하고, 영상과 조명, 그리고 24 채널 라우드스피커 오케스트라를 통해 수궁가의 드라마적 요소를 극대화하고자 했으며 어려운 옛말들을 쉽고 간결하게 풀어 보고 듣는이의 즉각적 이해도를 높이고자 했다. 아울러, 입체음향시스템을 통해 소리 객체가 다양한 방향으로 자유로이 이동하고, 수궁가의 배경이되는 물속과 뭍을 순식간에 넘나드는 역동적인 공간감을 연출하고자 했다. 뿐만 아니라, 관객들이 소리에 좀 더 집중케 하고자 소리꾼은 부채와 같은 소품을 사용하지 않고 손동작도 배제했으며 연주자들은 모두 의자에 앉아서 연주하게 했다. 더욱이, 영상을 공연 전체에 사용하지 아니하고 새로운 장면배경을 짧게 제시한다거나, 상징성 있는 중요한 동작이나 장면을 빠르게 등장시켰다가 이내 사라지게 하는 등 매우 제한적으로 사용했다. 이와 같이 '멀티채널 음향을 통한 입체감의 표현'을 중심에 놓고 나머지 요소들을 부가적으로 사용하여 관객들이 소리에 집중하면서도 극의 흥미를 잃지않는 새로운 수궁가를 연출할 수 있었다.

2018 년 11 월 다시 24 채널 라우드스피커 오케스트라를 인천 로봇랜드에 설치했다. 음악을 전시한다는 개념과 <멀티미디어 음악展-공감각>이란 제목으로 사흘 동안 관객을 맞았는데, 기존의 내 전자음악 작품들을 24 채널 음향 환경에 맞추어 재구성하고 재생되는 소리에 실시간으로 반응하는 3 채널의 FHD 영상을 프로젝터를 통해 3 개 벽면에 투사시켰다. 이 공연/전시에서는 멀티채널 시스템을 통한 입체음향에 매우 긴밀하게 반응하는 영상을 결합시킴으로써 관객들에게 시각과 청각 정보를 동등하게 제공하고 경험케하고자 했다. 이 것은 관객들이 소리에 더 집중해주길 바라며 다른 요소들을 제한적으로 사용했던 '수궁가'의 경우와 매우 다른 지점이며, 최근 몇 년간 미디어아트 현장에서 보고 배운 경험이 큰 영향을 끼친 탓이기도 하다.

24 채널 오디오는 세 개의 옥토포닉 시스템을 더하여 구성하는 의미가 있는 동시에 보유한 하드웨어를 현실적으로 활용하기 위해 내린 선택이기도 하다. '수궁가'와 '공감각'에 사용된 오디오 인터페이스는 썬더볼트 방식의 MOTU-16A 로

열 여섯 개의 아날로그 아웃과 두 개의 ADAT 출력을 지원하여 총 32 개 동시 출력의 활용이 가능하나, 예기치 않은 상황을 대비한 예비 출력의 확보 등을 고려했다. 사실, 24 개의 출력을 사용하여 스피커 시스템을 설치하는 일도 실로 매우 까다로우며 시간이 굉장히 오래 걸리는 일이다. 그리고, 시스템적으로 안정적인 공연/전시를 위해 소리와 영상을 제어하는 컴퓨터를 나누어 사용했는데, 예를들어 '공감각'에서 소리는 매킨토시 랩탑이, 실시간 영상은 다섯 개의 아웃을 지원하는 비디오카드 RX580 이 탑재된 데스크탑에서 각각 맡아 처리했으며 무선 인터넷공유기를 통해 두 컴퓨터가 통신하게 했다.

시각정보는 청각정보보다 더 강렬하고 즉각적이다. 이는 부인하기 힘든 사실이다. 하지만, 대다수 보통의 사람들이 더 크고 좋은 화면에 열광하는 동안 좋은 소리에 대한 관심이 후퇴를 거듭한 것은 뼈아프다. 좋은 소리를, 음악을 듣는 행위가 얼마나 즐거운지 청중들에게 알릴 의무가 작곡가에게 있다. 라우드스피커 오케스트라와 같은 어찌 보면 극단적인 형태의 시스템이 아니더라도, 소리를 통해 입체적 공간감을 만들어 내고 이를 통해 청중들의 흥미로운 경험을 이끌어 내는 작업을 꾸준히 해 나갈 생각이다. 이를 위해 소리가 다른 여러 매체와 손잡는 일 역시 적극적으로 할 생각이다, 체력이 허락하는 한. 더 많은 사람들이 소리가 만들어 내는 즐거운 경험을 일상적으로 했으면 좋겠다.

Clarinet and Electro-Acoustic Music: Reviewed by Performer's Perspective

Kim, Geonjoo

The purpose of this paper is to share the knowledge that I learned from my experiences of performing some post mid-20th century pieces for clarinet and electronics. The clarinet has been a popular instrument for contemporary composers for its wide range in register and dynamics so as to perform special techniques. These advantages have increased with the advent of electronic technologies. William O. Smith's *Duo for Clarinet and Tape* (1960), Charles Whittenberg's *Study for Clarinet and Tape* (1961) and Morris Knight's *Refractions for Clarinet and Tape* (1962) are a few pioneering pieces for clarinet and electronics at the beginning of the 1960's.

Since I entered a graduate school for my DMA, I was instantly attracted to the combination of sounds of clarinet and electronics, and I persistently worked on producing various clarinet colors. This led to my final dissertation, "Performer's Guide to Selected Works for Clarinet and Electro-Acoustic Music". Every year, I set a concert program that consists of composition works only for clarinet and electro-acoustic music. These pieces are performed by collaboration between contemporary composers and myself, and I always make a special effort to communicate with the audience. At the 2017 performance, I chose pieces composed in 10 years apart from 1970 to 2000 in order, and presented the concert with focus on showing the advancement of the clarinet and electro-acoustic music. In the 2018 performance, I played pieces that were consisted of all premieres with the same instrumental setting. These pieces were performed again at the Seoul International Computer Music Festival (SICMF), the International Computer Music Conference (ICMC), and other venues.

Based on the works that I have played, I would like to talk about three types of electroacoustic music for clarinet: first, music with fixed-media, second real- time electronic processing, and the last is with live-video. Also, it provides what I felt and learned as well as suggestions from the performer's perspectives.

연주자 관점에서 바라본 클라리넷과 전자음향을 위한 창작음악

김건주

이 글은 클라리넷과 전자음향이 결합된 20세기 중반 이후부터 생산이 시작된 특정한 음악장르에 대한 관심과 연구, 연주를 통한 직접 경험을 통해 얻은 정보와 지식을 나누는데 그 목적이 있다. 클라리넷은 상대적으로 넓은 음역과 셈여림은 물론 다양한 특수 주법 등을 이용한 폭넓은 표현력으로 현대음악 작곡가들로부터 꾸준히 사랑받아 오고 있다. 이러한 클라리넷의 장점은 전자음향과의 결합으로 더욱 증폭되는데 1960년대 초반 William O. Smith의 *Duo for Clarinet and Tape* (1960), Charles Whittenberg의 *Study for Clarinet and Tape* (1961), Morris Knight의 *Refractions for Clarinet and Tape* (1962)와 같은 작품을 기점으로 하여 클라리넷과 전자음향을 위한 새로운 곡들이 등장한다.

나는 대학 입학 이후, 클라리넷과 전자음향이 만들어내는 끝없는 음색적 다양성에 매료되어 특별한 관심을 가지고 꾸준히 연구하고 연주해오고 있으며, <Performer's Guide to Selected Works for Clarinet and Electro-Acoustic Music>이란 제목의 논문으로 박사학위를 받았다. 특히, 매해 클라리넷과 전자음향을 위한 작품만으로 구성된 연주회

<Electronica>시리즈를 통해 동시대 작곡가들 및 청중들과 활발하게 소통하고 있다. 2017년 연주회에서는 1970년대부터 2000년대까지 10년 단위로 작품을 선정하여 시대변화에 따른 작품변화의 경향을 소개하였고, 2018년 열린 연주회에서는 새로 작곡되어 처음 연주되는 작품들로만 구성한 바 있다. 아울러, 서울 국제 컴퓨터음악제(SICMF), 국제 컴퓨터음악 컨퍼런스(ICMC) 등 다양한 무대에서 연주하였다.

직접 연주해본 작품들을 작품형태에 따라서 클라리넷과 '고정매체 재생,' '라이브 프로세싱,' '영상재생' 이렇게 세 가지로 나누어서 각각의 특징들과 더불어 연주 시 느낀 점, 주의할 점 등에 대해 설명하고자 한다.

클라리넷과 고정매체 재생작품

연주자의 입장에서 고정매체 재생작품들은 연습과 준비과정이 상당히 많이 요구된다. 전자음향 부분이 완벽하게 고정된 상태에서 클라리넷은 매우 정확하고 정교하게 그에 대응하여 연주해야하기 때문이다. 특히 템포가 빠르며 악기와 전자음향이 매우 높은 수준의 상호일체감을 표현하는 작품일 경우 더욱 까다롭다. 그 대표적인 예로 미국 작곡가 잭 브라우닝의 시스템 도미네이터(2000)와 크랙 해머(2004)가 있다.

Music for Clarinet and Fixed-media

It is challenging to collaborate with the fixed-media, because a performer should very accurately respond to the firmly fixed sound. Especially when the music is in fast tempo and in unison with each other, it is even harder to play with it together. An American composer Zack Browning's *System Dominator* (2000) and *Crack Hammer* (2004) are the examples of this type of music.

그림1. 크랙 해머 mm.117-120, 4th=120.

그림2. 크랙 해머 mm.54-57.

그림3. 시스템 도미네이터 mm.61-69, 4th = 144.

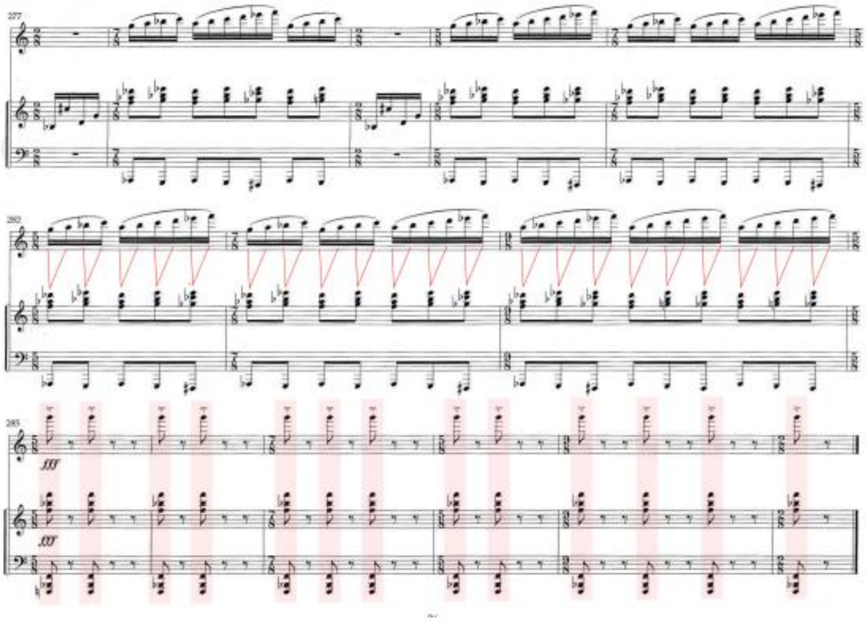
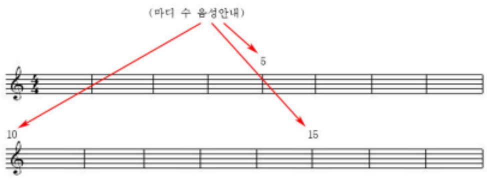


그림4. 시스템 도미네이터 mm.277-290.

또 다른 예로는 작곡가 현종찬의 클라리넷과 컴퓨터 (2010/2015개작)인데 연주자가 귀에 이어폰을 착용하고 클릭을 들으며 진행한다. 클릭을 들어보면 작곡가가 사전에 일정한 간격으로 마디 수를 음성으로 녹음을 해놓았다. 이는 연주자가 파트를 놓쳤을 경우를 위한 대비인데, 개인적인 견해로 클릭장치는 고정매체 재생 작품을 연주할 때 안정적인 연주 속도와 진행하는데 있어서 반드시 필요하고 생각한다.

Another example is a Korean composer Hyun's *Clarinet and Computer*, composed in 2010, revised in 2015. During the performance, a performer hears the clicking sound like metronome through the earphones. I also asked to record the measure numbers occasionally which indicates where to in and out. I personally think that these are all very helpful for the stable performance.

그림5. 마디수 음성 안내.



보다 정교한 정확성을 위해 Animated Score를 이용한 작품이 있었는데 작곡가 크리스 말로이의 천상의 숨(2015)이다. 모니터 화면을 통해 연주시작부터 끝까지 움직이는 신호[Ex6]를 따라가면서 연주를 진행한다. 쉬었다가 들어가는 부분[Ex7]도 모니터 화면에서 표시를 해주기 때문에 템포, 타이밍에 대한 두려움은 없는 것이 장점이었다. 따라서 고정매체 재생작품들은 전자음향파트에 대한 정확한 숙지와 템포에 대한 민첩한 변화 등 연주자에게 상당히 많은 준비 시간을 요하는 작품형태이다.

An American composer, Chris Malloy uses an animated score in his work, *A Celestial Breath* (2015). During the performance including the big pause, a performer can follow the moving indicator in the score on the screen. Therefore, the performer feels safe in terms of tempo and timing.

그림6.

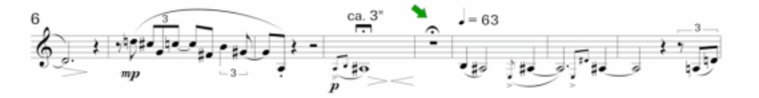
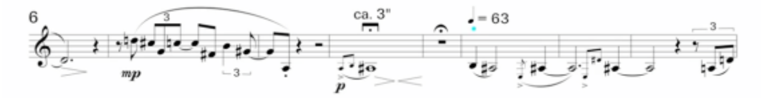


그림7.



라이브 프로세싱 작품

연주자의 입장에서 라이브 프로세싱 작품은 전자음향 부분이 고정 되어 있지 않기 때문에 사전에 작곡가와 충분한 의견수렴이 필요하며 곡에 대한 정확한 의도를 파악하고 있어야 한다. 또한 기술적인 면에서도 연주자의 컨트롤이 필요한데 대표적인 예로 작곡가 고병량의 내가 지금 하는 건, 상념에 잠긴, 막다름(2018)이다. 클라리넷에 무선마우스를 장착하여 연주자가 포인트Mouse Cursor를 모니터 화면에 직접 움직이며 사용한다. 모니터 화면을 보면 총 4개의 색깔이 다른 칸으로 나뉘어져 있으며 작곡가가 표시해놓은 위치(위, 아래, 좌, 우)에 포인트를 맞춰놓고 연주를 하는데, 이때 클라리넷 소리는 포인트 위치에 따라 소리와 효과가 변화한다. 또한 연주 시간을 연주자가 전적으로 생각하며 진행을 하는데 직접 페달을 밟으며 곡의 섹션들을 바꿔나간다. 어떤 시점에 연주진행을 바꿔야 하는지, 소리 변화 반응도 체크를 하며, 포인트 위치를 정확하게 맞춰서 연주[Ex8]해야 한다. 이와 같이 동시다발적으로 발생하는 여러 상황들에 대해 무엇보다 연주자의 순발력과 숙련도가 필요한 작품의 형태이다.

Real-time Electronic Processing

The most remarkably different thing of the real-time processing from the fixed-media is that nothing is really fixed. That is, this is aleatory. Therefore, a performer should thoroughly understand the contents, the process, and the composer's intention before the performance. Furthermore, sometimes a performer is asked to mechanically control the music while playing the instrument. A Korean composer, Ko's What I am doing, being lost in conception, coming to an end (2018) is under this category. A microphone and a cordless mouse are installed on the clarinet. Score is in the iPad and page-turning is controlled by the pedal. Then, the performer indicates the part of the score with the cursor as suggested by the composer and plays the given notes at the same time. The sound is kept changing and modified by the pre-set program on the score. The performer controls the rhythms, when to move to the next systems and pages, and of course the entire duration. This was the trickiest but interesting work out of all.

그림8.

같은 예로 조진옥 작곡가의 운무(2016)는 클라리넷 연주가 컴퓨터에 의해 여러 가지 형태의 소리로 변형이 되는데 미리 주어진 음의 조각들을 연주자가 랜덤으로 선택하여 순서를 배치하며 작곡가와 같이 조화를 만들어나가며 연주해 나간다. 이 역시 연주자의 소리 변화에 대한 섬세함과 순간적인 판단이 요구 되어 진다. 또한 라이브 프로세싱 작품들은 간혹 예상치 못한 사건들(기계의 오작동등)로 인해 연주가 중단 될 수도 있는 상황들을 항상 염두에 두어야 한다.

영상재생작품

클라리넷과 전자음향과 그리고 영상재생 이 세 가지가 한 번에 보여 지는 형태의 작품이다. 대표적인 예로 오예민 작곡가의 Contrapuntal Illusion (2017), The Way the Wind Sounds (2018)이 있다. 시간을 이용한 작품으로서 악보에 초단위로 표시[Ex9]가 되어있다. 연주자는 시계를 보며 타이밍을 맞춰 나간다. 연주자가 위치를 옆, 앞과 뒤로 옮겨가며 연주를 하는데 카메라가 현재의 모습과 이미 지나간 모습 또 그것을 녹화, 빠르게 재생 하여 관객들에게 여러 명의 연주자가 마치 같이 연주를 하는듯한 모습을 보여주게 된다.

Another Korean composer Cho's *Dance of Clouds* (2016) is somewhat different from the former: A performer chooses short pieces of scores out of ten in random order. As the performer plays them, the composer simultaneously modifies the sound. Since the performance is perfectly controlled by the collaboration of the composer and the performer, both of them should be sensitive to successively modified sounds and be able to give quick and smart decisions. Performers should always be ready for unexpected situations, such as interruptions and cancelations caused by machine malfunction. Also, since during the performance, most of the elements could be changed in diverse ways, performers are more tensed up than any other genre.

Live Video

This type of music consists of an acoustic instrument, which is clarinet, electronic sound and video. A Korean composer Oh's *Contrapuntal Illusion* (2017) and *The way the wind sounds* (2018) are in this category. Each section is measured by the exact time like certain seconds. As the performer plays each section, it is recorded on the video tape and replayed on the screen on the stage where and while the performer is playing the other section. In other words, the present performer and the past performers are playing the music at the same time on the screen on the stage.

그림9.

그림10. 영상 활용

다음, 안성희 작곡가의 Digilog-Fantasy(2018)는 작곡가가 전달하고자 하는 바를 영상으로 담아 스크린을 통해 보여준다. 이것 역시 시간이라는 매개체를 이용하였는데 시계를 보며 악보에 주어진 부분들을 연주해 나간다. 기존의 박자를 시간이 대신하며, 영상을 통해 메시지를 전달함으로서 관객들의 눈과 귀를 동시에 충족 시켜주는 장점이 있다. 또한 연주자가 연주를 함에 있어서 시간을 사용한 덕분에 표현이 비교적 자유롭다. 하지만 이것 역시 정해진 약속에 맞춰서 움직임이나 정확한 시간에 맞춰서 연주해야하기 때문에 정교함이 요구되는 작품 형태이다.

Another Korean composer, Ahn delivers her message with the video in her work *Digilog -Fantasy* (2018). This work also deals with time as a medium. A performer can watch the clock while following the given score. That is, the time substitutes the rhythm or tempo which is more familiar with the most of the musicians. The advantage of this work is that the audience can appreciate the piece visually as well as audibly at the same time.

결론

클라리넷과 전자음향 창작작품은 연주자와 작곡가가 같이 작품을 만들어 내는 것이라 생각된다. 작곡가는 작품이 의도하는 바와 원하는 것을 명확하게 연주자에게 전달을 해야 한다. 생각하는 소리와 실제로 연주했을 때 효과 차이도 있을 수 있으며 기존의 기법들 외에 새로운 효과들을 같이 만들어 나갈 수 있기 때문이다. 연주자는 기본적인 사운드 프로세싱에 대한 이해가 필요하며 작품의 특성과 성격을 분석하여 연주준비를 해야 한다. 또한 기존의 익숙한 연주 틀에서 벗어나려는 노력도 필요하며 평소에 익숙하지 않은 장비활용에 대한 적응 과정이 필요하다.

각각 다른 성격의 전자음악 작품들을 접하면서 연주자로서 많이 배워가는 경험이었으며 앞으로도 더 다양하고 새로운 것들에 대한 시도를 함께 함으로써 클라리넷과 전자음향 작품들의 대중화와 레퍼토리 확장에 기여하고자 한다.

Conclusion

It is totally a collaboration between a composer and a performer. The composer should clearly deliver the compositional intent to the performer, because there would be a difference between the imaginary sound and the real sound, and also the performer could suggest another or even better techniques to make the ideal sound. Performers should necessarily understand basic sound processing and characteristics of the composition as a preparation of the performance. On top of that, performers are expected to try to break the bound of the accustomed acoustic performance and, furthermore, learn how to use unfamiliar devices.

As facing various types of electro acoustic music, I have learned so many things and look forward to attempting to perform even more diverse kinds of electro acoustic music. So, eventually I would like to contribute to the development as well as enlargement of the electro acoustic music.

Communication and solutions between composers and performers: Performer's experiences in *International Computer Music Conference 2018*

Kim, Yookyung

My writing is based on personal experiences as a flutist performing for International Computer Music Concerts 2018. Preparing various types of musical works accompanied with electronic processes and computers, I have considered seriously performers' difficulties and frustrations that they could frequently meet when working for electronic compositions, and tried to seek proper ways of communication and solutions between performers and composers. I also talk about what kind of musical works that performers yearn to play, and some questions that I should ask to composers for successful performance in this field are followed.

전자음악 작곡가와 연주자 사이의 커뮤니케이션과 솔루션: 국제컴퓨터음악제에서 연주한 경험을 바탕으로

김유경

이 글은 저자가 국제컴퓨터음악제 2018(ICMC2018)에서 플루트 연주자로서 참가한 경험에 대한 몇 가지 느낀 점들을 적은 것이다. 컴퓨터와 함께 연주되는 다양한 작품을 준비하면서 연주자로서의 입장을 솔직하게 대변하고 작곡가와 연주자 사이의 소통과 그 해결점에 대해 고려해보고자 한다. 처음으로, 연주자로서 접하게 된 것은 악기에 대한 충분한 이해가 기반되지 않은 그저 실험적 테크닉들이 쉴새없이 나열된 듯한 악보였다. 복잡한 음표들이 꽉 들어차 있어 난잡해 보이고 기승전결이나 음악적 논리를 찾아보기 어렵다. 악보를 읽어 나가며 무엇을 해야 하는지 연습을 하면서도 무엇을 하고 있는지 알기 어렵다. 곡의 제목과 음악을 연결하기 어렵고 작품의 본질적인 의도를 찾기 어렵다. 연습하면 할수록 연주자로서의 의지가 낮아지기에 이르른다. 다음은, 시간을 정해두고 초second 안에 연주를 마쳐야 하는 작품들이다. 요즘 전자음악이 추구하는 경향인듯하나실제로 이에 맞추어 연주하기는 어렵다는 것이다. 컴퓨터가 아닌 사람 연주자가 기계처럼 연주하기를 원하는 것은 이해하기 어렵다. 어떤 작품은 초를 반드시 지키도록 요구했지만 어떤 다른 작품은 악보에 적힌 초를 무시하고 연주자가 임의로 연주하도록 한다. 얼마만큼 임의로 시간을 주어야할지 답을 찾기 어렵다.

There were several works that were full of experimental extended techniques. On top of that, some of them constantly had complicated rhythms with unorganized or incomprehensible structures. Also, I could not figure out the relationship between the music and the titles. These kinds of work make me discouraged to practice and to find out the ultimate purpose of work. In a lot of works, I was asked to play the music within the given period of time. In other words, measures were measured by the exact time like certain seconds. Then, I could not understand that if the composer wanted me to play the music with no emotion or not. If so, I wondered if the composer expected mechanical performance as AI does. Also, some composers who already gave me a time-measured score like I explained above suddenly asked me to ignore the instructions regarding the time on the score in rehearsals. Then, I had no idea how long I should play each measure as well as the entire work. I am wondering if this is a recent tendency of electro acoustic music and what the eventual pursuit of this kind of music is. Any kinds of explanations about work are always helpful. If they were provided in advance, it would be even better.

악보와 다른 작곡가의 지시사항은 목표를 향해 나아가려는 연주자의 길을 잃게 만든다. 이러한 종류의 음악은 감정을 없애고 건조하게 가는 것인지, 진정 사람의 감정을 배제한 음악을 추구하고자 하는 것인지 궁금하다. 그리고, 악보 뿐 아니라 연주자의 작품에 대한 깊은 이해를 위해 연주 전 작곡가들의 충분한 설명과 작곡의 의도를 알려주어야 하는데, 그렇지 않는 경우가 허다하다. 연주당일 만나서 악보를 바꾸는 행위는 연주자에게 매우 당황스런 일이다. 마지막으로, 연주자들의 악기와 음색을 상하게 만드는 지나친 실험적 테크닉은 그리 현실적이지 않다. 악기에 대한 학습 없이 어쿠스틱한 연주로는 불가능한 다이나믹이나 주법 등을 요구하는 경우도 적지 않다.

However, it happened in a few composers only. In addition to that, some composers switched the scores on the very day which made me very frustrated. In some cases, I was asked to play too much exceeding experimental extended techniques in a row and extreme dynamic levels which were totally impossible to play with acoustic performance.

연주자가 작곡가에게 원하는 작품은 이러하다. 첫째, 다양한 기법들이 빛을 발할 수 있는 음색을 만들어낸 작품이다. 악기에 대한 충분한 이해가 선행되어야 한다. 이 과정이 작곡보다 선행되었으면 좋겠다. 그래야만 다양한 기법들이 잘 표현될 수 있다. 책 속의 악기만 알고 쓴 작품과 실제로 연주를 하면 할수록 좋은 작품은 구분된다. 악기가 낼 수 있는 다양한 음색과 그 잠재성을 기반으로 한 작품들을 만나면 연주자들도 배우는 게 많다. 소리가 표제와도 잘 맞는다면 그 효과는 배가 되며, 청중들에게도 환영받는다. 수준이 높은 연주자일수록 음색에 대한 진지한 고민을 하게 되는데 이를 함께 이끌어주는 작품들이 있다. 카야 사리야호는 새에 대한 시를 읽고 진정 새를 표현하는 음색을 만들게 한다. 연주자들이 현대음악을 기피하는 경우는 악기가 지나치게 상하거나 음색이 너무 거칠고 빽빽거리기만 할 뿐 다른 의미를 찾기 어려운 작품들이다. 쉴새없이 빼곡한 음표들보다 연주자의 해석력과 연주력을 자극시킬 수 있는 작품을 희망한다.

I would like to encourage composers to study instruments thoroughly before they compose music. Insufficient knowledge of instrument causes many problems. Some performers tend to avoid playing such music. The reason is that it is just impossible to play and some techniques easily hurt the instrument. If the composers can understand the techniques and the actual sounds, they can express better what they really wanted to say through the music and the performers also to interpret the music even so much better than it was written. I had an experience to play Kaija Saariaho's *Laconisme de l'aile* meaning the conciseness of fluttering wings for flute and electronics on my own recital. The score itself did not look very fancy nor complicated, but I could notice that the composer understood the flute very thoroughly and put the right skills in the right places. Of course, the music was tightly related to its title, so that I could understand what I should do. The audiences were also very excited and curious about the music after the recital, and even several months later after the recital, there were still people asking about the piece who attended my recital. I would say that sophisticated performers seriously deliberate the timbre more than just the tone itself. However, I was very lucky to have a chance to learn so many things from Saariaho's work and hope I can meet many more pieces like this by many of you in the near future.

끝으로, 연주자가 전자음악 작곡에 대해 네 가지 질문을 던진다. 첫째, 전자음악은 시끄러운 음악인가, 모든 전자음악은 시끄러운가. 둘째, 전자음악이 추구하는 음악적 경향이 무엇인가. 셋째, 사용 기법이 어떤 효과를 위한 것인가, 구체적으로 어떠한 테크닉을 원하는가. 넷째, 왜 지속적으로 의미없이 나열을 하는가.

There are four questions that performers should ask on electroacoustic composition; is all the electro acoustic music loud and noisy, what do the composers pursue by playing electro acoustic music, what do the composers expect by playing the extended techniques, and why do they put so many techniques in a row?

A Study about How to Make Performance from Interactive Audio-visual Installation

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The user experience of interactive media installation and that of media performance are expected to be different, because the characteristic of the interface is different from each other. In this study, how interactive installation can be used effectively in the performance is investigated based on the case of *Room of Memory,* an interactive audio-visual installation work by the author. The following aspects are derived from the research for the more effective realization of the work: utilizing instruments, adding improvisational performance, organizing performance that responds to the visual information, and controlling appropriate sensitivity that suitable to performance.

인터랙티브 오디오비주얼 설치작품의 공연화 방안에 대한 연구

박순영
교신 저자 김현주

인터랙티브 설치작품의 인터페이스적 특징이 전시장에서 사용되는 방법과 공연 안에서 사용되는 방법에는 차이고 있고, 그로 인해 관객에게 주는 감화 역시 서로 다르다. 본 연구는 작품 <Room of Memory>를 중심으로 인터랙티브 오디오비주얼 설치작품이 어떻게 공연에서 효과적으로 사용될 수 있을지에 대해 연구하였다. 그 결과로, 음악적 구조로의 전환, 악기의 활용, 즉흥연주의 활용, 시각적 정보에 반응하는 퍼포먼스 연출, 공연에 적당한 센서 민감도의 조절 등이 설치작품의 공연화 요소로 도출되었다.

인터랙티브 설치작품이 전시장에 전시되었을 경우, 관객은 자유롭게 작품을 감상하고 움직여보면서 작품의 의미를 탐색한다. 이 때 그 결과는 작가의 의도와 맞을 수도 있고 아닐 수도 있다. 만약에 인터랙티브 설치작품을 공연에 사용하면 어떻게 될까? 공연 컨셉에 맞도록 공연 시간동안 설치작품의 인터페이스로서의 특징을 충분히 표현해주는 것이 공연내용의 중요한 지점일 것이다. 본 연구는 작품 Room of Memory을 중심으로 인터랙티브 설치작품이 어떻게 공연에서 효과적으로 사용될 수 있을지에 대한 연구이다.

In the exhibition where the installations are exhibited, the audience can appreciate as well as move around them to explore their meaning. However, it is not guaranteed if they exactly meet the composers' intention. What if I use the interactive audio-visual installations in the concert? In the exhibition, people usually spend only a few minutes per an installation which is not good enough to figure out details of the interface. But, in the concert, they can have plenty of time to do so. So, I think the concert should be designed for the audience to concentrate on the characteristics of the interface. In this study, I would like to discuss how to effectively use the interactive audio-visual installations in the concert through her *Room of Memory*.

Room of Memory

박순영 작가의 Room of Memory는 작곡가가 지나간 과거의 기억과 시간에 대해 후회하는 습관을 해소하고자 만든 인터랙티브 설치 작품이다. 사용자의 움직임을 인식하는 인터페이스로 키넥트Kinect 센서를 사용하고, 프로세싱Processing 소프트웨어를 사용해 오디오비주얼과 인터랙티브한 요소를 프로그래밍 하였다. 작품의 사운드와 이미지 내용으로는 작가의 나이 이십대 중반 시절 쓴 일기장에서 계속적으로 반복되는 고민과 후회의 단어와 문장 십 여 개를 선별하여 목소리로 녹음했다. 키넥트 센서는 관람자가 전시장의 어디에 위치하는지를 인식하여, 움직임의 가로 위치좌표(x)와 깊이 좌표(z)에 따라 컴퓨터 화면에 보이게 되는 텍스트의 변화와 녹음된 사운드의 재생을 조절한다.

This piece titled *Room of Memory* is an interactive audio-visual installation work with an intention to break my habit to regret my past memories and time. Kinect sensor is used for an indicator of an object and the processing software for a computer programming. For the sound and images, about ten most frequently used words and sentences implying worries and regrets extracted from her diary written in her mid-twenties are used. Kinect recognizes movement of the object whose values are expressed on x and z axis: X axis tells the horizontal movement and z the depth between the kinect and the object. The x axis is to select the pre-recorded sound out of 9, and z the locations of the texts and the sound.

1. 프로세싱에 의한 이미지 제어

작품은 관객의 깊이 위치(z값)에 따라 4단계로 다른 시각적 차이가 있다.

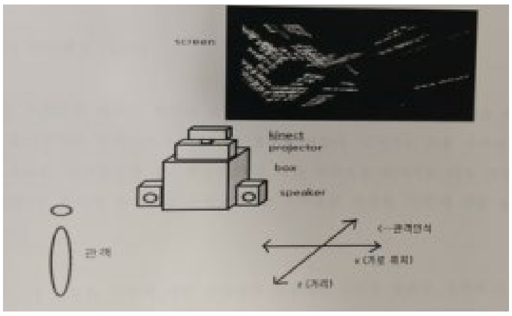


그림1. Room of Memory 전시구성

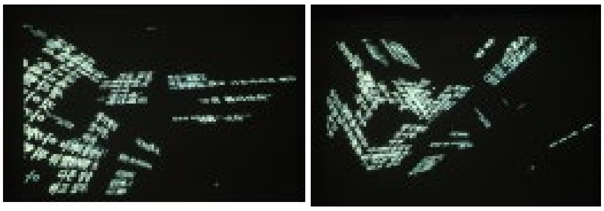


그림2. '기억의 방' 1단계

1단계(관객거리 3m이상): 회전하는 기억의 텍스가 정육면체 큐브 형태, 피라미드 형태 등 '방'의 형태를 이루었다 펼쳐졌다 하면서, 검정색 기억의 공간을 유유히 회전하고 있다. 2단계(거리 3m 입장): 회전하던 텍스트의 각각이 키넥트로부터의 거리 z값에 따라 점점 퍼져나간다. 나의 생각 안으로 나 혹은 타인(관객)이 들어왔다는 것을 형상화하며 나의 떠돌아다니던 여러 생각들이 펼쳐지는 장면을 표현한다. 필요 없는 생각은 점점 멀어지고 중요한 생각만 남아있다.

Step 1 (Depth usually more than 3m): The texts of memory are slowly rotating in the space of the black memory, repeatedly making cubes and pyramids on and off. Step 2 (Depth is within 3m): As the object becomes far away from the kinect, the value of z axis is increased and the rotating texts become scattered out respectively. I described what I was dissolved into my memories as the texts on each side of the cube are assembled or scattered out. I tried to express that the unnecessary thoughts are gone, but the important ones are remained.

그림3. '기억의 방' 2단계

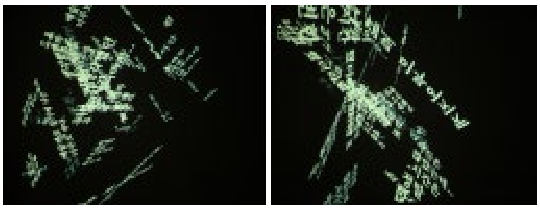


그림4. '기억의 방' 3단계

3단계(거리 3m~1m): 텍스트가 거리에 활발히 반응하며 가까이 다가가면 모아지며 관객에게 크게 다가온다. 구체적인 여러 텍스트들이 가로, 세로, z축 방향으로 제각각 활발히 움직인다. 기억에 빠질수록 여러 생각들 각각을 머릿속에서 처리하여 다시 하나의 큐브로 점점 모이는 장면을 형상화하였다. 4단계(1m이내): 1단계와 같다. 기억의 단어들은 다시 뭉쳐져 있다. 생각에 너무 깊이 빠져 더 이상 능동적일 수 없는 상태를 나타낸다.

Step 3 (Depth is around 1 through 3m): If the object becomes far from the kinect, the texts become scattered out. If close to, the texts form a cube. A lot of texts are actively moving forward to x, y and z axis respectively. Step 4 (Depth is within 1m): It is the same as the step 1. The texts represent me, an object. As I am so deeply lost in thought that I am not active anymore, the texts act the same.

2. 전시로서의 Room of Memory

Room of Memory는 소리와 이미지가 관객과 함께 반응하는 인터랙티브 설치 작품으로 기획되었고, 전시되었다. 작품은 '기억'이라는 누구나 경험하고 가지고 있는 과거에 존재했던 기억을 형상화하며, 일상을 탈피하여 몸소 체험하는 것을 의도로 한다. 키넥트의 거리인식 시스템은 '거리'라는 관계성과도 밀접한 부분을 실제 기계 시스템에서 작동하고 예술 작품 안에서 실현시킴으로써 관객의 현재와 과거, 그리고 관객과 다른 사람의 기억 사이의 관계를 '거리'의 조절로써 체험하게 된다는 컨셉의 실천이다.

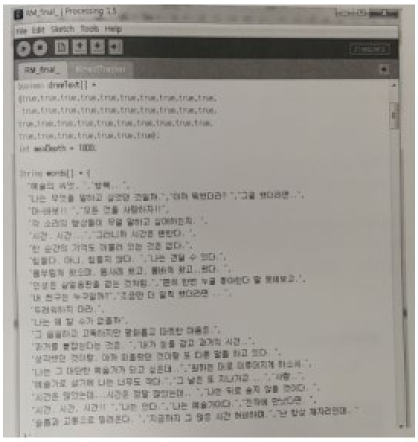


그림5. 큐브이미지 텍스트 코드

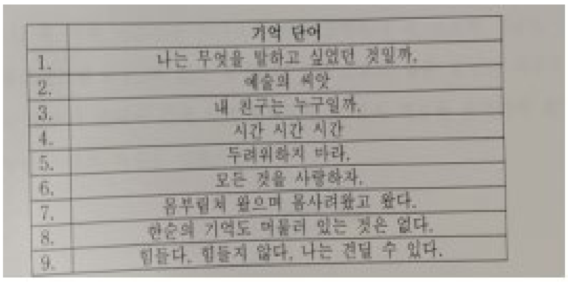
전시 작품의 공연화 가능성과 보완점

박순영의 Room of Memory는 인터페이스로서 사운드와 이미지를 모두 다룬다. 본 작품이 전시가 아닌 공연으로 구현되는 것이 가능할까에 대한 질문은 사운드아트와 퍼포먼스를 주로 연구하는 본 연구자로서 작업 이후 후속적으로 들게 된 의문이었다. 전시가 비교적 긴 시간동안 관객들의 자발적인 탐색을 제공한다는 차원에서 의의가 있지만, 한편 관객과 작가가 하나의 시공간에서 함께 작품을 경험하는 공연에 비해서 집중과 인상의 정도는 떨어질 수 있을 것이다. 이에 본 연구자는 이와 같은 인터랙티브 사운드 설치 작품이 어떻게 공연화 가능할 지에 대해서 Room of Memory 작품을 사례로 제언하고자 한다. 우선적으로 Room of Memory를 작동시키는 것을 공연으로 구성하기 위해서는, 공연자의 움직임에 반응하는 사운드와 이미지의 상호작용이 작품의 의미와 밀접하게 연결되도록 움직임을 만들어야 한다.

How do we perform the interactive audio-visual installation work on the stage? To perform Room of Memory, the interaction between the sound related to the movement of the object and the images should be closely related to the meaning of the composition.

1. 음악적 구조의 보완

키넥트 센서가 민감하기 때문에, 공연자가 움직이는 x 위치좌표와 z거리값에 따라 발생하는 기억의 문장과 단어의 녹음소리가 즉각적으로 변화되기 쉽다. 따라서 어느 위치에서 어떤 소리가 발생하는지 처음에 천천히 탐색한 후, 녹음된 문장과 단어소리가 음악적 연결이나 클라이막스를 형성할 수 있도록 움직임의 방향과 속도를 잘 조절해야 한다. 배치된 사운드는 아래와 같다.



	기억 단어
1.	나는 무엇을 말하고 싶었던 것일까.
2.	예술의 씨앗
3.	내 친구는 누구일까.
4.	시간 시간 시간
5.	두려워하지 마라.
6.	모든 것을 사랑하자.
7.	몸부림쳐 왔으며 몸사려왔고 왔다.
8.	한순의 기억도 머물러 있는 것은 없다.
9.	힘들다. 힘들지 않다. 나는 견딜 수 있다.

그림6. 사운드로 들리는 기억단어 아홉 개

1. Formation of music structure

Since the sensor of the kinect is sensitive, the sound source is instantly changed out of nine sources in accordance with the value of x and z axis. Therefore, prior to the performance, the object or the user should identify the locations and their corresponding sound sources. Also, it is expected to control the movement in terms of directions and speed for the better quality of music.

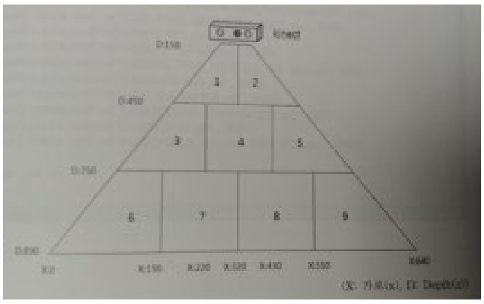


그림7. 키넥트 인식범위와 사운드 할당 위치

2. 악기의 사용

Room of Memory의 녹음된 사운드가 읊조림의 말소리이기 때문에, 보다 음악적으로 풍성하게 구성하기 위해서는 바이올린이나 플루트처럼 연주자가 움직이면서 연주 가능한 선율악기를 함께 사용할 수 있다.

3. 즉흥연주의 활용

공연자의 순간적인 판단과 움직임으로 Room of Memory의 기억의 읊조림 소리들을 이끌어낸다. 동작을 이어가면서 발생하는 소리를 연결하는 과정이 공연자의 경험에 의존하게 된다. 그리고 선율악기를 함께 연주한다면, 발생되는 기억의 읊조림 소리의 내용과 분위기에 어울리는 선율을 만들 수 있다.

4. 텍스트이미지 제어: 퍼포먼스

내용적으로 젊은 시절의 방황과 예술에의 도달점을 지향하므로 그것에 맞는 퍼포먼스가 중요하겠다. 키넥트 앞으로 다가가기도 하고, 뒤로 걸음질치기도 하고, 왼쪽 오른쪽으로 움직이면서 '기억의 방'이라는 정육면체 구조를 다양하게 형상화한다.

5. 센서 민감도의 조절

인터페이스를 많이 움직이면서 문제점들을 발견하였다. 센서가 민감하기 때문에 프로세싱 프로그래밍이 감지하는 x위치, z 거리값의 범위가 다시 조절되어야 한다. 또한 조그만 움직임에도 발생되는 사운드가 변화되기 때문에, 그 사운드의 변화가 매끄럽게 연결될 수 있도록 사운드소스의 위치를 재배치하고 사운드 내용을 다듬을 필요가 있다.

2. Use of an acoustic instrument

For the better quality of music, a portable acoustic instrument like violin or flute would be used on top of the pre-recorded sound which is recited human voice.

3. Application of Improvisation

Selection of the sound sources is totally based on a performer's quick decisions which are based on her experience. If she could use an acoustic instrument, she would be able to make the melody corresponding to the contents of the recited voice.

4. Controlling the Text Image: Performance

The performance should imply composer's compositional intent, the errors and stupidities of her youth and the arts in her mind. The performer shapes the cube by moving in front of the kinect, such as approaching, stepping back and forth, and walking up and down.

5. Sensor Control

I found many problems by moving around the interface. Since the sensor is quite sensitive, the values of x and z axis detected by the processing programming should be readjusted. Also, because the sound becomes changed even by slight movements, it is necessary that the locations of the sound sources must be relocated and the sound sources should be reinforced to make the sound changes smoother.

그림8. 기억의 방 공연모습

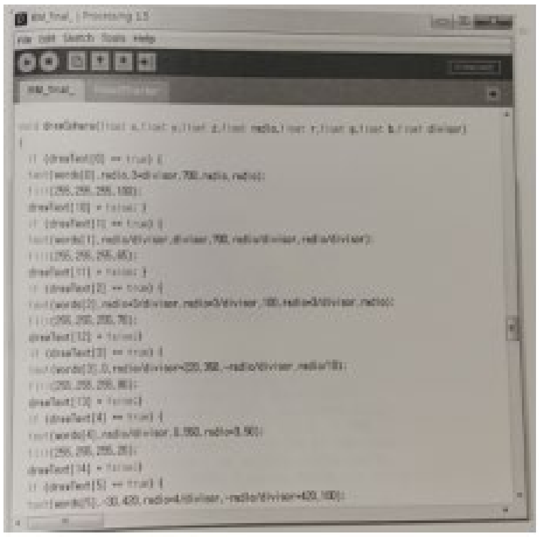


그림9. 큐브텍스트를 이루는 divisor값(depth값 인식)

결론

이상에서 본 연구자는 기존의 인터랙티브 사운드 설치 작품인 Room of Memory를 공연화 하는데 있어 보완 수정이 되어야 할 부분에 대한 방안을 모색해 보았다. 그러한 방안으로서 음악적 구조의 전환, 악기의 활용, 즉흥연주의 활용, 시각적 정보에 반응하는 퍼포먼스 연출, 공연에 적당한 센서 민감도의 조절 등이 도출되었다. 이는 특정 작품에 국한되지 않고, 여타의 사운드 아트 작품들에도 이들 작품이 공연용으로 재탄생할 경우에 고려할 수 있는 지점이라 여기며 연구의 의의를 두고자 한다. 다만, 본 연구가 좀 더 객관성과 현실성을 확보하기 위해서, 여타의 사운드 아트 작품에 대해 이들 방안을 적용해 공연화를 실천 및 분석하거나, 이러한 방식으로 전시에서 공연으로 전환된 사례를 추가로 찾고 확인하지 못한 점이 연구의 제한점으로 남는다.

Conclusion

So far, we have discussed several significant viewpoints to improve the performance of *Room of Memory*: enhancement in terms of musical structure, the accompaniment of acoustical instruments and improvisation, performance of text images, and more delicate control of the sensors. I hope to study further the similar or different cases continually and to generalize the suggestions better so that it could be more applicable and useful to other sound art works.

CALL FOR WORKS / Seoul International Computer Music Festival 2019

The Korean Electro-Acoustic Music Society is proud to announce the Seoul International Computer Music Festival (SICMF) 2019.

CATEGORIES

1. Tape (Fixed media) music
2. Electro-acoustic music (tape or live) with instruments (up to 3 players)
3. Live electro-acoustic music
4. Audio-visual media art
5. Experimental Electronic Music (including EDM)

RULES & REGULATIONS

1. The submitted work has to be composed after 2016.
2. The duration has to be less than 12 minutes.
3. For the works of the category #2, the number of players is limited to 3.
4. For performances requiring non-standard or special instruments, composers are responsible for providing the instruments and the performers on location.
5. Channels for audio playback are limited to 8 channels.
6. Up to two works may be submitted, but they must belong to different categories.
7. Attendance at the festival is required for all participants

SUBMISSION DEADLINE (ONLINE)

1 February 2019, 6 pm (UTC+9)

SUPPORT POLICY

We agree to pay all costs for performing selected works (performer fees (up to 3 performers), instrument rental, etc).

* This policy may be subject to change.

HOW TO SUBMIT

1. Only online submissions are allowed.

- Send an email to master@keams.org with the link to the files(refer to #2 and #3 described below)
- Do NOT attach the files but send us the link. Use the web services such as dropbox.com, wetransfer.com.

2. Media Files - Audio file(s) must be in stereo (either mp3, AIFF, or WAV)

- For the category #2 and #3: the recorded audio file and/or related files(patches, documents, programs, etc.)
- For the category #2: the score (PDF)
- For the category #4: the video file in any format (mpeg, mov, avi, etc.). Size of the file should, however, not be bigger than 1GB. (You may submit a YouTube or Vimeo link.)

3. Document (format should be either TEXT, RTF, or DOC, but NOT PDF) that includes the following information:

- Last Name
- First Name
- Nationality
- Email
- Homepage (if any)
- Biography
- Title of work
- Duration
- Category
- Instruments (if any)
- Number of Audio Output Channels
- Program Notes
- World premiere / Asia premiere / Korea premiere (if applied)
- Special Requirements for the Performance (if any)

4. Submission Fee

Submission fee US$20 per work is required.

5. Additional Notes

- If you receive no response from us after your submission, please email us to this alternate address: trebari@gmail.com
- If you wish to submit offline, please contact us via email as early as possible.

FOR FURTHER INFORMATION

festival@keams.org
http://www.computermusic.or.kr

서울국제컴퓨터음악제 2019 작품 공모

한국전자음악협회는 서울국제컴퓨터음악제 2019에 연주될 작품들을 공모합니다.
서울국제컴퓨터음악제 2019는 10월 10일부터 10월 13일까지 열릴 예정입니다.

공모 분야

1. 테입(Fixed media) 음악
2. 악기(3명 이내)와 전자음악(테입 혹은 라이브)
3. 라이브 전자음악(악기 없이)
4. 오디오-비주얼 미디어 작품
5. EDM을 포함한 실험적 컴퓨터음악

공모 규정

1. 작품은 2016년 이후 작곡된 것이어야 함
2. 작품의 길이는 12분 이내여야 함
3. 악기를 동반한 전자음악일 경우 연주자는 3명 이내여야 함
4. 특수한 악기를 동반한 음악일 경우 작곡가의 책임 하에 악기와 연주자를 동반하여야 함
5. 모든 작품은 8채널까지만 가능
6. 두 작품까지 접수 가능하나 서로 다른 공모분야의 작품이어야 함
7. 선정될 경우 페스티벌에 반드시 참가하여야 함

공모 접수 마감

2019년 4월 12일 (금) 오후6시 (서울 시각, UTC+9)

지원정책

1. 당선된 작품의 연주에 필요한 비용(연주자 사례비(3명까지), 악기 렌탈비 등)은 본 회가 지불합니다.

* 이 정책은 본 회의 사정에 따라 변경될 수 있습니다.

접수 방법

1. 접수는 온라인 접수만 가능함
- 이메일 master@keams.org로 작품 관련 파일(아래 2,3번 참조)들을 보낼 것
- 단, 첨부파일로 보내지 말고 dropbox.com, wetransfer.com 등의 서비스를 이용하여 링크를 제출

2. 작품 파일
- 오디오 파일은 반드시 스테레오 버전으로 보낼 것 (포맷: mp3, AIFF, WAV 중 택일)
- 라이브 전자음악일 경우: 녹음된 오디오 파일(있을 경우, mp3)과 관련 파일(패치, 도큐먼트, 프로그램 등)을 업로드
- 악기를 동반한 전자음악일 경우 반드시 악보 (PDF) 업로드
- 오디오-비주얼 작품일 경우: 영상 파일은 mp4, mov, avi 등의 포맷으로 올리되, 전체 용량이 1GB를 넘지 않게 할 것 (youtube 혹은 vimeo 링크를 제출해도 무방)

3. 다음 정보를 담은 도큐먼트 파일 업로드 (포맷: TEXT, RTF, DOC, HWP 중 택일 / PDF는 제출 금지)
- 성명
- 국적
- 전화 (휴대전화)
- 이메일
- 홈페이지 (있을 경우)
- 프로필 (Biography)
- 작품제목
- 작품길이
- 공모분야
- 악기 (있을 경우)
- 오디오 아웃풋 채널 수
- 프로그램 노트
- 세계 초연/ 아시아 초연/ 한국 초연 (해당사항이 있을 경우)
- 연주시 특별히 필요한 요구 사항 (있을 경우)

4. 참가비

참가비 작품당 US$20(한화 25,000원)을 내셔야 합니다.
(한국전자음악협회 회원은 공모 참가비 면제)

문의 및 기타 정보

festival@keams.org
http://www.computermusic.or.kr

fest-m 2019 작품공모

fest-m은 젊고 개성있는 작곡가들의 컴퓨터 음악이 공연되는 축제입니다. fest-m은 한국전자음악협회가 주최하고 매년 공모를 통해 선정된 작품이 연주됩니다. 올해에도 젊은 작곡가 여러분들의 많은 응모 바랍니다.
fest-m 2019는 4월말~5월초에 열릴 예정입니다.

응모 작품 분야

1. 테이프 음악
2. 라이브 전자 음악 (인성 혹은 악기와 전자 음악)
3. 오디오-비주얼 작품
4. 실험적 전자음악 작품 (EDM과 같은 대중적 작품 포함)

제출할 것

1. 다음 항목을 담은 문서
   - 성명
   - 성별
   - 생년월일
   - 전화 (휴대전화)
   - 이메일
   - 작품 제목
   - 작품 길이
   - 공모 분야
   - 악기 (있을 경우)
   - 오디오 아웃풋 채널 수
   - 프로그램 노트
   - 프로필
   - 연주시 특별히 필요한 요구 사항 (있을 경우)
2. 작품해설
3. 관련자료 (악보, 녹음, 공연을 위한 Max패치, 비디오 등)
4. 공연에 필요한 장비 목록 및 세팅

응모 마감

2019년 3월 31일 오후 6시 (당일 우체국 소인 우편물은 유효합니다.)

보낼 곳

master@keams.org

응모 규정 및 참고 사항

1. 1984년 1월 1일 이후 출생 작곡가
2. 작품의 길이는 10분 이내
3. 한국전자음악협회에서는 공연장 및 공연 장비를 제공하며 연주자를 위한 소정의 연주료를 지원합니다.
4. 별도의 응모 접수비는 없습니다.
5. 응모된 작품은 예선 심의를 거쳐 한국전자음악협회 홈페이지(http://www.keams.org)에 공지됩니다.
6. 공연당일 실연 심사를 통해 공연의 최우수작은 서울국제컴퓨터음악제 2019에 초대될 수 있습니다.

더 자세한 문의 master@keams.org

Call for Proposals

The Korea Electro-Acoustic Music Society (KEAMS) announces a call for proposals for the 2019 KEAMS Annual Conference (KEAMSAC) and the journal *Emille*.

If you want your paper to be considered for the 2019 KEAMS Conference, please send an abstract or proposal (maximum of 2,000-characters including spaces) and curriculum vitae as PDF documents by 31 May. Selected papers from the conference will be published in *Emille* Vol. 17. emille[at]keams.org

KEAMSAC was formed to promote active research and discussion on electro-acoustic music, and this year's conference will be held in Oct. 11-13 in Seoul, Korea. This event will go with the Seoul International Computer Music Festival 2019(SICMF 2019).
http://www.computermusic.asia/

Language
Conference Presentation: English
Conference Article: English or Korean
Journal Article: English or Korean

Categories
For the KEAMS conference, the following topics are encouraged:

a) Creative Encounters between Music and Science
b) Multidisciplinary or Interdisciplinary Research (co-authors acceptable)
c) Systematic Musicology
  - Computational Musicology
  - Computational Music Theory
d) Analysis of Electronic and Computer-based Music
e) Sound Synthesis
f) Music Psychology
g) Instrumentation
h) Development of Electronically-extended Musical Instruments
i) Music Software Engineering
j) Artificial Musical Intelligence
k) Computer-aided Composition/Analysis
l) Automatic Composition
m) Aesthetics
etc.

제안서 공모

한국전자음악협회(KEAMS)는 2019년도 연례 학술대회(KEAMSAC)에서 발표될 연구물과 학술지 <컴퓨터음악저널 에밀레>에 게재될 논문의 제안서를 모집합니다.

저희 협회의 연례 학술대회(KEAMSAC)는 전자 음악에 대한 활발한 연구 및 토론을 촉진하기 위해 만들어졌으며, 이번 학술대회는 10월 11일부터 13일까지 서울에서 개최될 예정입니다. 이 행사는 전자음악 연구 학자와 예술가들의 교류를 위해 2019년도 서울국제컴퓨터음악제SICMF2019와 함께 진행됩니다. 최종 선별된 연구물은 선정 과정을 거쳐 <컴퓨터음악저널 에밀레> 제17호에 게재됩니다.
http://www.computermusic.asia/

연구물을 2019년도 전자음악협회의 연례 학술대회에서 선보이고 싶으신 분들은 제안서(공백을 포함하여 최대 2000자까지)를 약력과 함께 PDF 문서로 작성하여 emille[at]keams.org로 5월 31일까지 보내주십시오.

언어
학술대회 발표: 영어(요청에 따라 한글발표를 위한 통역을 사용할 수 있습니다.)
학술대회 논문: 영어 또는 한글
학술지 논문: 영어 또는 한글

분야
한국전자음악협회는 다음과 같은 다양한 분야의 연구물에 귀를 기울이고 있습니다:

a) 음악과 과학의 창조적인 만남
b) 다학제적 연구 및 학제간 연구 (여러 저자의 공동 연구물 포함)
c) 체계적 음악학
  - 전산처리를 기반으로 하는 음악학
  - 음악이론
d) 전자음악 및 컴퓨터음악 작품의 분석
e) 음향 합성
f) 음악 심리학
g) 악기론
h) 전자적인 수단을 통행 확장된 새로운 악기의 개발
i) 음악 소프트웨어 공학
j) 음악 인공 지능
k) 컴퓨터의 도움을 받는 작곡 및 분석
l) 자동 작곡
m) 미학
기타.

Important Dates
- Deadline for Proposal Submission
  May 31, 2019

- Notification of Acceptance of the Proposal
  August 31, 2019

- Deadline for Paper Submission for the Conference Proceedings
  September 30, 2019

- Conference
  October 11-13, 2019

- Notification of Selected Paper for the Journal *Emille*
  November 30, 2019

- Deadline for Final Paper Submission
  December 31, 2019

Session Formats
1. Presentations
- Each session will consist of three to four presentations.
- Each paper will be presented in person for about 25 minutes followed by ca. 5 minutes of discussion.
- Video conferencing over the Internet may situationally be available.

2. Keynote presentation
- A keynote speaker will be given 50 minutes to address, followed by 10 minutes of Q&A.

3. Workshops
- The length of each session will be around 90 minutes.
- Each workshop may consist of two to three sessions in one to two days.

Fees and Accommodation
Thanks to the financial support of the Art Council Korea, the registration and publication fee will be waived, and accommodation also will be provided for two nights.

It is also possible for students and non-experts in the fields mentioned above to submit proposals for the conference and the journal, *Emille*.
All proposals will be screened by the program committee and selected solely based on the quality of the research and topic.

We are welcome any ideas for electro-acoustic music research from you, and believe them to be precious assets for the conference and the journal.

Supported by Arts Council Korea

주요 일정
- 제안서 제출 마감일
  2019년 5월 31일

- 제안서 승인 통보일
  2019년 8월 31일

- 학술대회 원고 마감일
  2019년 9월 30일

- 학술대회
  2019년 10월 11-13일

- 학술지 논문 게재 여부 통보일
  2019년 11월 30일

- 최종 원고 제출
  2019년 12월 31일

Session 구성
1. 발표
- 하나의 session은 3-4개 정도의 발표로 구성될 수 있습니다.
- 각 발표자에게 주어지는 시간은 약 25분이며 약 5분간 질의 문답 시간이 뒤따릅니다.
- 경우에 따라 인터넷 화상 채팅을 이용한 발표도 가능합니다.

2. 기조 연설
- 기조 연설자는 50분의 연설과 10분의 질의응답의 시간이 주어집니다.

3. 워크숍
- 워크숍 각 세션의 시간은 90분 내외입니다.
- 워크숍은 1-2일에 걸쳐 2-3개의 세션으로 구성될 수 있습니다.

비용 및 숙박
한국문화예술위원회(ARKO)의 재정 지원에 힘입어 이 행사에는 참가비와 논문 게재료가 없으며 이틀간의 숙박이 제공됩니다.

연구물의 내용에 따라 학생과 비전공자에게도 학술대회 참가 및 논문 게재의 기회가 주어집니다.
제출된 모든 제안서는 학술지 조직 위원회에 의해 면밀히 평가되며, 오로지 연구 내용의 우수성에 의해서만 채택됩니다.

여러분들의 작은 아이디어 하나가 학술대회와 에밀레를 풍성하게 합니다. 많은 응모 바랍니다.

후원: 한국문화예술위원회