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PART I: Selected Papers from KEAMSAC2014

제1부: 한국전자음악협회 2014년 연례학술대회 선정 논문

Listening between the Abstract and the Real: Context in electro-acoustic music analysis

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Pierre Schaeffer's notion of reduced listening, closely related to his concept of the *objet sonore* (sound-object), encourages analytical attention to internal sound relationships only, downplaying real-world associations. This approach to analysis mirrors conventional practice in the analysis of Western instrumental music, with its philosophical underpinning in German metaphysics. However, such methods run the risk of missing the full potential that audio technology holds in altering sense perceptions, as they fail to recognize how the affordance of virtual events and spaces can play a central role in the experience of certain electro-acoustic works. Short analyses of three works—Hildegard Westerkamp's *Cricket Voice* (1987), Judy Klein's *The Wolves of Bays Mountain* (1998), and Yves Daoust's *Mi Bémol* (1990)—are presented, revealing a key structural role in each case to the play between abstracted and real sound-worlds. In conclusion, the author argues in favor of real-world contextual-awareness in mapping the listening experience as a model for the analysis of electro-acoustic works, along with a re-positioning of the aims of analysis.

In my research as a music theorist in the field of electro-acoustic music, one of my main interests has been investigating various means for analyzing works for fixed media, composed primarily of recorded environmental sounds; that is, works that may be generally classified along the continuum that includes soundscape composition and acousmatic music. Listening has a played a central role in this scholarship; in this paper, I explore issues related to the listening experience and analysis.

Electro-acoustic music and listening

Marshall McLuhan states, "[t]he effects of technology do not occur at the level of opinions or concepts, but alter sense ratios or patterns of perception steadily and without any resistance" and the artist is "an expert aware of the changes in sense perception" (1964: 18). While it is evident that recording technology has changed *how* we listen in terms of using speakers and headphones, etc., following McLuhan the challenge is then to ask ourselves how technology has changed our aural perception itself. For example, Pauline Oliveros recalls how her first tape recorder forever changed the way she listened to the world, once she recorded her first sounds and discovered that what played back on the machine was not exactly what she had remembered hearing at the time of recording (Duguid 1998). It is experiences such as this that have led many scholars to contemplate different types of modes of listening, for example:

- Pierre Schaeffer (1966): 4 modes of listening – écouter / ouïr / entendre / comprendre
- Michel Chion (1990): 3 modes of listening – causal / semantic / reduced
- Denis Smalley (1996): 3 listening relationships – indicative / reflexive / interactive
- R. Murray Schafer (1977) – immersed / peripheral listening
- Pauline Oliveros (1999): quantum listening – hearing / listening (focal / global)
- Kai Tuuri and Tuomas Eerola (2012): 9 listening modes
  – experiential (reflexive / kinaesthetic / connotative)
  – denotative (causal/empathetic/functional/semantic)
  – reflective (reduced / critical)

Most influential among these is the theory of four modes of listening posited by Schaeffer, which has served as the basis for subsequent theories such as Chion's three listening modes, the three listening relationships described by Smalley, and more recently the taxonomy of nine listening modes proposed by Tuuri and Eerola.

Furthermore, at the recent European Music Analysis Conference in Leuven, Belgium (17-21 September, 2014) there was an entire session devoted to "Listening to Electro-acoustic Music through Analysis"; and Leigh Landy's keynote address at the same conference posited listening-based analysis as a means for understanding electro-acoustic music.[1]

This emphasis on listening in the analysis of electro-acoustic music would seem uncontroversial if not for the fact that listening has not played as central a role in analytical practices associated with 'traditional' Western music theory.

Conventional music theory and analysis

The theory and analysis of Western art music, at least as practiced in the English-speaking world, was dominated throughout most of the twentieth century by Schenkerian analysis on the one hand, as the standard tool for analyzing works of tonal music, and pitch-class set theory on the other, as the standard tool for analyzing post-tonal music. While differing on the surface, both of these approaches share the same underlying assumption that the aim of analysis is to demonstrate the unity or coherence of a given work with emphasis given to abstract pitch relationships observable in the written score. In the case of Schenkerian analysis, unity is framed within terms of how pitches written in the score—conceptualized as the surface level of the work—can be understood as being organically grown out of the underlying Urlinie which serves as the deep background of all successful works of tonal music. In contrast, the principles for demonstrating the unity of a given work in terms of set theory can be understood as a combination of Arnold Schoenberg's theory of developing variation (in which all subsequent pitch material of a given work can be related back to an initial motivic cell or group of motivic cells) together with the numeric sequences of serialism (in which all pitches are assigned positions in a numeric sequence which then undergoes a series of mathematical permutations and transformations). Moreover, as pointed out by both Lawrence Kramer (2004) and Martin Scherzinger (2012) such methods of music analysis that lay emphasis on abstracted relationships of form can be understood as having aesthetic roots in 19th-century German metaphysics.

Metaphysics, idealism, and the absolute

It can be useful to indulge in a brief digression at this moment to review (in a necessarily simplified manner) the underlying philosophical orientations that have guided the theory of Western music and its analytical practices in the nineteenth and twentieth centuries.

We can begin with the Age of Enlightenment of the seventeenth and eighteenth century Europe. At this time, we can observe a general trend away from mysticism and alchemy toward naturalism, a philosophical orientation that places high value on empirical evidence and thus tangible connections to the material world of objects and observable processes. Aesthetic experience in the arts was explained in terms of cause-and-effect, in which an artwork induces a specific reaction in its beholder through mimesis, the imitation of either nature or human emotions. Under this system of aesthetics, music was generally relegated to either the lowest position of aesthetic value among the arts, or unworthy of being considered as having a position among the arts at all. This was due to the perceived deficiency of music as a medium for representation; except in the case of vocal music with its accompanying text, musical expression was considered too ambiguous in conveying its content and therefore allowing for too wide a variation of reaction among its listeners. It is for this reason that Immanuel Kant deemed it "more pleasure than culture" (Bonds 1997: 391).

By the early nineteenth century, however, there was a growing trend away from naturalism toward idealism. Under idealism, artworks attain aesthetic value not through their imitation of nature and the material world, but are rather reflections of a higher ideal, an unknowable absolute truth. Whereas its ambiguous or non-referential nature contributed the devaluation of music as an art according to the tenants of naturalism, according to idealism music is elevated in status from being barely counted among the arts to the most privileged position. Idealism is in turn is related to that branch of nineteenth-century philosophy known as metaphysics, associated with Arthur Schopenhauer and other primarily German philosophers and their contemporary Romantic composers.

Kramer (2004) and Sanna Pederson (2009) argue that many scholars in the twentieth century came to conflate the concept of the absolute in idealism and metaphysics with the debates surrounding absolute music and programme music which arose in the 1880s. While the principle of idealism in actuality could be used in support of either side of the debate, by specifically aligning it to the side of absolute music it could be used to further validate the modernist aesthetic of valuing abstract form over referential content. Pederson suggests that by aligning the aesthetics of absolute music with the revered figures of German metaphysics, Western scholars of the Cold War era sought to distinguish their aesthetic position from Marxist thought.

In summary, idealism served to elevate the aesthetic valuation of music for the exact reason it had been devalued under naturalism: namely, its inability to unambiguously represent real-world concepts. This non-referential nature of music was then further emphasized and valued as the principle of absolute music. Thus tools for music analysis were specifically aimed and developed to deal with music only in terms of its abstract, non-referential properties.

Music theory and electro-acoustic Music

Although the study of electro-acoustic music has made some inroads into musicological and music-theoretical circles in recent years, it remains along the fringes. This may be partly due to the technological nature of electro-acoustic music; indeed, looking at the Yale-based *Journal of Music Theory* in the 1960s—the most prolific period in terms of such articles in the journal—we can find, alongside the emphasis on the application of serialist techniques, a fair number of articles that describe equipment for analog electronic music studios, both in terms of their inner mechanisms and musical applications, as well as technical descriptions of the physics of electronic sound. There is a steady decline in articles related to either electronic or computer music to appear in the journal through the 1970s and following. Similarly, looking at Music Theory Spectrum—the official journal of the Society for Music Theory in the USA—with respect to the topic of electro-acoustic music, we find only one article (Wayne Slawson's study of musical timbre), and one book review (of *Music, Cognition and Computerized Sound*, edited by Perry Cook), to appear on its pages during the first two decades of its publication, from 1979 to 1999.

Another reason for the lack of analytical attention provided works of electro-acoustic by the musicological community is the absence of a conventional score, which renders unsuitable the standard tools for music analysis, which—as I mentioned before—are configured toward the study of scores for observable pitch relationships. This is one reason for the drive within the electro-acoustic community to develop analytical models through graphical representation, such as the use of mechanical representation such as waveforms and FFT spectrographs (Cogan 1984), or through the iconic/symbolic representation of the so-called sound object—posited by Schaeffer—using software such as EAnalysis or the Acousmograph (Couprie 2004).

Schaeffer's concept of the sound object (*objet sonore*) is closely linked to his idea of reduced listening; that is, repeated listening of an isolated sound until all referential aspects inherent in the sound are stripped away from consciousness, allowing the listener to focus solely on the perceptual properties of the sound itself. The aim of Schaeffer's theory is to present the concept of the sound object as a replacement for that of the note (pitch and duration) as the basic musical unit in electro-acoustic music; and to train musicians to distinguish sound objects and describe them in parametric terms such as dynamic shape, mass, grain, etc. This idea of the sound object lies at the heart of many analytical approaches to electro-acoustic music, the most prominent being Smalley's spectromorphology (Smalley 1996).

Reorientation for method of analysis

Schaeffer's idea of the sound object as unit for analytical listening has been critiqued and challenged recently by scholars such as Brian Kane (2007, 2012) and Robin Parmar (2012). As a contrast to Schaeffer's "phenomenological subject," Kane presents Jean Luc Nancy's philosophy of listening as promoting "a subject that is listening to the infinite *renvoi* [resonance] of meaning, sound, and self" (Kane 2012: 446). Similarly, rather than treating sound objects as sounds isolated from their real-world origins, Parmar argues "now that the separation of origin from resulting sound is a commonplace in our listening world, it is ever more important to develop an integrated and sustainable model of sonic critique, one that does not forsake origin, context and intentionality" (Parmar 2012: 203).

In order to take up Parmar's challenge of developing a more integrated approach to analysis, I look to recent development in music scholarship for possible models. Sources may be found in interdisciplinary research in perception and cognition that focus on more rounded accounts of the listening experience (Tuuri / Eerola 2012; Windsor 1995); scholarship that calls for a re-examination of the purpose of analysis (Guck 2006; Kramer 2004); and scholarship that draws on feminist theory and culture studies to reclaim the listener's subjectivity using narrative and hermeneutic devices (Gopinath 2009; Maus 2005; McCartney 2000; Norman 2004a). Keeping these new models in consideration, I explore the interplay of abstracted sounds and referenced real places and events in the following three works: Hildegard Westerkamp's *Cricket Voice*; Judy Klein's *The Wolves of Bays Mountain*; and Yves Daoust's *Mi Bémol*.

Abstracted sounds from specific places

Hildegard Westerkamp's *Cricket Voice* (1987)

Westerkamp's music belongs to the subgenre of electro-acoustic music called 'soundscape composition' which aims to provoke in the listener a deeper awareness of the sonic environment in daily life. In order to do this, there is an inevitable need to encourage an interaction of both referential and 'morphological' listening. Westerkamp recorded the sound sources that she eventually used in the composition of *Cricket Voice* while participating in a month-long artist retreat in a specific geographic area (namely, the Zone of Silence in Mexico); the retreat was a rather intense experience for the composer, such that she did not feel comfortable using the recordings for the purpose of musical composition until two years later (McCartney 2000). It is impossible for anyone—save, perhaps, for a few of her retreat companions—to share the same distinct sense of place as experienced by the composer when listening to *Cricket Voice*. I hear, however, a more generalized sense of place in the work, one that moves in and out of association with an earth-bound environment and an other-worldly one that plays an important role in the experience of large-scale structure in the work.

Guided by this sense of place, I hear *Cricket Voice* as structurally dividing into five sections, a kind of arched form:

1. Opening section (duration: about 2 minutes): a sense of being in the out-of-doors, a natural earth-bound environment, with blowing wind (or ebbing waves).

2. A (duration: a little over 3 minutes): looped whipping/scraping sounds mark the transition as the wind is replaced by the pervasiveness of long, low sustained tones/rumblings; the sense of place turns from earth-bound to otherworldly.
3. Middle section (duration: about 1 ½ minutes): the space becomes enclosed, the only sounds heard seem close in proximity with little sense of spatial depth.
4. A' (duration: about 2 minutes): a return to the vast, otherworldly space as the deep-rumbling tones returns.
5. Closing section (duration: a little under 2 minutes): reverberating clapping/stomping foretell a return to earth-bound space; gradual fade-out of otherworldly material until only a cricket remains.

While I have laid out broad distinctions between sections of earth-bound/otherworldly senses of place, ambiguities do pervade the surface material among the different sections. For example, the pulsating tones that enter in the opening section do not necessarily seem to "belong" within the kind of environment presented by the wind; that is, they cannot be identified as sounds of a natural environment, but have rather an artificial quality to them reinforced by the way they move toward (fade in) and away (fade out) from the listener. Similarly, the unprocessed cricket sound continues through the "otherworldly" sections, anchoring the listener to the memory of the natural environment. Andra McCartney (2002) interprets the varying sense of otherworldliness throughout the work as a kind of critical commentary on how the contemporary urban dweller experiences untamed nature as alien and a cause for anxiety. However an individual listener may interpret this interplay between varying senses of place, there is no denying its important role in the structure and experience of the work.

After the first gust of wind establishes a sense of place in the opening seconds of the work (virtually transporting the listener from the enclosed concert hall—or other interior listening space—to the open outdoors), a pulsating tone enters from the distant left (0:04), gradually drawing nearer, steady in pitch (Eb3) and pulse (ca. 85bpm) like a low-level warning signal. As this tone continues pulsating, keeping to the left, it is answered to the right by another tone (0:11) about a fifth higher in pitch (Bb3) and at a quicker rate of pulse. A momentary increase in intensity occurs as a buzzing tone rises in the center (0:21), a semitone or so above the lower pulse on the left and therefore creating a sense of dissonance. Shortly thereafter, a third pulsating tone rises in the center (0:34), at the same pitch as the buzzing tone before but duller in timbre. The pulsating tone on the right fades out (0:27–0:32); when it returns (0:36), it is initially about a minor third higher than before (Db4), then shifting a pitch up or down by a semitone each time and thus presenting a kind of short melody (Db-Db-C-Db-Dn-Dn-Db-C-C-C-C). Meanwhile, the pulsating E/Eb of the original "bass pulse" grows louder while a new sound enters: that of a chirping cricket.

At some point, it becomes clear to the listener that these pulsating pitches are in some way related to the cricket sound. Indeed, the cricket sound itself is a high, pulsating tone. Again, the listener may be struck by the similarities between the sound of nature represented by the cricket sound on the one hand, and the sound of urban life represented by these pulsating tones—as warning signals, tympani, ambulance alarms and computer bleeps—on the other.[2]

The overriding "Eb-ness" does not seem to me as an arbitrary abstract pitch choice in the way that keys are chosen for instrumental music in traditional Western art music; while I find the pitch content to be part of the surface level play, it does not carry the primary role in my sense of the overall composition, structure, and aesthetic effect of the work. Rather, the pitch content may be understood as a kind of by-product of a concrete source: the original song of a lone cricket. The high-pitched, rapidly pulsating sound made by the cricket is maintained—within the unaltered instances presented in this work—in the vicinity of a high Eb.[3] Furthermore, this sound is produced not by vocal chords but by the cricket scraping its wings together. Thus all of the sounds Westerkamp explores in this work relate back to the cricket "voice" as pitched and percussive pulsations and scrapings; the former are produced through electronic processing of the original cricket sampling, the latter are sounds associated with scraping a stick or similar object over corrugated surfaces (just as the crickets rub their wings).

However, the relationships among these sound-objects are not merely acoustical, concerned only with the abstracted properties of sound itself. The wooden-like sounds are produced for the most part not from manipulations of the cricket sample, but from recordings of the composer knocking on various types of cacti located in the cricket's habitat. Thus the main sound sources are those of wind, cricket and cacti—an aural fantasy on the Mexican desert.

Judy Klein's *The Wolves of Bays Mountain* (1998)

This work is documentary in nature, with similar features to soundscape composition. It may invoke in the listener a sense of virtual reality, with very clear interactions of referential listening. As the title indicates, Klein created this work from sound recordings made over a two-year period in the 1990s, of a particular pack of wolves and their surrounding environment in the Bays Mountain Park in Eastern Tennessee. Listening to the work, I find that most of the sounds I hear have very obviously implied sources—that is to say, they are strong signifiers for particular objects and actions in the real world. The sounds of [what I hear to be] bird calls, train whistles and crickets together with the sounds of the wolves interact to provide the listener with a very vivid impression of a particular virtual space and location—one that can be identified according to the listener's experience in the real world. The sounds of wolves running, panting, huffing, and drinking water provide an impression of the wolves' bodies—physical presence, energy, etc.—beyond their howls; these body sounds, together with the supporting sounds of birds, trains and crickets, might be thought of as a kind of recitative that links the various howl-arias, as it were. Yet the story being told is still a musical one, a sonic play between the abstract and programmatic that is set up in the opening section.

As the composer describes in her program notes, this piece can be divided into three sections—opening, middle, and closing—with the middle section further partitioned into two sections, representing morning and night:

> The piece opens with sounds derived from the recording of a winter chorus howl. Over time, the voices of the wolves become distinct. Two wolves bring the howling to an end with a sequence of short, antiphonal calls. In the middle sections, the recordings are virtually unedited. It's nearly spring. The wolves are heard in their environment, first in the early morning and then in the still of the late night. The howling in the final section is again from winter, the mating season. It ends with the love song of Kashtin, the alpha female of the pack, and her majestic mate, Navarro, who died the following year and in whose memory the piece was written. (Klein 2005)

Listening to the opening section, I note that the initial sounds do not afford for me any definite real-world event (although other listeners might immediately hear the sounds as derived from the howls of wolves), and thus my listening is attuned to the qualities of the sounds themselves: timbre, pitch relations, rhythm. In an attempt to describe the timbre, imaginary sources come to mind: water glasses, resonant crystals, celestial motion. At the same time, my previous experience with computer music offers a less fantastical description of the sounds as products of comb-filtering techniques. Either way, however, my attempt to account for sound quality (timbre) leads me to guess at some aspect of the sounds' creation. With respect to pitch relations: for certain stretches of time, a single pitch predominates, with others—mostly at intervals of a tritone, minor third and perfect fourth—revolving around it. My expectation is for some sort of motivic development to unfold from these pitch relationships—an expectation that is soon thwarted as the work progresses and the real sources of the sounds are eventually revealed.

Part way through the opening section, my attention is drawn away from pitch structure to spatialization; that is, how sound as a whole seems to create a sense of virtual space, within which individual sounds are located and move. This moment of my attention to virtual space happens around the same time that I become aware that the sounds I had been listening to were the howls of wolves. I find myself wondering whether the wolves care what pitches they sing, in essence grappling with the definition of musical composition as a human activity. Although Klein is credited here as composer, she did not tell the wolves what notes to sing; the song is, rather, a product of the wolves themselves. But I'm not quite ready to give up listening in terms of abstract pitch structures, as I've been trained to do; yet, at the same time, I've been constructing a kind of programmatic narrative around these same sounds during my listening experience. My experience at the beginning of the piece, in evaluating what I hear initially as 'abstract' music, does not preempt any "extra-musical" significations that the listener may associate with the sounds—such as the various impressions of celestial motion, slumbering dreams, and melancholia that the sounds evoked in my imagination.

A pivotal moment occurs approximately five minutes into the work, when the transition from the opening to the middle section is marked by silence broken by a distant birdcall, resonating as in nature to establish a clearly defined virtual listening environment, as I describe below:

> *A new, unaccompanied sound comes from somewhere to my right, signaling a shift in the soundscape (5:11): my virtual transportation from concert space to an open field (?) somewhere in the countryside is now complete. It sounds like perhaps the caw of a crow (?), followed by another, a little closer and to my left. There must be trees or telephone poles nearby. Apart from the birds, there is relative quiet. The way their calls resonate, I think the air might be a little damp; that, coupled with the quiet, makes me think it is morning—besides, my experience has been that birds are noisiest at dawn.*

There is something about the arrival of this moment that is a little bit like Dorothy stepping out of her house after the tornado—I feel like I, too, have opened my eyes (and ears) after some dream-like sequence, only to find myself transported to a strange-yet-somehow-familiar place; the (imagined?) walls of the concert hall have dissolved into wide-open space. Although one might argue that this analogy with *The Wizard of Oz* can also be understood in the reverse, with the processed sounds at the opening of *Wolves* having more in common with the Technicolor processing modifying the view of Oz in post-production, there is something hyper-real about this moment of the birdcall and the other, mainly unedited material that follows.

In Katharine Norman's synopsis of the work, she attributes a "psychological role" to the processed sounds of the opening and closing sections, one that "transforms listening" (Norman 2004b: 16)—a statement reminiscent of McLuhan's assertion that technology changes sense perception, cited above. Following this argument, the processed sounds of the opening establish a conventional musical context for the listener—human, abstract, pitch-centered—that allows the listener to accept what follows as music, too; the processed sounds of the closing section reinforce the underlying conventional musical context of the whole, not only by returning to an abstract, pitch-centered sound world that has obviously been molded by human hands, but through the very act of recapitulation itself.

I mentioned before that the wolves' howls are not composed in terms of Klein telling the wolves what notes to sing; rather, the compositional act (in human terms) occurs at what one might call a higher structural level, in the act of selecting these particular howls—arranged in this particular order, spaced over time in this particular manner—from (presumably) hours and hours of field recordings. In this realization, I find myself in the role of a Pythagorean akousmatikoi: although I think I know what the source of these sounds are, the technical details with respect to how the sounds were recorded and edited (or processed) remain still hidden from me. Here, I've moved from the question, "what is that sound?" to another: "how did that sound get here?" Katharine Norman admits to having gotten caught up in this question for a little while during her first hearing of this work:

> [A]s I listen, I'm wondering how she recorded some of these sounds, the yelping, scuffling to and fro of running wolves – a breathless, powerful pounding run, paws springing from dry earth, a prey (in mind or actuality), barking and growling with exhilaration. Perhaps she was hanging from a tree, or hovering near them – heart in mouth – or perhaps the microphones were secreted there and she was safely down the road – but somehow I think not. (Norman 2004b: 16)

Such questions about "how was it made" are, of course, common to the activity of music theory and analysis, although they do betray constructionist leanings (not surprising when one considers how many hyphenated composer-theorists are active in the field). It is especially common in writings about electro-acoustic music; as if, to write about such music, one must demonstrate one's membership in the inner circle, as *mathematikoi*. I would be projecting myself in that role if I were to mention Klein's use of comb-filtering techniques. Norman, similarly, could not help but identify Csound as Klein's preferred software tool. Many discussions and analyses of electro-acoustic music are filled with such technological references—in extreme cases reducing works to the technologies they use, exhibiting an overuse of what Denis Smalley calls "technological listening" (Smalley 1997: 109).

Although such discussions certainly have merit to composers and students, overemphasis on the technology employed to create certain sounds does can obscure other equally valid aspects of the listening experience. In Norman's case, getting caught up in guessing at Klein's use of technology distracted her from becoming fully absorbed in the musical experience of the work.

Yves Daoust's *Mi Bémol* (1990)

In his program note, Daoust writes:

> Around a small tonal object (E flat, Mi bémol in French) developed into a drone used as a thread in this piece, I have brought together some of my 'fetish' sounds. A stereotypical form emerged, a hyper-condensation of my style, of my articulation and construction processes: confrontation of widely different sound elements, a preference for the anecdotal, the crossfading of textures, oscillation between the musical discourse and the documentary approach. Mixtures of levels, polyphony of sounds and of meanings. A pastiche where I attempt to imitate myself…[4]

We can compare Daoust's use of the word "fetish" here, in describing his sounds, with Michel Chion's negative assessment of so-called fetishisms in electro-acoustic music:

> Fetishisms which have to do principally with focussing attention on the sources of the sounds and the means whereby they are pro- duced, whereas the sounds themselves are what really count, and they can be made in any and every way. (Chion 1993: 53)

We can understand Daoust's use of the word "fetish," then, to be aligned with the adjectives "anecdotal" and "documentary"; that is, sounds which more readily lend themselves to real-world interpretations in terms of their sources and means of production.

My introduction to Yves Daoust's *Mi Bémol* (1990) was through an analysis by Luke Windsor presented as an example of his perceptual approach to acousmatic music, grounded in ecological acoustics. (Windsor 1995: 122–49). Windsor makes many useful observations regarding moment-to-moment connections and interplay between "musical" and "everyday" sound events, the juxtaposition of implied sub-environments, and how certain events or gestures act as linking structures between those sub-environments; however, I find he is less successful in his explanation of the large-scale structure of the piece, partly because—in purposefully downplaying interpretation of everyday sounds, with particular avoidance of the three speech events in the piece—he fails to account for the sense of tension and drama within the flow of time.

Windsor chooses to couch his understanding of the large-scale structure of the piece in terms of sonata-form:

> The opening motive also seems to behave almost as if it was a sonata-form subject, returning clearly at the end. One might even suggest that the second subject of the work is the everyday environment, contrasted with a 'musical' first subject, and that the recapitulation brings these two environments together through plucked instrument melody which enters towards the end of the piece (Windsor 1995: 138).[5]

One problem with this explanation of large-scale structure is that it conflates the repetition of a concrete sound event, immediately hearable to the listener, with a posited thesis-antithesis-synthesis process going on between 'musical' and 'everyday' environments, distinguished from each other through Windsor's abstracted theoretical construction.

Rather than using a top-down approach to understanding large-scale structure, trying to fit the piece into a preconceived notion of musical form, I prefer to approach an understanding of large-scale structure by first mapping out the main partitions of implied events and spaces—what Windsor calls "sub-environments"—in the piece:

1. Opening/introduction (duration: about 30 seconds): bouncing metallic instrument / intimate interior space.
2. Playground (duration: about 25 seconds): oscillating, metallic creaking of playground swings, children's voices / exterior space.
3. Rally (duration: about 10 seconds): chanting crowd juxtaposed with rising and falling abstracted sounds.
4. News broadcast (duration: about 30 seconds): spoken word juxtaposed with irregular clacking noise.
5. Playground (duration: about 10 seconds): oscillating, metallic creaking of playground swings accompanied by oscillating chord progression (absence of children's voices).
6. Fireworks-thunder-rain (duration: about 30 seconds) interspersed with imitative synthetic sounds and human speech / exterior space.
7. Countryside (duration: about 30 seconds): rain droplets give way to plucked string instrument, sounds of cows and crows in wide open space.
8. Coda/epilogue (duration: about 15 seconds): final foregrounded repetition of bouncing metallic instrument punctuated by synthetic rising sound.

As Windsor points out, there is moment-to-moment coherency between adjacent sections or sub-environments through similarity of timbre or gesture, as well as punctuation of the transition between sub-environments by means of a recurring synthetic sound presented as either a rising or falling gesture. Similar to Klein's *Wolves* piece, while there are an abundance of real-world environmental sounds within the body of the work, these are framed at the beginning and end by more purely musical sounds.

As I mentioned before, there are three separate "speech events" that occur in this work. The first sounds like a large group of people chanting something that ends with the word "… Québecois!" (0:58–1:03); much like what one would hear at a political rally. The third speech event comprises of a number of individual voices, mostly male and mostly unintelligible, among sounds of a fireworks display (1:51–2:07). Windsor transcribes some of the more intelligible voices as saying "'fire', '…there's a double one' and 'O wow, look at…'" (Windsor 1995: 132). The second, and most substantial speech event, sounds to have been recorded from a radio or television broadcast, and offers a very clear implication of a specific time and place; this speech event is transcribed below:

> Radio announcer (male): " … accomplishing much today … occupying the town … with a guard of honour for their dead comrade, where Mohawks have been [set?] in now for six days. But their main spokeswoman said the police, known here as the SQ,[6] brought the death upon themselves"…
>
> Interviewee (female): "All of us know that the SQ had no right to come in the way they did and disturb one of our sacred, uh, ceremonies where we're burning our tobacco. This is happening over a golf course!"
>
> Echo: "This is happening over a golf course!"

While the first speech event may serve to situate the listener in the province of Quebec, it is ambiguous regarding whether the chanting is fueled by anger or celebration. The third speech event is more vague in terms of location, implying only a North-American English-speaking community, but the mood is unambiguously light. It serves a stark contrast to the serious mood of the second speech event, whose drama is underscored by an accompanying low sustained tone and violent foregrounded clacking. Moreover, most Canadians who were of age in 1990, especially those in Montreal, would immediately recognize historical event to which this speech event refers. This historical event, known as "The Oka Crisis," took place just outside of Montreal over the summer of 1990 and involved racial and political tensions between the Mohawk people and their white neighbors, with acts of violence (as well as peaceful protest) on both sides.[7]

The central position of this second speech event—the echo "This is happening over a golf course!" occurring around 1:30, the half-way point of the piece—serves to anchor interpretation of all of the anecdotal material in *Mi Bémol* to a snapshot of Montreal in the summer of 1990. This is not to say that the piece is mere 'sonic tourism', what Drever characterizes as the aural equivalent "to a public showing of personal holiday slides" (Drever 2002: 21). Rather, the dramatic narrative implied by the speech and other anecdotal material adds to the richness of the musical experience.

Conclusion

In the preceding analytical samples, I have been able to touch on the richness of the listening experience by allowing attention to both intrinsic and extrinsic properties of sounds and their interrelations. In the case of Westerkamp's *Cricket Voice*, this revealed an interplay between the earth-bound and otherworldly, a thick web of interconnections among various 'sound objects', and a sense of the opening and closing up of space between adjacent sections of the piece—the latter a technique that Barry Truax has called a "variable spatial perspective" model for structuring soundscape composition (Truax 2002: 8). I was able to notice a similar use of such spatial variations as structural markers in Klein's *The Wolves of Bays Mountain* and Daoust's *Mi Bèmol*. Also in terms of structure, I noticed that both Klein and Daoust framed their use of real-world sounds within an abstracted musical space by beginning and ending their respective piece with more conventionally music-like, pitch-centered material. Also, both Klein and Daoust guided the listener's sense of the passage of time by employing cues that denote different times of day as well as, in Klein's case, different seasons of the year.

While spectromorphology and other analytical tools that provide ways of describing the intrinsic properties of sound certainly have their merits, the attitude that privileges the concept of the sound object (abstract, intrinsic, and non-referential in nature) over sound's ability for signification and meaning (programmatic, extrinsic, and anecdotal) seems unnecessarily restrictive. Indeed, there has been a movement within the field of music theory in general—by theorists of traditional Western instrumental music—to question and re-examine this attitude within the context of contemporary multi-cultural and globalized society. Moreover, some composers of electroacoustic music, such as Trevor Wishart, have readily acknowledged how—in addition to their intrinsic sonic properties—the referential properties of their sound materials inform their compositional processes (Wishart 2012). From these examples we can expand our understanding and definition of musical listening as not just attention to intrinsic acoustic patterns and qualities, but also associative listening, listening for meaning, signification, and implied narratives. In this way, we allow ourselves to contemplate the impact that sound recording technology has made in allowing us to appreciate the acoustic properties of sounds abstracted from their original sources and contexts, but also in how it allows us to insert those sounds into new contexts and novel juxtapositions with other sounds and environments to create a rich, multi-layered experience. In so doing we may reevaluate the purpose of analysis with consideration to the target audience: the study of compositional methods and techniques when aimed at composers; insights into how to interpret a score or other instructions from the composer when aimed at performers; and an enhancement of musical experience and appreciation when aimed at general listeners. As Marion Guck suggests, "music analysis can be seen as a way that analysts work on themselves to understand and improve their experiences of music they have chosen, as well as offering the possibility of musical self improvement to their readers" (2006: 207).

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[1] Of specific note, among the papers presented at this session were: John Dack, "Listening to 'Plastic' and 'Musical' Languages in Pierre Henry's Variations pour une porte et un soupir"; Bill Brunson, "Triangulating Narrativity in Electroacoustic Music"; and Joshua B. Mailman, "Renewing the Riverbed: Critical Aesthetic and Epistemological Purposes for Analysis, Fueled by Performative Theory." The full title of Leigh Landy's keynote address was "How Listening-based Analysis Can Aid the Appreciation and Understanding of Electroacoustic Music."

[2] As I mentioned before, McCartney asserts that it is the sound of the cricket (representing nature) that causes the sense of anxiety many urban listeners experience in this work—she draws on Marlon Brando's line from *On the Waterfront* to substantiate her claim: "I don't like the country, the crickets make me nervous" (McCartney 2002: 46). My interpretation of this work, however, seems to imply an argument in the opposite direction: namely, it may be the sounds that I associate with non-nature (warning signals, ambulance alarms, etc.) that are the source of anxiety for some listener; or, perhaps, it is the juxtaposing of nature *with* non-nature, as represented through sounds, that causes such distress?

[3] Actually, it might be more accurate to say the cricket's chirp occupies a space between Db6-Eb6.

[4] From the "Track Detail" information for Yves Daoust's CD *Musiques naïves* (1998) on the website of the Electroacoustic Music Store http://www.electrocd.com/en/cat/imed_9843/pistes/ (retrieved August 30, 2014)

[5] I have come across a number of analyses of electroacoustic music that, on making the observation that material from the beginning returns at the end, jump to the conclusion that the work in question is in sonata form. Usually, as in the case of Windsor's analysis here, it is a mark of the analyst displaying only superficial understanding of what sonata form entails.

[6] SQ stands for *Sûreté de Québec*, the police force of the province of Quebec, Canada.

[7] In brief: A white-owned development company was planning an expansion of a local golf course onto land claimed by the Mohawk Nation, including an ancient burial site. Mohawk protesters set up barricades blocking the development plans; when white police officers stormed the barricades, a group of Mohawk warriors decided to barricade the Mercier bridge—thus cutting off easy access to the city and enraging local white commuters. A gun battle on July 11 resulted in the death of one police officer, the "dead comrade" mentioned by the radio announcer. For a more detailed account, see http://www.firstnationsdrum.com/fall2000/hist_oka.htm/

[Abstract in Korean | 국문 요약]
추상과 현실 사이의 청취: 전자음향 음악 분석의 맥락

캐시 콕스

피에르 셰퍼Pierre Schaeffer의 관념, 대상으로서의 소리*objet sonore*와 일맥상통하는 또 다른 그의 개념, 제한적 청취reduced listening [écoute réduite]는 소리 내부의 연관성 만을 집중 분석하도록 하고 실제 주변 세계와의 관계성은 경시하게 만든다. 이 접근방식은 독일 형이상학을 철학적 기반으로 하여 서양기악음악을 분석하던 기존의 관행과 닮아있다. 그러나 전자음악을 감상하면서 실제 일어나는 사건이나 공간에 대해 경험하게 되는 중요한 감각적 여지들을 이러한 [철학적인] 방법들로는 간파하지 못하기 때문에, 오디오기술이 감각적 인지를 변화시키는 데 끼치는 풍부한 영향력 역시 모두 놓칠 수 있다. 이 글은 세 편의 작품, 힐데가드 웨스터캠프Hildegard Westerkamp의 《귀뚜라미 소리Cricket Voice》(1987), 주디 클라인Judy Klein의 《베이산의 늑대들The Wolves of Bays Mountain》(1998), 이브 대우스트Yves Daoust의 《내림 마Mi Bémol》(1990) 에 대한 간략한 분석과 함께, 각 작품이 추상화된abstracted 소리세계와 실제 소리세계 사이에서의 작용하는 구조적인 핵심 역할에 대해 설명한다. 결론적으로, 저자는 전자음악을 청취 경험을 바탕으로 분석할 때 실제 세계와의 연관성 인식을 주장하는 바이며, 분석의 목적도 이와 함께 다시 자리매김되기를 바란다.

Augmented Interactive Scores for Music Creation

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This article addresses music representation issues in the context of the contemporary music creation and performance. It exposes the main challenges in terms of music notation and representation, in regard of the new forms of music and with an emphasis on interactive music issues. It presents INScore, an environment for the design of augmented, interactive music scores that has been developed in response to current artistic evolutions. It gives an overview of the system with a presentation of its main features and highlights on the main technologies involved. Concrete examples of use with recent music creations, composers' viewpoint and an electro-acoustic piece modelling will also be given.

Up to a few years, the support provided by computer music to digital music scores has remained quite conventional. Regarding the symbolic notation of music, the approach was mimicking the traditional engraving process. Sophisticated software like MuseScore [1], or Lilypond[2] (Nienhuys / Nieuwenhuizen 2003) – to cite just a few among free software - provide very efficient ways to generate music scores but for traditional usages i.e. similar to paper scores.

Acousmatic and electro-acoustic music genres have led to new forms of graphic representation of the music, for analytic and musicological purposes, with music scores made *a posteriori*. This kind of notation has found little support from computer music, apart the approach proposed for years by the Acousmograph (Geslin / Lefevre, 2004) or more recently with EAnalysis (Couprie 2012).

Premises of interactive music are present for a long time. Stockhausen (Stockhausen 1959) or Cage with the Variation series (Cage 1960-1966), have explored indeterminacy and performers interaction, with specifically designed music scores. But with the use of computers, interactive music has become a common musical form.

More generally, the music score has to face the new musical forms resulting from the digital tools used at all levels of the music process, from composition to performance, including live coding (Magnusson T. 2011). It has also to face the migration of musical instruments to gestural and mobile platforms, hybridizations with dance, design, and multimedia.

Music notation generated in interaction with live performance exists for more than a decade. As mentioned by Freeman (Freeman 2011), numerous approaches exist: selection of pre-determined score excerpts (Kim-Boyle 2005), mixture of symbolic and graphic elements (Winkler 2004), use of unconventional graphical notation (Gutknecht et al. 2005), complex staff based notation (Didkovsky 2004).

These works are based on custom tools that are generally specifically suited to a composer approach. Didkovsky used JMSL (Didkovsky / Burk 2001), a programming language for Java applications, to design interactive scores. Baird is using Lilypond for audience interaction (Baird 2005). Lilypond can't be considered as a real-time environment for generating music scores, but it works in Baird's context due to relaxed time constraints.

With the recent Bach (Agostini / Ghisi 2012) or MaxScore (Didkovsky / Hajdu 2008) environments, the symbolic dimension of the music notation starts to be accessible to interaction using common tools.

Representation of the interaction process may also help for the design and the performance of interactive music pieces. When a computer is involved in a performance, almost no feedback is provided to the performer regarding the interaction system state. When there is, the system displays information like cues, time, or pedals state on a separate monitor that is presented is parallel to a paper score. Most of the time, the performer has to concentrate on the score, which makes the separate display hard to follow.

(François et al. 2007) has designed a system for visual feedback in performer-machine interaction that is focusing on musical improvisation. In the improvisation domain, OMax is also proposing a visualization (Lévy et al. 2012) under the form of a graphic representation of the Factor Oracle graph.

Mostly, audio feedback remains the main channel to convey the interactions system state, which is far from being sufficient in many cases.

Performance representation may also be valuable for the performer in rehearsal situation or for pedagogic purpose. For the latter and based on a mirror metaphor, experiments have been made to extend the music score in order to provide feedback to students learning and practicing traditional music instruments (Fober et al. 2007). This approach was based on an extended music score, supporting various annotations, including performance representations based on the audio signal, but the system was limited by a monophonic score centred approach and a static design of the performance representation.

In regard of the issues above and of the contemporary music creation needs, a unified environment, covering symbolic and graphic notation, opened to real-time interaction is missing from the current landscape of solutions for digital scores and music notation. This has been the main motivation for the development of INScore, an environment for the design of augmented interactive music scores (Fober et al. 2012a).

The next sections give an overview of the INScore environment and of the main technologies involved. Next, this article explains how these technologies are involved in the creation of innovative music scores. Examples of use in concrete artistic situations are given with pieces from Richard Hoadley, Sandeep Baghwati, Jean-Baptiste Barrière and a modelling of *Turenas* from John Chowning.

INScore Overview

INScore is an environment for the design of interactive augmented digital music scores. It extends the traditional music score to arbitrary heterogeneous graphic objects:

- symbolic music notation using the Guido Music Notation format (Hoos et al. 1998) or the MusicXML format (Good 2001),
- text (utf8 encoded or html format),
- images (jpeg, tiff, gif, png, bmp),
- vectorial graphics (basic shapes like rectangles, ellipses, bezier curves or SVG),
- video,
- an original performance representation system (Fober et al. 2010).

Each component of a score has a graphic and a temporal dimension and can be addressed in both the graphic and temporal space.

The graphic properties include common attributes like position, scale, colour, basic transformations like 3-axis rotations, shear, and effects like blur, colorize or shadow. The time properties include a date and duration.

Time synchronization in the graphic space

A simple formalism is used to describe relations between the graphic and time space and to represent the time relations of any score components in the graphic space on a *master/slave* basis.

The formalism relies on segments and mathematical relations between segments. Time segmentation constitutes the spine of the system. Each object includes at least one *mapping* that is a relation between the object graphic and time segmentations. Composition of different objects relations through their time segmentation results in a *graphic-to-graphic relation* that expresses the objects time relationships in the graphic space.

The scope of this formalism extends beyond the music score context and could be used as well to describe relations between gestures and audio in a performance setting. A detailed description is available from (Fober et al. 2012b).

Figure 1 shows graphic rectangles used as time cursors and synchronized to a symbolic score.

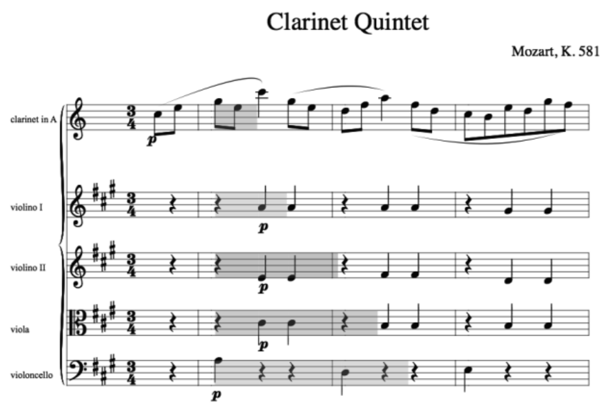

Figure 1. A multi-voices score with synchronized cursors. The cursors date is '1/4' and their duration varies from 1 to 5 quarter note. The cursors' width is graphically extended to the corresponding score duration.

Performance representation

Performance representation proved to be valuable in particular in a pedagogic context (Fober et al. 2007).

INScore includes a performance representation system based on signals (audio or gestural signals). The system approaches the graphic of a signal as a *graphic signal*, i.e. as a composite signal made of several signals in parallel:

- a y coordinate signal
- a thickness signal
- a color signal

Figure 2 illustrates the components of a graphic signal at a time *t*.

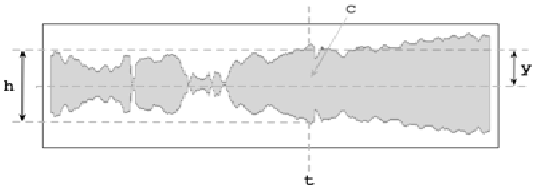

Figure 2. A composite signal at a time *t*. Any vertical graphic slice is defined at a time *t* by its *y* coordinate, a thickness *h* and a color *c*.

A composite graphic signal includes all the information required for drawing without additional computation. It constitutes a very flexible system to elaborate dynamic representations of a performance. Figure 3 gives the example of a combination used to represent both pitch and articulations.

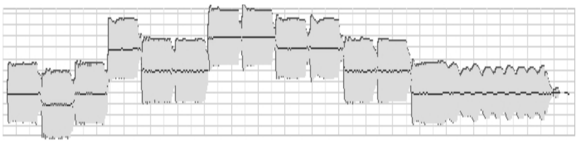

Figure 3. Pitch and articulation combined in a single representation using f_0 and *rms* values in parallel.

The graphic signal *g* is expressed using 3 signals in parallel as follows:

$$g = S_{f0} / S_{rms} / k_c$$

where S_{f0} is the fundamental frequency, S_{rms} is the RMS values and k_c is a constant colour signal.

A message based system

INScore is a message driven system that is based on the Open Sound Control [OSC] protocol (Wright 2002).

An OSC message is composed of an address, specified like a Unix path, followed by arbitrary parameters. The parameters type is among *integer*, *floating point* and *string* values. Example:

```
/mysynth/channel1/vol  0.7
```

INScore specializes the basic OSC format with a string as first parameter that describes an action or an attribute of the target object of the OSC address (Figure 4).

Figure 4. General format of an INScore message.

For example, the following message:

```
/ITL/scene/score x 0.8
```

addresses an object named *score* to set its *x* position attribute to 0.8.

Messages are provided to control the graphic and time attributes of the score components, to design graphic signals, to synchronize objects and to describe interactive behaviours.

The set of supported messages constitutes the application programming interface [API] and the main way to design music scores.

This message-oriented design opens the door to remote control and to interaction using any OSC capable application or device (typically Max/MSP, Pure Data, but also Python, CSound, Super Collider, etc.)

Musical process representation

Representation of musical process may be critical for the performer in case of interactive music. Existing representation systems are coupled to specific environments and disconnected from the music representation itself.

INScore approach to process representation is inspired by (Berthaut et al. 2013), where the objective was to improve audience experience notably in the case of electronic music. Computer musical processes are characterized in (Fober et al. 2014). From INScore viewpoint, a process state and activity is denoted by signals. INScore allows connecting a signal to any graphic attribute of a score component (position, rotation, scale, colour…). This way, any object of a score may convey information about interaction processes.

Events based interaction system

INScore provides interaction features provided at score component level by the way of *watchable* events. These events are typical UI events (like mouse clicks, mouse move, mouse enter, etc.) extended in the time domain (time enter, time leave, etc.). The principle consists in associating a list of messages to an event (Figure 5). When an event occurs, the associated messages are triggered.

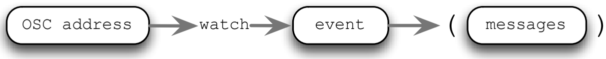

Figure 5. Basic mechanism to describe interactions: a set of messages is associated to an event by sending the *watch* message to an object.

The messages could be any valid INScore message but arbitrary messages as well, which can be send to any external application using an extended address scheme.

Plugins

INScore can be dynamically extended via external plugins, which are loaded when the corresponding objects are created. It supports currently 2 extensions, one in the domain of gesture following with the IRCAM gesture follower (Bevilacqua et al. 2010), another one in the domain of signal processing with the FAUST compiler (Orlarey et al. 2009).

With the gesture follower, specific events are available to design gestural interactions.

The FAUST compiler has been included to provide pre-processing of signals for representation purposes (performance of interaction process representation).

Scripting language

A textual version of the OSC messages that describe a score constitutes the INScore storage format. This textual version has been extended as a scripting language with the inclusion of variables, extended OSC addresses to control external applications, and support for embedded JavaScript sections.

INScore script files can be dropped to score windows to *send* the enclosed messages. It constitutes an original way of programming since these files may represent a score, but interaction features as well. In a given way, one may think of script files as an extensible commands system.

An open source software

INScore is an open source software that is available from SourceForge[3]. It runs on the main operating systems (GNU Linux, Windows and MacOS).

INScore in Music Creation

Since its first public release, INScore has been used in several musical creations, notably to design interactive music scores.

Calder's Violin

Calder's violin has been composed by Richard Hoadley and was premiered in Cambridge on October 2011. The piece is defined as "*automatic music for violin and computer*". It involves the live presentation of common practice symbolic music notation created through algorithmically generated material (Figure 6). The notation is then performed by a human musician alongside computer-generated diffused sound or other 'real' musicians. Technologies used include the SuperCollider audio programming environment and INScore with the OSC protocol used to communicate between them. More details can be found in (Hoadley 2012).

Figure 6. Calder's Violin - a typical output as displayed to the performer.

Alien Lands

"*Alien Lands*" is the title of a concert given in Montreal in February 2011, entirely dedicated to Sandeep Bhagwati. Three compositions were presented: *Alien Lands*, *Monochrom*, and *Nil Nisi Nive*. All the pieces were using INScore for presenting the music score to the performers, with uses that fall in 4 different categories:

- *automatic traditional music score*: the system is used as a traditional music score but with automatic page turning.
- *music score with computed choice*: in *Divide* (a movement of *Alien Lands*), the performer was instructed to change the order of the measures, lines etc. With the INScore version, the choice was made by the computer and the pages simply presented to the musician.

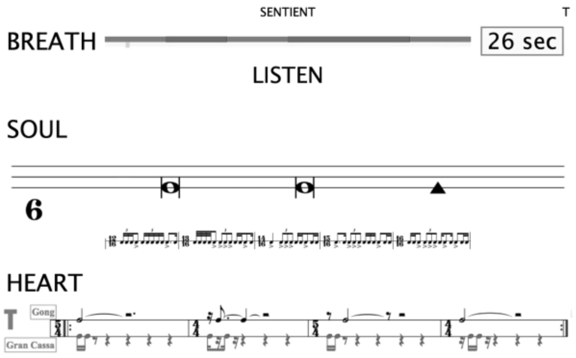

Figure 7. A *complex computed music score* as presented to the performer.

- *complex computed music score*: in *Sentient* (last movement of *Alien Lands*) and *Monochrom* 1 & 2, the computer was automatically distributing the score pages. Some elements of the score were generated algorithmically in real-time (like instructions, notes, some elements remained unchanged. A counter was displaying the remaining time. Red and grey coloured boxes at the top of the score were indicating when to play (Figure 7).
- *complex interactive score*: in *Nil Nisi Nive*, the performer was controlling the musical elements. The score was generated algorithmically but on performer request, who could ask for a new page at any time.

Miroirs distants

Miroirs distants has been composed by Jean-Baptiste Barrière and was premiered in Lyon and New York, in March 2014, during the Musiques en Scène biennale.

It proposes a special musical situation: two flautists are face to face, look and play straight in the eyes while they are in two remote locations (Lyon and New York for the creation), through what appears to be a large electronic mirror, reflecting both their image and that of the distant performer. The resulting enigmatic image must be deciphered and interpreted: it is in fact a music score (Figure 8).

Figure 8. Aesthetic and musical functions of the score in *Miroirs distants*.

The composition of the image has two functions: one plastic, the other musical. Part of the aesthetic challenge of this project was to mix the two without compromising the quality of both functions.

The image is generated in real-time using a combination of Max/MSP-Jitter and INScore for the symbolic music notation.

Turenas

Turenas has been composed by John Chowning in 1972. It was one of the first electronic compositions to have the illusion of sounds moving in a 360-degree space. A graphic transcription of the piece has been designed by Laurent Pottier (Pottier 2004), which has been turned into an interactive score with INScore (Figure 9).

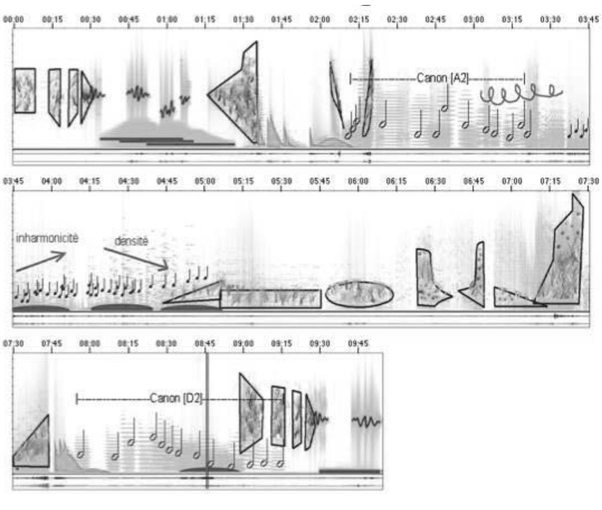

Figure 9. *Turenas* score, as transcribed by Laurent Pottier and as it appears in INScore. A red cursor indicates the current position in the audio recording of the piece.

The whole piece modelling makes use of Max/MSP or Pure Data to play the audio file and to send clock messages to INScore, in order to move a cursor to the corresponding time location.

The score implementation supports multiple views, which can be switched by simple drag & drop of INScore scripts, even in real-time. Figure 10 displays a structural representation of the piece, presented on a single line. In this case, the master/slave synchronisation scheme is inverted: master object is the cursor and the graphic representation is slave of the cursor, which has the effect to scroll the score when the cursor moves in time.

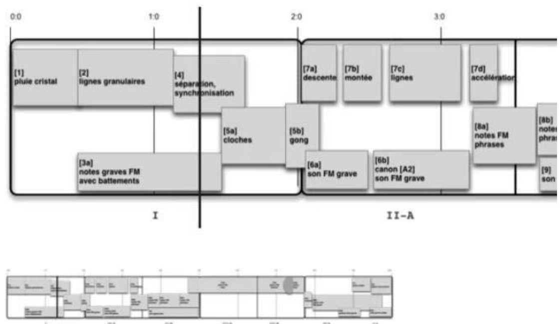

Figure 10. A structural view of *Turenas*. The score is presented as a single line. The bottom view gives the whole score overview and can be used to move the current reading position. The blue cursors indicate the same time position in both views.

The score makes use of interactive features: mouse clicks trigger time position messages that are sent to the audio player and internally to the cursor as well. Time events are used to temporary display analytic information over the score, as if living only for a given time span.

Conclusion

Computer technologies for music notation start to be mature enough to support new forms of representations and new artistic forms based on digital scores. Today, many interesting approaches exist, but music notation is mostly used as auxiliary to the composition and writing tools.

Although the way we represent the music is central to the composition process and thus to the musical thought, it is also critical for the performer. Indeed, with the preservation role, the transmission function has been one of the primary orientations of the music notation, which influences the composition process as well.

Today, tools for the performance start to emerge, proposing new approaches to music notation. Although it supports many applications, INScore can be focused to performance issues and proposes a graphic space opened to arbitrary representations (from symbolic notation to pure graphics) and features especially designed to take account of the dynamic aspects of the notation explored by interactive music.

As shown by the presented artistic works, INScore is mature, stable and ready to be involved into music creation. However, it remains an on-going project that takes place in a global research on music notation and representation. Future extensions should enforce the scripting approach in order to develop the system programmability. Migration to mobile platforms (e.g. tablets) and to the Web is also planned, and issues like collaborative approaches to music score design, web performance using shared scores, should be part of future research.

Technological note. INScore makes use of the following technologies:

- The GUIDOEngine[4]
- The IRCAM Gesture Follower[5]
- The FAUST Compiler[6]
- The Qt5 cross-platform application and UI framework[7]
- The V8 JavaScript Engine[8]

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[1] http://musescore.org/

[2] http://www.lilypond.org/

[3] http://inscore.sourceforge.net/

[4] http://guidolib.sourceforge.net/

[5] http://imtr.ircam.fr/imtr/Gesture_Follower/

[6] http://faust.grame.fr/

[7] http://qt-project.org/qt5/

[8] https://code.google.com/p/v8/

[Abstract in Korean | 국문 요약]
음악 창작을 위한 상호작용형 증강 악보

도미니크 포버 / 얀 올래리 / 스테판느 레츠

이 글은 현대음악의 창작과 연주를 위해 사용되는 표기방식music representation에 관한 사안을 역설한다. 이에 대해 새로운 형태의 음악, 특히 상호작용형 음악에 사용되는 기보법과 표현법에 집중하여 주요한 쟁점들을 제안한다. 이를 위해 오늘날의 예술적 진화에 발맞추어 개발된 확장 상호작용형 음악의 악보를 만드는 프로그램, 인스코어INScore에 대해 기술한다. 이와 관련된 기술의 주요한 특성과 눈에 띄는 기능을 설명하면서 전체적인 시스템을 대략 살펴본다. 최근 프로젝트의 창작 과정에서, 작곡가의 관점에서나 전자음악작품의 기획 모델로서 이 시스템이 활용된 구체적인 예도 다룬다.

Composing for Musical Robots: Aesthetics of electromechanical music

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Scholarly literature on musical robotics has primarily focused on the design and technical capabilities of robotic instruments rather than their musical potential. Drawing upon my own experience building and composing for robotic instruments as a co-founder of Expressive Machines Musical Instruments (EMMI), this paper presents an exploration of robotic musicality, an aesthetic approach that considers the characteristics of robotic music that differ from both human-performed music and loudspeaker-based computer music. Within this context, I investigate the history of mechanical music as well as notions of expressivity that date back to eighteenth century musical automata. I also present an analysis of my own compositions for Expressive Machines Musical Instruments' (EMMI's) musical robots. This includes examples of music that is unplayable by humans, the "broken machine" aesthetic, and the use of robots to critique contemporary notions of futurism.

Musical Robots are built for a variety of purposes including understanding the physiology of human performance, research into human-computer interaction (HCI), and the search for sonic novelty. While researchers typically focus on the first two categories, very little has been written about the aesthetics of robotic music. Most of the literature focuses on the design and technical capabilities of robotic instruments as well as their role within interactive multimodal performance systems (Solis 2011). Analysis of such systems gets folded into more generalized discussions of computer music, ignoring concerns specific to robotic musicality.

Differentiating robotic music from the wider field of computer music represents a challenge. MIDI sequencing, algorithmic, and interactive control are used to make music with both robotic instruments and computers. However, robotic output is quite different from loudspeaker-based computer music. Loudspeakers are designed to reproduce the full range of frequencies of human hearing, while robotic output is designed to excite a specific material such as a steel string or plastic drumhead. The sound produced contain all of the associated imperfections of vibrating bodies in the physical world. Robots also maintain the visual and sonic relationship between gesture and sound production.

This paper describes the aesthetics of robotic music as the specific relationship between control and output in music created for electromechanical instruments. It also considers how the capabilities of these instruments differ from both human-performed and loudspeaker-based computer music. These differences extend beyond the technical capabilities of robotic instruments and incorporate the notion that human audiences tend to anthropomorphize the actions of these instruments. To explore these issues, this paper will discuss the history of automatic instruments from the classical period to today, the ways in which robotic music differs from human-performed and loudspeaker-based computer music, and robotic musicality within the context of several of my own compositions for Expressive Machines Musical Instruments' (EMMI's) musical robots.

From musical automatons to musical robots

Musical robots can be traced back to early European automatic instruments such as the water organ (c. 875 c.e.) and mechanical carillons in the Middle Ages (Fowler 1967, Kapur 2005, Murphy 2012). Inventors in the eighteenth century developed sophisticated musical clocks and organs that were controlled with pinned barrels (Ord-Hum 1983b). These instruments played both existing compositions and new works commissioned from famous composers of the time, including Mozart, Haydn, C.P.E. Bach, and Beethoven (Richards 1999, Dolan 2003, Ord-Hume 1983b). Classical music continued to be transcribed for musical automatons in the nineteenth century, however, industrialization shifted the emphasis from reinterpretation to mechanical reproduction. This resulted in higher volumes of lower quality transcriptions and less interest in creating new music for these instruments (Ord-Hum 1983a: 169).

Recording technology developed in the late nineteenth and early twentieth centuries that could accurately capture and reproduce a musical performance. This new technology displaced musical automatons as the preferred method of musical reproduction (Satz 2010: 77). While automated instruments such as player pianos continued to exist, they became novelty items. Some composers, most notably Conlon Nancarrow, took advantage of the player piano as a compositional tool (Drott 2004), however, most shifted their focus towards electronic and computer music, which dominated the field of music technology in the latter half of the twentieth century.

The development of transistors as well as the availability of surplus parts in the 1970s initiated a new era of automated instruments (Leitman 2011). In the 1980s-90s academic research institutions such as Waseda University in Japan began developing robotic musical instruments to study the mechanics of human performance (Solis / Takanishi 2011). A number of research schools continue this work, with notable advancements in human-computer interaction from Gil Weinberg at the Georgia Institute of Technology (Weinberg 2006), Ajay Kapur at California Institute of the Arts (Kapur 2011), and Scott Barton at the Worcester Polytechnic Institute (Barton 2013). At the same time, musician-technologists, such as Trimpin, Godfried-Willem Raes, Eric Singer, and others created ensembles of robotic musical instruments designed for creative exploration (Maes 2011, Singer 2003). Following this model, Troy Rogers, Scott Barton, and I created Expressive Machines Musical Instruments (EMMI 2007), a collective dedicated to designing, building, and composing new music for robotic instruments.

Human, computer, and robotic music

In order to define robotic musicality, it is important to distinguish between the music-making capabilities of humans, computers, and robots. Table 1 outlines these differences based on dexterity, rhythm, dynamics, and expressivity. Dexterity implies the speed and complexity of changing pitch; rhythm describes the level of metric complexity, polyrhythm, and tempo; dynamics refers to amplitude of sound produced; and expressivity refers to articulation, phrasing, and other expressive gestures. This table does not represent a comprehensive list of all capabilities of these three forces, but focuses on those most important to the present discussion.

	Humans	Robots	Computers/ Loudspeakers
Dexterity	Fast/ complex passages for fixed period of time	Extremely fast, repetition rate determined by velocity, pushing limits of instrument produces undefined behavior	No limits
Rhythm	Complex changes in meter, limits to complex polyrhythm	No theoretical limits to complexity of rhythm beyond maximum performance speed. Rhythms less precise than computer due to gravity/ friction/etc.	No limits
Dynamics	Full range of dynamic control on single notes/over phrases, limits to rapid successive changes in dynamics	Controllable by velocity, each value must be programmed, (limited to 128 values in standard MIDI)	Limited by loudspeaker response, requires extensive programming
Expressivity	Capable of micro-variations in pitch (non-keyboard instruments), dynamics, pulse, etc.	Some micro-variations inherent in mechanical system (different than human expressivity), other expressive gestures limited by hardware capabilities	No limits, requires extensive programming

Table 1. Differences in capabilities of human, robotic, and loudspeaker-based computer music

The main distinction between loudspeaker-based computer music and robotic music is the fact that robots maintain the relationship between physical gesture and sound production (Murphy 2012: 45). Thus, musical robots can be thought of as "real" virtual instruments. They are virtual in the sense that they are computer controlled, however, since these devices function in the physical world their sounds possess variations caused by friction and gravity. Aside from differences in sound production between computers, robots, and humans, audiences that encounter musical robots tend to anthropomorphize their actions, regardless of whether or not the robot looks humanoid (Fussell 2008). The mapping of human action to a machine represents an extremely important part of what differentiates robotic music from loudspeaker-based computer music.

Interactive control

Many designers create robotic instruments as part of interactive multimodal systems, which can be broken down into input, processing, and output stages (O'Sullivan 2004, see Figure 1). For them, this type of system represents the minimum necessary qualification to consider music to be robotic. Gil Weinberg defines "robotic musicianship" as, "a combination of musical, perceptual, and interaction skills with the capacity to produce rich acoustic responses in a physical and visual manner" (Weinberg 2006: 28). For Weinberg, perception and interaction are necessary components of robotic musical systems.

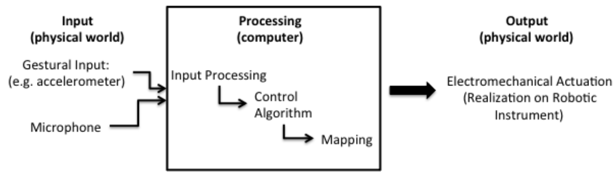

Figure 1. Interactive multimodal robotic system design

While the focus on interactive systems makes sense in the context of human-robotic interaction, the point of interaction lies in the input and processing stages. For example, Georgia Tech's Haile percussion robot uses a variety of interactive modes to produce musical outcomes. These rely on beat detection and stochastic transformation of incoming data to allow Haile to improvise with human performers (Weinberg 2006: 36).

The problem with considering the entire system in the context of robotic musicality is that the input, processing, and output stages are modular. The modularity of these stages makes it difficult to trace the relationship between input and processing algorithms and robotic output. Therefore, the input and processing stages could just as easily be realized through computer playback. Such interactive computer music systems have existed since the 1960s, with pioneering work by Max Matthews, Barry Vercoe, and George Lewis among others (Risset 1996, Lewis 1999). Just as Haile's input and processing stages can provide output to a computer-controlled loudspeaker, any of these computer-based input systems could be mapped to a musical robot. Before we consider robotic musicality in interactive systems, it is important to understand the possibilities of robotic instruments from the perspective of musical output, detached from specific modes of input. Though beyond the scope of this paper, analysis of interactive multimodal systems represents an important topic for future work.

Expressivity in robotic music

One persistent criticism of robotic music is that it lacks expressivity. This critique dates back to the musical automata of the classical period, and reflects the fear that technology will encroach upon traditionally human activities. In describing his reaction to Vaucanson's 1738 mechanical flute player, Johann Joachim Quantz reflects the anxiety of the era:

> With skill a musical machine could be constructed that would play certain pieces with a quickness and exactitude so remarkable that no human being could equal it either with his fingers or with his tongue. Indeed it would excite astonishment, but it would never move you; and having heard it several times, and understood its construction, you would even cease to be astonished. Accordingly, those who wish to maintain their superiority over the machine, and wish to touch people, must play each piece with its proper fire. (Richards 1999: 383)

Emily Dolan explains this notion of expressivity as the result of a mid-eighteenth to nineteenth century desire for acoustic instruments to mimic the human voice (Dolan 2008: 11). Criticisms of musical automata at this time did not stem from their mechanical nature per se, but rather that automated percussive instruments (the easiest to build) were incapable of the sustain and nuance of the human voice. Other automated instruments, such as the Aeolian harp and glass harmonica, were revered for their timbral characteristics (Dolan 2003: 13).

Contemporary criticisms about the lack of expressivity in robotic music come from instrumentalists as well as computer musicians. If these criticisms refer to the limited timbral palette of robotic instruments, they possess some validity. As in the eighteenth and nineteenth centuries, percussive instruments remain the simplest to build. The most basic of these instruments lack the ability to control the volume of an attack (velocity control). In more complex instruments, expressive gestures that may be easily achieved by a human performer, such as vibrato on a string instrument, are quite difficult to produce on a robotic instrument. To do so requires the addition of specialized hardware to either adjust the string tension or move the "finger." Even if such hardware capabilities are built into the system, advanced software control is needed to make the vibrato sound "natural."

If, as Quantz suggests, expressivity is used as a substitute for human emotion or soul, then by definition robotic instruments cannot possibly be expressive. To this I would argue that the capabilities and limitations specific to robotic instruments account for their own "robotic expressivity." I will discuss several examples in the following section. As the body of music for robotic instruments grows, these gestures will become more apparent.

Musical Examples

In my own compositions for EMMI's robots I explore the ways in which the robotic musicality differs from human performance. This exploration occurs on several levels beginning at the note/phrase level and expanding to notions of mechanical performance and technological futurism. On the note/phrase level I focus on creating musical gestures that are unplayable by humans including extremely fast performances, sudden changes in tempo, and granular textures. Exploring ideas about mechanical performance, I discuss the "broken machine" aesthetic. Finally, I demonstrate ways in which I have employed musical robots to critique notions of futurism.

Unplayable by humans

As previously mentioned, one of the most apparent differences between humans and robots is the ability for robotic instruments to perform rapid successions of notes for long periods of time. This hyper-virtuosic performance tends to initially impress an audience by showing off mechanical dexterity far beyond human capabilities. Unlike human virtuosic performance, however, there is no evidence that this type of fast performance presents a challenge to a robotic instrument. This lack of tension causes audiences to quickly lose interest in sustained rapid phrases, especially when performed at an unchanging tempo.

My own compositions for robots feature rapid performance, though that gesture is typically interspersed with slower sections. *PAM Solo, Take One* (2009) for EMMI's Poly-tangent Automatic multi-Monochord (PAM, Figure 2), begins slowly with cycles of sixteenth notes being played at an increasingly rapid tempo. Between 0:50-0:55 the tempo decreases dramatically followed by a continuous increase to 333.33 BPM, the fastest moment in the piece (Figure 3). The juxtaposition between slow and extremely fast sections creates a greater sense of tension, and the ending repetition rate of this section (45ms between notes) tests PAM's technical capabilities—the instrument cannot play any faster.

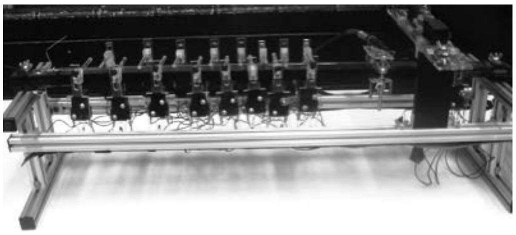

Figure 2. PAM: Poly-tangent Automatic (multi)-Monochord

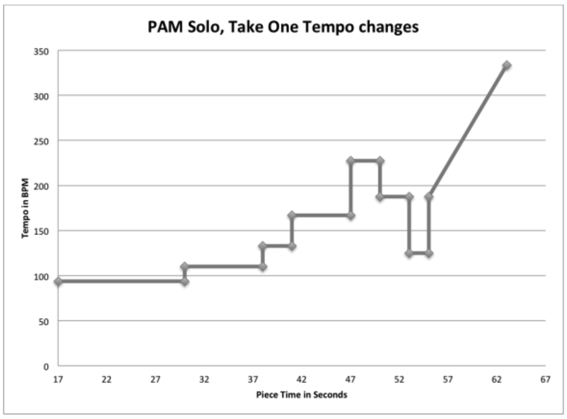

Figure 3. Tempo changes in *PAM Solo, Take One*

In addition to pushing the limits of PAM's speed, I explore rapid trills between low and high notes over the range of the instrument. In *PAM Solo*, the most rapid passage consists of trills between F6-F5, one of the highest notes on the instrument and the lowest articulated note on the instrument (not the open string). Combined with the extremely rapid tempo, this moment displays the technical limitations of the instrument, much as a virtuosic passage challenges the boundaries of human capability. The difference is that there are no limits to the length of time that PAM can sustain this level of rapid performance. Thus the context of increasing the tempo into this moment and retreating to a slower moment afterwards manufactures a sense of tension and release that would be lost if PAM were allowed to continue playing as fast as possible for a longer period of time.

Robotic expressivity and granular control

As previously mentioned, one of the reasons listeners consider robotic music to be less expressive than human performance is because of the precise timing of computer control. On the contrary, due to their mechanical design, robots inherently produce random variations in sound that alleviate the hyper-precision of computer-based virtual instruments (Kapur 2009: 49). These variations, however, lack the subtle temporal fluctuations found in aspects of human performance such as rubato. Improvements in algorithms to mimic human performance, now standard in many digital audio workstations, are one way to remedy this issue. Moving in the opposite direction, I have developed a control method where sonic "grains" performed by robotic percussion instruments are controlled through a stochastic process that is similar to granular synthesis (Truax 1988). This method allows the composer to determine attack times and amplitudes based on a window of probability.

I have implemented this system of granular control in Max where a master clock controls timing and sends impulses based on window size. Sub-patches, one for each MIDI note, tap into these impulses to generate individual notes (MIDI note on and velocity messages). This allows the composer to specify either a precise grain time within the window or a range of times (Figure 4). The composer can also determine velocity either as a set level or a probabilistic range. Large window sizes with wide ranges of attack times will create sparse, cloud-like textures. Small window sizes combined with an envelope on the velocity allow shaping of individual notes comprised of varying grain density. The minimum window size is limited by the repetition rate of a particular instrument. For EMMI's Transportable Automatic Percussion Instrument (TAPI), there is a maximum repetition rate (minimum window size) of 20ms, producing a maximum of 50 grains per second per striking arm.

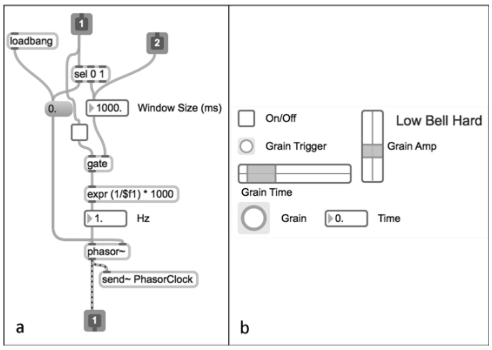

Figure 4. Implementation of granular control in Max. a) window size controls frequency of master timer (phasor~) b) controls for grain time/grain amplitude

I have employed the granular note generation technique in two pieces to date: *Microbursts* (2012) and *Conjuring the Machine* (2014). In *Microbursts*, TAPI shifts slowly between sharp rhythmic attacks and cloud-like textures, while supported by rapid, monophonic gestures played by AMI (Automated Monochord Instrument) and CARI (Cylindrical-Aerophone Robotic Instrument). *Conjuring the Machine*, for electric guitar and TAPI, uses the granular approach in two sections. In the first, the amplitude of the electric guitar, played using an EBow, controls the grain amplitude of all of TAPI's striking arms. This allows the human performer to directly control the envelope of the granular texture in real time. At the end of the piece, onset detection is used to determine the length of notes played on the guitar. This length is mapped to envelope length of the granular texture. This texture becomes increasingly sparse throughout iterations of the three-note guitar melody.

"Broken machine" aesthetic

There is often the perception that, compared to humans, machines are capable of "perfect" performances. This led me to question the notion of what "mistakes" a robotic instrument would make. One type that I have explored is the "stuck loop." For example, in *PAM Solo* at 1:56 there is a slow trill between F6-F5 at 60 BPM that mirrors the extremely rapid trill mentioned above. This slow, steady trill continues for nineteen seconds, which is far longer than one would expect given the musical context. The fact that this trill continues for so long gives the impression that the machine is stuck in some kind of infinite loop.

Another example occurs at the end of *Eleki-Robo* (2011) for PAM and MADI (multi-Mallet Automatic Drumming Instrument). After the final iteration of the melody at 2:48, the synchronization between PAM and MADI becomes disrupted. At this moment, PAM plays short, rapid phrases, and MADI plays a halting rhythm in a different tempo from PAM's phrases. This moment lasts twenty seconds, at which point rimshots played on MADI resynchronize with PAM's phrases and the piece comes to an end. In both of these examples, the idea that the machine's timing may have broken "humanizes" the performance by pointing to the idea that machines are not perfect.

Critiquing futurism

On a more abstract level, the idea of robots playing music points to a future where autonomous agents threaten to replace humans. Futurists such as Ray Kurzweil posit the idea of a technological "singularity," where existence is forever changed by the accelerating rate of technological innovation (Kurzweil 2005: 7). Though Kurzweil embraces this future, the concern that we are losing our humanness to machines represents the same anxieties about technology presented by Quantz almost three hundred years ago.

In Illo Tempore (2012) for saxophone, bassoon, AMI and CARI contrasts acoustic instruments (saxophone and bassoon) and twenty-first-century technology (musical robots) with the Kyrie from Monteverdi's mass *In Illo Tempore* (1610). The goal of this contrast is to problematize the notion that in Western society, technology is equated with "forward progress." The title of the piece refers both to Monteverdi's mass as well as the fact that "In Illo Tempore" translates from Latin to "in that time," a term religious studies scholar Mircea Eliade uses to refer to the time before history—mythical time (Eliade 2005: 58).

Instead of celebrating futurism through the superhuman speed and precision of robotic instruments, *In Illo Tempore* confronts the notion of technological irreversibility by combining these new instruments with a four-hundred year old mass. The piece also plays with the audience's expectations of robotic musical performance. One of the defining features of robotic instruments is their ability to perform complex rhythms at fast tempos—a gesture that occurs only briefly in the piece. Instead, *In Illo Tempore* explores AMI and CARI's fine dynamic and timbral control.

In Illo Tempore takes advantage of AMI and CARI's ability to produce infinite sustain. AMI possesses an electromagnetic bowing system similar to the commercially available EBow. CARI produces sound by using a compression driver to force an air column into resonance. Both instruments are driven by audio signals allowing for infinitely long tones with complete dynamic control. LEDs are used to visualize the amplitude of the resonating string and air column (see Figure 5). By producing sound through slowly changing amplitudes, AMI and CARI are more closely related to the vocal-like timbres of the early Aeolian harp and glass harmonicas described above (Dolan 2008: 16-18).

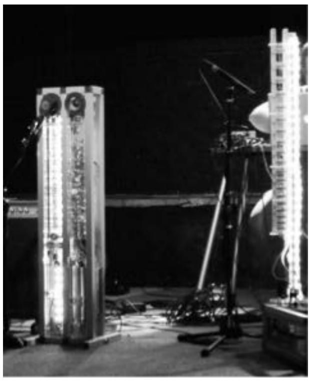

Figure 5. AMI: Automated Monochord Instrument (left) and CARI: Cylindrical Aerophone Robotic Instrument (right)

Thwarting the notion of a march to technological singularity, the piece ends with a temporal suspension of old blended with new, and human and robotic performers on equal footing. The final section combines temporal suspension with a reinterpretation of Monteverdi's *In Illo Tempore*. The tempo of the original is slowed down considerably, and continues to ritard throughout the movement. The six voices from the Kyrie are arranged for saxophone and bassoon. Though the instrumental lines imply harmonic motion, the extremely slow tempo obscures any sense of harmonic resolution. Underneath this counterpoint, AMI and CARI play swelling intervals based on the harmony of the counterpoint while the saxophone and bassoon continuously move to a higher register.

Conclusion

Though musical automata have existed since the eighteenth century and contemporary musical robots have been around since the 1970s, research into the aesthetics of robotic music is still at an early stage. The examples presented here from my own work loosely define several important aspects of robotic musicality, including differences in performance between humans, computers, and robots, as well as ideas about the nature of machines performing human activities.

Future research on musical robots should move beyond technical descriptions of hardware and software control to focus on musicality and expanded notions of expressivity. This should include an analysis of the large body of existing works for musical robots created by composers collaborating with groups such as the Logos Foundation, LEMUR, and EMMI. Additionally, analysis of interactive multimodal systems that feature human-robotic interaction should be conducted in a way that examines the input, processing, and output stages as a complete system within the broader context of robotic music.

Musical robots may never become ubiquitous, however, the availability of inexpensive hardware and the desire to bring physicality to computer music has generated a surge of interest in recent years. New audiences have been exposed to these machines through high-profile collaborations with popular musicians, notably Pat Metheny's Orchestrion tour (Metheny 2010), Bjork's Biophila Tour (Bjork 2011), and Squarepusher's collaboration with Z Machines (Squarepusher 2014). In order for musical robots to move beyond their novelty status, musicians working with robotic instruments must continue to develop expanding notions of robotic musicality.

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[Abstract in Korean | 국문 요약]

음악 로봇을 위한 작곡: 전기기계적 음악의 미학

스티븐 켐퍼

음악 로봇에 대한 학계의 문헌들은 로봇의 잠재적인 음악성보다는 로봇기계로서의 디자인과 기술 역량에 주로 초점이 맞추어져 있다. 이엠엠아이(표현하는 기계적 악기)EMMI(Expressive Machines Musical Instruments)의 공동설립자로서 로봇을 개발하고 이를 위한 음악을 만든 저자의 경험을 기술하면서, 사람이 연주한 음악이나 스피커로 들려주는 컴퓨터 음악과 구별되는 로봇 음악의 특성을 고려한 미학적 접근을 통해 로봇의 음악적 성격을 탐색한다. 이 맥락에서 18세기 자동연주시스템Musical Automata으로 거슬러 올라가 기계로 다루는 음악Mechanical music의 뿐 아니라 표현성에 대한 개념까지 역사적으로 살펴본다. 더불어 이엠엠아이 음악 로봇이 연주하는 저자의 자작 작품을 분석한다. 이 글은 사람에게 연주불가능한 음악, "망가진 기계"의 미학, 현대적 관념의 미래주의를 평가하는 로봇의 사용 예를 포함한다.

Cognitive Sound Image: The creative compositional process involved in electroacoustic audiovisual music and motion graphic score designing

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This article will demonstrate the unique form of communication and artistic practices achieved through the utilization of motion graphic score (MGS) in author's electroacoustic audiovisual composition entitled *Cognitive Sound Image* composed in 2013. This work is composed for Korean traditional percussion Janggu and the visual is comprised of MGS where the Janggu notation and moving images inform every aspect of the performance. The author will focus on establishing a link between music and human cognition by explaining the encoding/decoding processes shared between the audience and performer through the MGS during the performance of the work. This paper illustrates the creative compositional process in three phases: conceptualization, design and performance and contains a study of aesthetics of traditional Korean music and art. Furthermore, the author will discuss the outcome of the implementation of the MGS through various performance models of compositions that emerged from the process such as real-time sound processing and electro-interactive music installations.

Cognitive Sound Image

The Cognitive Sound Image (CSI) is an audiovisual piece composed for Korean percussion instrument Janggu. The composer's appreciation of traditional and historical aesthetics and values of Korean music are re-interpreted in a modern context and visualized through two movements with contrasting music and images in the Motion Graphics Score (MGS). The MGS is made visible to the performer and audience through the screen on the stage and is designed to inform every aspect of the performance. The CSI seeks to contemplate how the audience perceives Janggu symbols projected on the screen, which corresponds to the sound of Janggu and the playing motion/gestures of the performer. The whole aim of this study leads to examining human perceptual system and challenge human's ways of dealing music which are based on "beliefs, intentions, interpretations, experience, evaluations, and significations" (Leman 2008). The CSI motivates the performer to express musical ideas and improvise freely based on the information received from the MGS, which leads the audience to spectate the performer's decoding process of the symbols and moving images. Having participants' cognitive processes exposed and shared within the performance space fulfils the composer's compositional goal, which is to change traditional streams of performance and suggest new ways to engage and involve audience in electroacoustic audiovisual music performance setting. The main purpose behind this work consists of enlarging the boundaries of Korean traditional music through computer music technology as a mediator that serves to generate new modes of communication, creative expression and dynamical experience in music performances.

Links between music and cognition

The MGS consists of two correlated ideas. The first concerns the design of new Janggu symbols and its meaning; the second involves the manipulation of its meaning through the MGS. Before describing the compositional process in detail, it is important to establish the links between music and cognition and how this process is stimulated in the CSI.

The performance and musical listening in the CSI involves a multitude of cognitive processes by the performer and the audience. The performer is to play and improvise based on the Janggu symbols and is encouraged to elaborate extended techniques guided by the moving images in the MGS. This places the audience who is not aware of the functional aspects of the MGS, to figure out how the symbols and moving images projected on the screen correspond with the matching sounds of Janggu and playing motion/gestures of the performer. Wide ranges of cognitive processes during the performance include "auditory scene analysis, streaming, attention, learning and memory, formation of expectations, multimodal integration, recognition, processing semantic symbols, processing of forms of meaning, emotions, and social cognition" (Pearce / Rohrmeier 2012: 473). In the first movement of the composition, only one Janggu symbol is intentionally projected in a sequential manner to help the audience establish and develop an understanding between the symbols, which carry a specific meaning, and the moving images, which carry a specific function and narrative. Once the audience aware of the functional and semantic aspects of the MGS, the spectators can more readily contemplate on the performers own cognitive processes and observe how the performer interprets and decodes the MGS in his/her own performance style. The cultural, traditional and historical dimensions, and the aesthetics variety and complexity embedded in the visual component of the work enlightens and elevates one's musical experience and aesthetic appreciation. The MGS in this work is a communicational device that is first interpreted by the performer, and then understood by the audience through the embodied movements of the performer. Here, the exposure of music cognition processes take place by having the encoding/decoding processes shared between the audience and performer during the execution of the work. The CSI is an intriguing work that connects dots of "different disciplines of psychology (such as perception, attention, memory, language, action and emotion)" (Pearce / Rohrmeier 2012: 473) and could be a viable model for an in depth study of the human cognition involved in music processing.

The photograph below demonstrates the electro-interactive music processes manifested during the performance of Cognitive Sound Image in 2013 (Figure 1).

Figure 1. Cognitive Sound Image live performance at the Sydney Conservatorium of Music, December 2013

The composition process demystified

The following sections illustrate my cognitive process involved in the composition of CSI. The compositional process is explained in three phases: conceptualization, design and performance. I will elaborate on the processes of manipulating and combining many different kinds of thoughts and information into a coherent idea, encoding non-visual ideas into visual code and materialization of those ideas.

Conceptualizing Phase

This section describes the conceptualizing phase. The basis of this composition stems from my personal interest in finding correlation between visual and sound, and links between the composition and cognitive processes within the realm of electroacoustic music. A major source of inspiration that shaped the interesting concept of this work included reinterpretation and reinvention of Korean traditional music in a contemporary context. An appreciation of the past is what my idea of modernity was based on "as tradition is a living process connecting the present with the past" (Park 2010: 66). I designed new extended technique symbols of Janggu and re-created a traditional Janggu notation to a new shape to respond to the shifting times and aesthetics of modern society, contemporary communication and artistic expression.

Aesthetics in Korean traditional music. The most significant aspect of style and aesthetics in Korean music is the flexibility of the performer that "permits personal deviation and improvisation in the process of performance." The extent of Korean improvisational musical styles and "variables depend on the performer's artistic idiosyncrasy and aesthetic preference." However, improvisatory music is extemporized by using the macro-unit and micro-unit models (Lee 1997: 34).

Taking the significance of improvisation in Korean traditional music to account, I designed a symbol that indicates the performer to improvise freely within the structured rhythmic framework. The symbol indicating the cue to begin a free improvising section is shown on the screen in figure 1. When the improvisational symbol and extended symbols appear, the performer is to explore every possible textural sound using different parts of the Janggu along with the accompanying electronic music in the background. This allows the audience to observe and recognize different degrees of creativity and artistic expressions in composition and improvisation.

Visual scores and digital technology. In 1950s, a few experimental composers such as Earle Brown, John Cage and Karlheinz Stockhausen initiated the development of graphic notation, and many composers today are now creating their own ways to communicate visually through new styles of music notation. And the type of the visual scores varies from simple picture to detailed signs that indicated instructions. (Bergstrøm-Nielsen 1993: 40) The development in digital technology and introduction of visual scores in music have expanded the course we experience and express music today. New ways of compositional processes are manifested, and new modes of communicating artistic ideas are invented as technology allowed digital media composers greater flexibility in expressing their creative and artistic ideas (Zavada 2008). The CSI is aimed to produce a new visual score with traditional Janggu symbols by taking an advantage of technology that allowed the composer to combine and integrate aesthetics of Korean traditional music, and supported the old traditional forms and music one step closer to the public.

Designing phase

This section illustrates the design phase. The construction of MGS began after the conceptualization phase.

The MGS follows the basic characteristic of Korean art, which is the simplicity. The MGS is constructed with two layers. The layer 1 is a fixed layer that only shows the symbols to inform the player what to play. The layer 2 is a moving image that carries the narrative and informs the player how to play the symbols. Then the visual interpretation guide for the MGS is produced for the player as shown in Figure 2. The brightness and visual effects of the moving images in the second layer of the MGS determine the speed and dynamics of symbols.

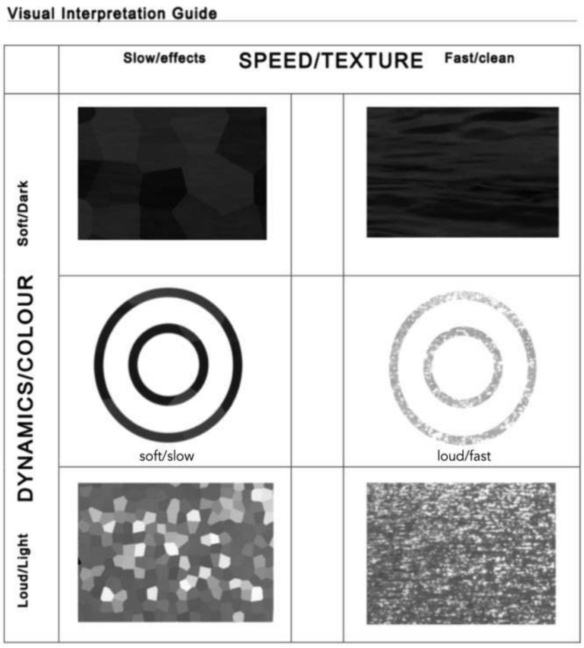

Figure 2. Visual Interpretation Guide for MGS

The 'line' and its philosophical meanings became a significant element that connected links between two layers in the visual with the sound, and combined various ideas into a coherent framework, which unified the entire work. I will go through the decision-making process of designing MGS and how I linked it with music in four steps.

1. Notion of round energy. First step involved the study of Janggu notation, which began with a contextual research on the aspects of traditional Korean music. The inspiration of new designs came from Janggu symbols, which are in the form of 'circles.' Duk-Soo Kim and Dong-Won Kim in the book 'Samulnori Textbook (1990)' describes that the reason why Janggu symbols are in a circular shape is due to the belief that "a musical sound should always be felt as 'round.'" One of the fundamental principles when playing the Janggu, is the use of round energy that departs from the lower part of the abdomen and the round gesture of performer's body movement; hence, creating powerful resonance on the instrument. This notion of round energy connects a link with the formation of the traditional Janggu notation, which the shape and form of the symbols are "based on our understanding of the sound and energy in music" (Kim 1999: 18). Drawing this notion into the work, I designed new symbols for the extended techniques that I developed during the course of composition (Figure 3). The extended technique symbols were designed based on the motion, direction and the formation of sound.

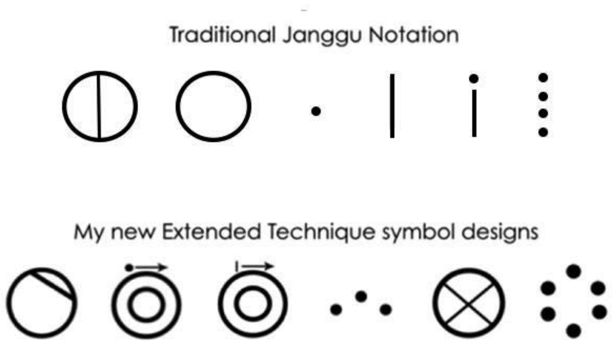

Figure 3. Symbols designs for Janggu MGS

2. Tradition and modernity. Based on the notion of roundness in Korean music and Janggu notations, I decided to make a distinct comparison between traditional and contemporary aspects of Korean music and art using contrasting shapes and lines to creatively express the aesthetics and preferences of the tradition and modernity. The change from a circular shape to a cube is a symbolic representation that connotes the shift in time of aesthetics from the past to present. The two symbols in figure 4 consecutively illustrate the image of traditional Janggu symbols and my new interpretation of traditional Janggu symbols in a modern context.

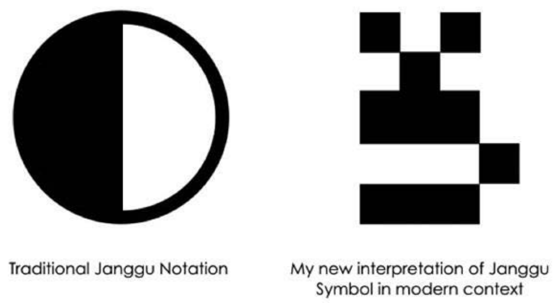

Figure.4 Key symbols representing the two movements

These two symbols become key symbols that represent the two movements in CSI. In the movement 1: 바다 (the sea [bada]), the circular shape of traditional Janggu notation is used as a visual motif since movement 1 is highly comprised of traditional Janggu rhythms. Contrastingly, the movement 2: 도시 (the city [doshi]), introduces the new shape of Janggu symbol using cubes to represent the modern time.

3. Linking two layers of MGS using 'lines'. The third step involved linking two contrasting Janggu symbols (figure 4) in layer 1 to moving images in layer 2. Layer 2 of the MGS holds a dualistic function that both signify the speed and dynamics while narrating the composer's message behind the work. The vigorous search to solve this problem triggered my memory from observing Hundertwasser's architectures and artworks around two years ago.

Friedensreich Hundertwasser is an Austrian artist and an architect, who incorporates natural features on his architectures and paintings. He stated "the straight lines leads to the downfall of mankind" and "it is the line which does not exist in nature" (Alsen 1996: 272). The use of spirals and curves are the philosophical expression of his artistic practice, which became a significant symbol of his works. Contrastingly, Piet Mondrian evolved modern styles only by using straight lines. Through the manipulation of lines and shapes, these artists have articulated creative ways to communicate with people. Based on the notions discovered from the research, I began to film curved and straight lined objects for layer 2 in the MGS and soon realized that the straight lines seemed mostly man-made. Hence, the characteristic and geometrical shape of nature and man-made structures became the visual theme of each movement. In movement 1, the circular shape of traditional symbols that hold the notion of traditional Korean music aesthetics, i.e., the roundness of sound is coined with spiral and curved images such as clouds, waves, bird and the wind portrayed through flags. Conversely, straight lined images such as streets, neon-signs, bridges, buildings and railway became main visual features of the layer 2 of the second movement. Bringing philosophical ideas and sources from architectures and artworks, I linked layer 1 with layer2 of the MGS (figure 5), in which the symbols and moving images matched with my intention of the work, i.e., juxtaposing and speaking about the tradition and modern time.

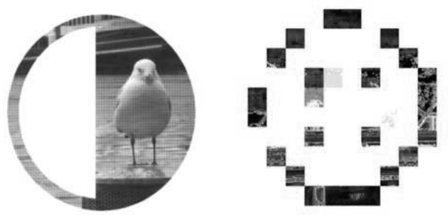

Figure.5 Images of the MGS in movements 1 and 2

4. Linking visual to the sound. The final step required forming the connection between visual ideas and the music composition. First, I formed the table of visual elements (e.g. line, shape, motif, colour, place setting, texture and style) and musical elements (e.g. pitch, rhythms, timbre, dynamics, texture and instrumentation) to show clear contrasts of the two movements. A specific type of *Jangdan* (rhythmic pattern) is chosen to enhance this contrast. The *Jangdan* called *daseureum* used in movement 1 is mostly used in the opening of traditional Janggu solo piece, in a kind of prelude. The characteristic of this rhythm is in its ability to create calming atmosphere. This work slowly begins with one symbol projected on the screen, which helps the audience to form a perception and an association between the body movement and symbols. The second movement features *jajinmori* and *hwimori jangdans*, which carries dynamic and exciting rhythms with fascinating body movement match well with vivid and vibrant modernistic images and the composer's intention in the second movement. Using tables helped to visualize non-visual ideas that enabled me to systemize and organize ideas during the course of music composition. Designing with sound and visual gives a rousing experience to a composer since the visual elements can trigger and motivate musical ideas, which may also work vice versa.

Performance phase

This section explains the performance phase and the implementation of the MGS in different performance models. Four compositions emerged from the process and are described in this section. These compositional outcomes are the direct result of my work and interaction with the Janggu and MGS.

Cognitive Sound image is in the form of a fixed media performed with MGS that contains fully composed music and fixed visuals. In order to achieve various versions of this fixed media, the performer's comprehension of the piece, interpretation of the MGS, exploration of the textural effects on the Janggu, and the ability to improvise with various musical ideas are advised and encouraged.

Tangent is a real-time performance in collaboration with Dr. Ivan Zavada., electroacoustic composer and lecturer at The Sydney Conservatorium of Music. The performer improvises based on the MGS and provides musical and sound material to the computer as a live input that instantaneously records the sounds of Janggu to process new sound effects and sonic textures accordingly. In return, the performer improvises with the associated electronic sound transformations in a live performance setting. Such an interesting concept and method places the performer on a constantly switching position of being a sender and a receiver simultaneously. From a performer's perspective, this collaborative performance challenges the performer to break out from the conventional styles of playing and improvising. The performer is encouraged instantaneously think of the transformed sound effects as an artistically responding being. It requires a huge leap of faith if the performer is trained as a Korean traditional musician. In Tangent, the MGS acts as a mediator that alters conventional frameworks and styles of improvisational music, and expands artistic processes in collaborative works.

One-Nori and *Two-Nori* are sonic visualizations and an electro-interactive music installations based on the Janggu and MGS. The work is inspired by the Korean traditional percussion quartet called *SamulNori*. I attached Piezo sensors on the skins of Janggu and connected those sensors to the Arduino board that is interfaced with software Max/MSP. Each sensor is programmed with a specific range of vibration values. So when the participant hits the sensors, it would trigger different sounds and symbolic images of SamulNori instruments. The main objective of these installations is to give educational and unique experiences to users who are not familiar with traditional Korean instruments through the MGS and contemporary technology in a sonic and visual environment.

Conclusion

The strength of this work lies in the projection of abstract images and sounds of traditional Korean music and art, and unique styles of Janggu symbols and its associated meanings expressed through distinct characteristics of the MGS. This article explained the notions and aesthetics of Korean music and art, and demonstrated the process of its transformation and modernization. It may seem like that the "Tradition is perceived as more archaic and disconnected from the present" (Park 2010: 63) especially in the fast changing world of new media and digital technology. However, with the music technology mediation, the contemporary field of electroacoustic music associated with traditional and cultural music is thriving on new approaches in creative domains.

The CSI seeks to establish new perception of the modern audience and suggests creative visions to the musician through the MGS in an artistic performance setting. The creation of these new types of notation not only means the development of traditional Korean musical notations but also contributes to the advancement of playing methods and styles. The CSI discovered promising potential of live performance that invites the audience to embrace new forms of Korean traditional music and to engage with the performance through the embodied movements of the performer creating gestures according to the visual representations of the Janggu symbols in the MGS. This unique form of communication and artistic practices can facilitate traditional performances one step closer to the contemporary audience and foster new realms of music cognition within electroacoustic music.

Acknowledgement

This work was developed and composed during my Bachelor of Music in Composition degree at Sydney Conservatorium of Music in 2013. I would like to express my sincere gratitude to my professor Dr. Ivan Zavada for his inspiring guidance, valuable supervision and constant encouragement throughout the development of this work. I would also like to thank my family and friends for their endless support rendered towards the completion of this work.

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[Abstract in Korean | 국문 요약]

인지적 소리 이미지: 전자시청각음악과 모션그래픽악보 디자인에 관련된 창조적인 작곡과정

김 데보라

이 글에서는 저자가 2013년 작곡한 전자음향적 시청각 작품 《인지적 소리 이미지Cognitive Sound Image》에서 활용한 모션그래픽악보Motion Graphic Score (MSG)를 통해 얻게 된 독특한 형태의 소통과 예술적 시도를 입증하고자 한다. 이 작품은 한국의 전통 타악기인 장구를 위한 곡으로, 영상은 장구의 악보와 동영상으로 연주할 모든 지시사항을 전달하는 모션그래픽악보MGS로 구성된다. 작품이 연주되는 동안 모션그래픽악보가 청중과 연주자 모두에게 보여주는 암호화 과정과 이를 해석하는 과정을 설명하면서, 음악과 사람의 인지 사이의 연결고리를 만들어가는 데 논의의 초점을 맞출 것이다. 이 글은 음악의 창작 과정을 개념화와 기획, 연주의 세 가지 측면에서 기술하되, 전통 한국의 음악과 예술 미학적 고려도 포함한다. 더 나아가, 저자는 실시간 사운드 프로세싱과 전자적 상호작용 음악 설치 등의 형태로 만들어진 작품들의 다양한 연주 방식의 예를 들며 모션그래픽악보의 실용성에 대해 논의한다.

Performing Audiovisual Corpora of Arbitrary Instruments

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We present an instrument for audio-visual performance that allows to recombine prerecorded sounds through concatenative synthesis. A three-dimensional visualization derived from feature-analysis of the recording becomes accessible through a theremin-inspired interface, allowing the player to shift from exploration and intuitive navigation towards embodied performance on a granular level. In our example we illustrate this concept by using the audiovisual recording of an instrumental performance as a source. Our system provides an alternative interface to the musical instrument's audiovisual corpus: as the instrument's sound and behavior is accessed in ways that are not possible on the instrument itself, the resulting non-linear playback of the grains generates an instant remix in a cut-up aesthetic. The presented instrument employs the structural outcome of machine analysis as performative access to audiovisual corpora to enable a musical expression.

In our research we present a remix instrument that follows the concepts of cut-up and collage rather than simulation and imitation. We are applying the ideas of Burroughs, Gysin and Oswald to a real time assemblage. With our instrument we provide an alternative interface to the sonic possibilities contained in the recording of an instrumental performance, the *corpus*.

When we look at a cello, it becomes clear that the instrument itself seems to be the best interface to its own "natural" character and sound. A bow on four strings, the stops on the fingerboard and all the historic and extended techniques from plucking the strings to knocking on its body.

The application of technology to instrumental performance on the other hand is often encountered in the context of simulation. Looking at string instruments from the perspective of a composer, we find that high quality sample banks, often encompassing multiple terabytes, can generate an impression of instrumental performance almost indistinguishable from "the real thing".

A parallel development in the visual domain can be seen in photography. It has been recently revealed (published in different media, notably by The Independent) (Vincent 2014), that 75% of the images in the IKEA catalogue are in fact computer generated graphics, created in 3D modeling software. Art directors prefer a computer generated image over photography, not only because it can be faster and cheaper to produce, but foremost because of the level of control over the image unparalleled by means of traditional photography.

We don't take pictures, we render them. Just like we don't play the instruments themselves, we generate the sound of their performance. That tendency is especially apparent when it comes to movie scores or games. Both visual and auditive simulations are generated in real-time and according to Moore's law we can expect that rendering at a quality beyond our perceptional capabilities will be possible in the next years.

Simulated sonic and visual worlds can be cheaper, fast to produce and can offer a more direct control over the outcome. In the case of interactive experiences like games, the real-time simulation no longer has an analog alternative.

In contrast to this hyperrealism the intent of our research is to create an abstraction. We are not trying to play the cello or control a simulation thereof, but instead to generate a meta-relationship to what is created during a real instrumental performance. We are not indulging in Baudrillard's simulacra, instead we wish to rearrange and collage like Burroughs. While he used newspaper as a source for his cut-up texts, we use a video of the cello to reassemble it — the wrong way.

Remix instrument:
platform for discovery and performance

How can we generate the potential for such accountability within the process of remixing fragmented media streams that are often complex and difficult to memorize? In his article *Transforming Mirrors* (Rokeby 1995), David Rokeby describes how accountability in exploratory interactivity emerges in *belief systems* established by the perceived relationships between action and result.

Within this process of establishing accountability, *exploration* and *performance* fluidly merge into a single activity: Exploring the point cloud representing the parametric distribution of fragments of the analyzed recording, the user gradually accumulates experience with the effects of their own physical actions on the perceptual result. A relationship between expectation and appearance unfolds that can sustain the interest of the player, while the disclosed range of possible action strategies gradually permits the player to *perform* effects intentionally. This process is not only an increase in the *control* over the behavior of the resulting playback, but following Alva Noë (Noë 2006) we could say that *perceptual strategies* are established and gradually evolve during both the exploration of and performance with the instrument.

Controlling the remix instrument

The user has three perspectives to the remix instrument. First, the strategy of fragmentation and analysis that is applied to the media content to generate the *corpus* has to be chosen and applied to the media stream; In the current setup we pre-analyze the media before playback to generate the analysis meta data that allows for indexing and display. On-the-fly analysis and indexing (of newly generated media) would be supported by the setup with minor changes to its structure. In a second step, the analysis is transformed to a visualization that is simultaneously and interface. The user can choose the specific mapping strategy by which the result of the analysis is distributed on the spacial position of points in a cloud that can be interactively browsed to re-assemble the fragments. Finally, in a third perspective, the user is addressed with an audiovisual presentation: the playback of the re-assembled media stream. The last display is the most suitable for an audience in a performative setting. In the following paragraphs we will describe the current implementation of these components.

In order to permit musicians to evoke specific perceptual experiences, musical instruments need to provide performers with a sense of accountability — reliable and predictable connections between player action and perceptual result.

Implementation

Analysis and fragmentation

The instrument uses William Brent's *timbreID* (Brent 2009) to splice the audio component of a media stream into short snippets (further also referred to as *unit* of the concatenative synthesis). Each unit is described by a feature vector in which each analyzed sound feature appears as added dimension in a multi-dimensional Cartesian space. See *Cepstral analysis tools for percussive timbre identification* (Brent 2009) for a list of extracted features. The media source is a four minute recording of a cellist as 48kHz audio, 30fps/720p video. The musician has been instructed to create as many different sounds as possible by improvisation, thereby attempting to generate an encompassing *corpus* of the musical sounds that can be produced on the cello.

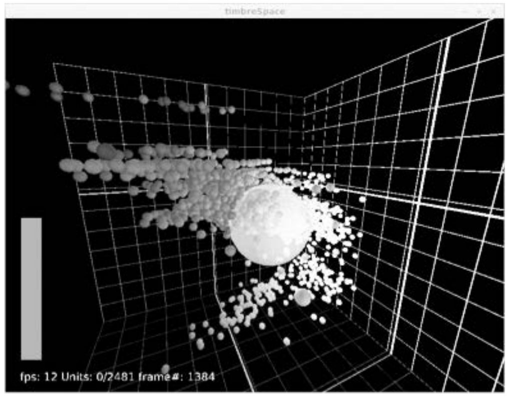

Figure 1. Pointer and units of the analyzed recording visualized as a scatter plot in a 3D grid.

Visualization and navigation feedback

Every unit appears as an individual point. Together, all units of the recording visualize as a cloud. It forms a three-dimensional scatter plot that can be zoomed and navigated in real-time. Depending on which feature dimension is mapped on which axes of the cloud, the units appear in a different spatial distribution resulting in a different interactive accessibility (figure 1). The varying visualizations of the analysis simultaneously help to understand the nature of the recorded sound and provide the user and player with an intuitive expectation of the unit's contents. Organization by pitch for example makes contained musical scales immediately visible. Correlations between different feature dimensions become apparent, for instance, when viewing the average pitch of a fragment versus the number of zero crossings its audio waveform contains. In that sense the remix instrument may also be used for Music Information Retrieval (MIR) as it permits the multidimensional analysis of a media artifact to be explored.

In order to trigger points inside the resulting point cloud, we are using a non-haptic interface to define the right hand as the focal point of the playback. Multiple methods are applied to help the user's perception of the depth in the 3D space as described in detail in (Neupert 2012). Additionally, the currently selected unit is highlighted in color.

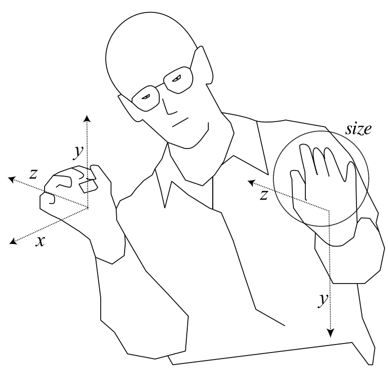

Figure 2. Control parameters: right hand = position (x, y, z) left hand = (y, z, size)

Remixing

Human-Machine Interface

For navigation in the point-cloud we are using *the Leap Motion* controller. This consumer USB device is a compact infrared stereo camera which is tied to the appending computer vision software running on the host. Driver and SDK are available for Linux, OS X and Windows. It extracts absolute position and orientation for several hands including fingers from the frames of the camera. Previously we had been using the *Microsoft Kinect* as HMI (Neupert / Goßmann 2013). Both are contact free spacial sensing devices but have different capabilities. For a brief summary of our findings comparing the two, see (Goßmann / Neupert 2014).

Interaction

The skeleton tracking of the user's hands allows not only a three dimensional space for interaction, but provides orientation, roll, tilt and finger positions as well. After experiments with single-handed operation, we concluded that we needed to employ both hands in order to permit sufficient number of control parameters to be influenced by the performer. The principal hand navigates the point-cloud and selects particles for playback (figure 2). The secondary hand controls the volume (x) and adds a reverb effect (z) to the sound. Its size controls the grain duration (fist=short, stretched-out fingers=long). Like any instrument, it requires practice to accumulate experience with regard to the relationship between the user's self-movement and the resulting behavior of the instrument.

Performing concatenative synthesis

The re-assembly of sound from micro-fragments is usually addressed as *granular synthesis* (Roads 2004) and more recently as c*oncatenative synthesis*, for example by Schwarz (Schwarz 2006b). The re-assembly of media streams from larger units has also been addressed as *Musaicing* (Aymeric Zils 2001) and *Sound Spotting* (Spevak / Favreau 2002).

While the waveform of the grains has been taken into account in methods of grain crossfading — for example to enable a seamless combination of grains avoiding transition artifacts (Behles et al. 1998), the parameters used by granular synthesis to re-assemble a continuous sound from grains are generally agnostic to the grain's content.

Concatenative Synthesis in the sense of Schwarz on the other hand juxtaposes a database of sound units — the *corpus* — to processes of algorithmic re-composition that operate on the descriptive metadata harvested in a process of signal analysis (Schwarz 2006a). This allows the re-assembly of sound particles to take signal features present within the original media artifact into account. The reassembly of particles can be controlled by a guide signal for which appropriate units are selected from the database. This enables the creation of gestures within expressive dimensions that also characterize the various playing techniques of real instruments (Schwarz 2012)—from noise-like to tonal, from low to high pitch, et cetera.

Our remix-instrument allows performative access to the metadata, without the use of a guide signal. The result is a continuous media stream assembled from the respective units stored in the database in real-time. By visually organizing the fragments or units along freely selectable analysis dimensions, the spatial layout of the *corpus* does not need to adhere to abstract parameters such as pitch transposition or particle length, but can be derived from signal features that are emergent *principal components* of the analyzed media artifact itself. Thus the performer of the sample-based remix instrument does not have to think in abstract synthesis parameters but is instead brought in direct contact with the structural aspects of the analytical corpus of available fragments.

A short demo of the instrument can be seen at https://vimeo.com/maxneupert/audiovisual/

Manipulated video

While the user navigates and performs the scatter plot and thereby links the sound units found in the displayed point-cloud, our system simultaneously shows the corresponding video frames (figure 3). Analogous to the nature of concatenative synthesis in which non-consecutive units of the analyzed audio waveform are linked into a continuous stream, the video is played back alongside its respective audio fragment which results in random-access cueing, a *cut-up* of the original video footage: a real-time remix of audio-visual media fragments. Consequentially the video shows micro loops consisting of a minimum of two frames up to five frames depending on the audio grain size. When we navigate to another unit in the point cloud the video cuts to the other micro loop. The density of micro loops superimposed with a high frequency of cuts leads to a unique visual aesthetic. In the video, the performer acts out discontinuous movements and impossible gestures, like plucking strings first and playing notes with the bow in the next moment without any transition. However, some correlation still becomes visible: Moving in the point cloud downwards, while pitch is mapped to the y-axis, the cellist's movement follows a generalized tendency: High notes are often reached bending forward while low notes tend to be played leaning back while repositioning the left hand on the neck to reach stops farther from the bridge.

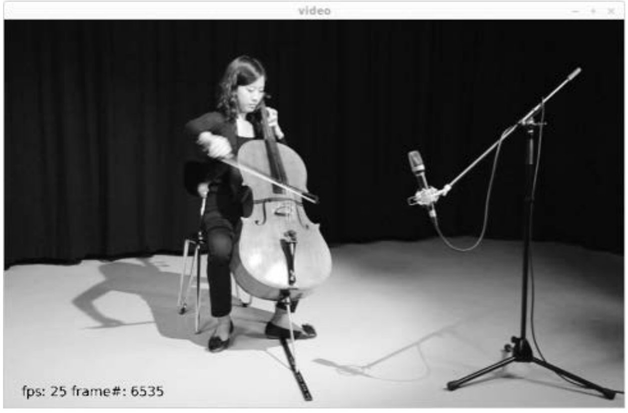

Figure 3. Video output in sync to the corresponding frames from the current playback unit.

Additional Remarks

The corpus and 'instrument-inherent expressions'

As it may have become apparent to the reader, the purpose of our instrument is not necessarily to hide behind the content that was analyzed and fragmented in the creation of the corpus, but to instead use a performative approach to the corpus as a vehicle for new forms of expression.

We can explain what this means by a simple example: When regions of recorded sound are spliced together, the perceptual result necessarily lies on a continuum between two extreme cases:

1. the discontinuity can be imperceptible and undetectable. The experience of the listener is the illusion of a transparency toward the recorded material. This is the goal for example in the editing of classical music, where fragments from various recording takes are seamlessly assembled to create the impression of a continuous cello performance. The involved technology and assembly strategy become imperceptible.
2. the discontinuity becomes itself *expressive* to a degree that the original source of the sound becomes unrecognizable. The technological treatment of the fragment effectively severs the illusory connection between the observer and the sound source and the experience appears to emerge from *within the technological system*. In the realm of music, we find this strategy to *remove a sound from its source* exemplified in Pierre Schaeffer's Musique Concrete (Schaeffer 1966).

Perceptual artifacts generated within a technological system such as our remix instrument can alternatively be interpreted as disturbance or as an aspect of a specific expressiveness which the instrument makes available to the performer.

With strategies such as those presented in (Behles et al. 1998), artefacts of discontinuities between audio grains can be greatly reduced and may allow for the emergence of a *virtual cello*. The same is much more difficult to achieve for the video image. As a result, the corpus of the cello is currently rendered as a discontinuous playback of cut-up audio-visual fragments, balancing between the material's origin in a cello performance and a distinct *instrument-immanent* expression.

Cello as source instrument appears especially appropriate for multiple reasons. On the one hand it offers an especially rich range of possible timbres and a wide frequency spectrum. On the other hand, it appears in the video image with roughly the same size as its player, which creates parity in the perception of instrument and musician. Additionally, due to the seated position of the instrumentalist the movement is somewhat restricted and the instrument is usually at rest while the player moves around it in different ways. This makes the cut up video easier to follow visually. Finally, we see the choice of the cello as an artistic reference to musician Charlotte Moorman who collaborated with artists such as John Cage and Nam-June Paik in experimental performances.

Perspective on particle clouds and embodiment

Different mappings between analysis parameters and interaction space evidently affect the intuitiveness of the interaction. Some mappings are more plausible than others, for example to map pitch to the y-axis, with the lowest at the bottom.

In the section *Instrument: platform for discovery and performance,* we have expressed a demand for reliable relationships between action and result that allow the user to develop from an explorer to a performer, and for the described interface to be *played* and performed as an audio-visual instrument—a process of embodiment as outlined by Paul Dourish (Dourish 2001). We need reliable and stable connections between the interaction paradigm and the resultant audio-visual feedback, both within the visual interface itself and for the playback of media fragments. This is especially important since, unlike most traditional instruments, our instrument does not provide haptic feedback. Instead it relies on the comparably indirect visual feedback as well as auditory cues.

Outlook

Future research may encompass the following aspects:

1. morphing strategies to fill the voids of the point cloud with interpolations,
2. inclusion of image data analysis as presented by Collins (Collins 2007),

3 principle component analysis for the creation of point-cloud layouts of maximal relevance,

4 collapsing higher dimensional clouds into the three-dimensional visualization using Multi-Dimensional Scaling (MDS), as implemented in (Mital / Grierson),

5 experimenting with other tracking infrastructures, for higher accuracy and lower latency,

6 the use of a 3D screen or head-mounted displays to enhance the understanding of the scatter plot,

7 effects of different unit playback sizes and the application of unit-blending algorithms to allow for a greater control of perceptual artifacts occurring in the grain assembly,

8 using high frame rate video to allow for enough frames to playback even while looping short units,

9 implementation of attack onset detection on the analysis (Aubio) to create more musically meaningful units of variable size in the concatenative synthesis.

Acknowledgments

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[Abstract in Korean | 국문 요약]
임의의 악기로 연주되는 대량의 시청각 텍스트정보

막스 노이퍼트 / 요하임 고스만

녹음된 소리를 연쇄합성concatenative synthesis을 통해 재조합하는 시청각 연주 악기를 소개하고자 한다. 녹음된 소리의 특성을 분석한 것에 기반하여 만들어진 삼차원 영상은 테레민theremin과 비슷한 인터페이스를 통해 접근할 수 있는데, 연주자가 구체적인 연주 행위를 하는 식으로 인터페이스 위에서 직관적인 여러가지 시도를 하면서 그래뉼라의(매우 세세한)granular 정도로 그 효과를 조절할 수 있다. 악기 연주를 녹화한 시청각 정보를 예로 들어 그 의미를 설명한다. 악기 자체로는 불가능하게도 악기의 소리와 연주 행위를 다루고 있기 때문에 이 시스템이 악기 연주로 만들어지는 대량의 시청각 정보corpus를 대신 처리할 수 있는 인터페이스를 제공하는 것이며, 세세한 단위로 다른 양상을 띄는 그 결과물은 막 만들어진 미학으로 일시적인 재탕(인스턴트 리믹스)instant remix을 만들어 낸다. 언급된 악기는 대량의 시청각 정보를 음악적 표현으로 활용하기 위해 연주의 측면에서 기기의 구조적인 분석을 활용한다.

Sound of Rivers: Stone Drum
Translating limnology into multimedia

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With the intention of translating the research of limnologist Mark Lorang into art, computer music composer and electric violinist Charles Nichols collaborated with video artist and animator Amber Bushnell, choreographer Nicole Bradley Browning, poet Mark Gibbons, dancer Allison Herther, and narrator Stephen Kalm, on a multimedia piece for computer-processed audio, sonified data, electric violin, computer-processed video, animation, narrated poetry, and dance, performed live and later reworked into a piece for fixed media. Three kinds of music were composed for the piece. First, to illuminate the onomatopoeia of river sounds and movements in the narrated poetry, source recordings of the poet reciting his text were stripped of their harmonic partials, stretched in time, shifted in pitch, and granularized, creating an echoing chorus of text-painting accompaniment. Second, data from spectral analyses of environmental sound at the field station were mapped to bandpass filterbanks, processing audio recordings taken in and above the river, producing a harmonic wash, and data of river velocity and depth, and wind velocity from the North and East were mapped to bow speed, pitch, bow pressure and position synthesis parameters, of a bowed string physical model, producing simple melodies. Third, a live electric violin, processed with phasers, delays, and reverb, played phrases based on rhythmic motives and melodic fragments from Jazz standards and Pop tunes of artists mentioned in the poem.

Starting with a float down the Middle Fork Flathead River, on the border of Glacier National Park in Montana, where data and audio were recorded, musician Charles Nichols joined a collaboration with limnologist Mark Lorang, to translate into multimedia art scientific research into how stoneflies navigate flood plains by the sound of rivers.

Nichols assembled a team of artists, including animator Amber Bushnell, choreographer Nicole Bradley Browning, and poet Mark Gibbons, who created a live multimedia piece, that Nichols and Bushnell performed with dancer Allison Herther and narrator Stephen Kalm. Later, Nichols and Bushnell assembled material from the live performance into a piece for fixed media (Nichols et al. 2014).

Musical textures were composed by mapping environmental data to settings of bandpass filters processing above water and underwater recordings, and using river and wind data to drive bowed string physical model synthesis parameters. Recordings of read poetry were computer-processed to complement the live narration, with a chorus of text-painting accompaniment, and melodies were composed for electric violin, that combined rhythms and motivic fragments by musicians mentioned in the text. Both the bowed string physical model and live electric violin were processed with layers of phaser effects and delays, that evoked a watery environment.

Limnology

The flow of water in a gravel-bed river creates unique sounds from low frequency moans and groans associated with breaking waves in rapids and the pumping of water in boils during floods to the babbling of riffles. When flows reach levels high enough to move the cobbles, gravel and sand that compose the channels and banks of the river also begin to change shape and form. New channels are created; banks are eroded with that bank sediment being deposited further downstream in the form of new gravel bars. This geomorphic process of cut-and-fill results in the creation of new or reshaping of old aquatic habitats in the form of riffles, runs and pools that compose the channel. Seeds and self-propagating pieces of wood from riparian vegetation also deposit on the newly formed gravel and sand bars resulting in colonization of these new sub aerial habitats of the river and its flood plain with an array of plant cover. The growth of riparian vegetation creates new wetlands, grassy meadows and forests that in turn support a wide diversity of organism from insects to birds and mammals like beavers, elk and bear. The abandoned channels create new ponds, backwaters and springbrooks which support the growth of a wide variety of aquatic insects that then provide food for juvenile fish; hence these habitats become the nursery grounds for fish. Perhaps most importantly portions of surface water from the river flows into the ground below and next to the river while in other areas water in the ground flows back to the river. Biological and chemical processes that occur beneath the surface of the river and flood plain during this exchange of ground-and-surface water cleanse the water, cool it and support a wide variety of aquatic insects that live most of their life in this subterranean environment. Hence a river is much more than just the channel where we fish or simply sit to enjoy the soothing sounds but rather a river is a complex 3D array of interconnected habitats above and below ground that all change in time. In a healthy river this mosaic of habitat is constantly changing as a function of flow levels from floods to base flow that move sediment composing the bed to major changes that reshape the entire flood plain. These processes are pivotal to maintaining a "shifting" mosaic of habitat (Stanford / Lorang / Hauer 2005) because the flow of water coupled with the movement and transport of gravel as bedload in rivers and streams are primary drivers of ecosystem structure and function in fluvial systems.

A natural product of bed material transport is the sound that is generated by particles banging and rubbing into each other as well as the scrubbing action of sand (Lorang / Tonolla 2014). This sound can range from an intermittent plinking caused by sporadic collisions of individual particles colliding to a load roar produced when the whole bed is moving. These various levels of sediment transport intensity and associated bed scour during floods can become a catastrophic disturbance for benthic communities (plants and animals that live on the bed), drastically reducing their abundance. The movement of gravel in rivers and streams is also an important regulator of aquatic ecosystem metabolism linked directly to watershed hydrology, and hence, climate change (Cronin et al. 2007). In this regard rivers can be thought of as organisms that need to breathe whereby floods cleanse the lungs or bed sediments allowing new plants (algae) to grow that are grazed upon by aquatic insects which then feed the carnivores in the system.

River bed sediments are colonized from two directions: (i) from surface organisms (e.g. insects) which penetrate downward into the sediments and need to return to the surface to complete their life cycles, and (ii) from groundwater organisms (e.g. crustaceans) who colonize near-surface bed sediments by migrating upwards from deeper groundwater attracted to near-surface habitats because of the higher food availability (Brunke / Gonser 1997; Ward et al. 1998). The production of sound by the river may provide the cue that these organisms use to migrate through the subterranean environment of the river (Tonolla et al. 2011; Lorang / Tonolla 2014). Sediment dwelling invertebrates (stonefly larvae) do seek such refugia during flood events, and some migrate laterally over many kilometers to the river through the subterranean environment of the floodplain to emerge as adults and mate thereby completing their life-cycle (Stanford / Ward 1988). Almost nothing is known about the cues these organisms perceive to induce such behavior. The underwater sound produced by the river provides a river soundscape that such organisms can use as a cue to guide these types of life cycle behavior patterns (Tonolla et al. 2011; Lorang / Tonolla 2014).

Figure 1. Scientists Chris Gotschalk, Diego Tonolla, and Mark Lorang calibrate an Acoustic Doppler Profiler, before a series of floats, down the Middle Fork Flathead River. Photo by Charles Nichols.

Music

To translate this limnological research into how animals, specifically stoneflies, navigate the floodplains throughout their life-cycle by the sound of rivers, three kinds of music were composed, to accompany narrated poetry, danced choreography, processed video, and animation.

Appearing first in the piece, to illuminate the onomatopoeia of river sounds and movements in the narrated poetry, source recordings of the poet reciting his text were processed, creating an echoing chorus of text-painting accompaniment. Using the Sinusoidal Partial Editing Analysis and Resynthesis (SPEAR) software programmed by Michael Klingbeil (Klingbeil 2009), recordings of words were stripped of their harmonic partials, stretched in time, and shifted in pitch, so that similar soundfiles could be differentiated, when spatialized in parallel around the audience. These processed soundfiles were then granularized, using the Grani instrument programmed by Fernando Lopez-Lezcano, for the Common Lisp Music programming language written by William Schottstaedt, in the Grace application developed by Rick Taube. The result was a chorus of insectoid voices, mirroring the stonefly subject of the poem.

To set the piece in the floodplain, three harmonic background textures, based on spectral analysis of environmental sound at the field station, entered progressively in the second section. The data, recorded every second in 1/3 octave bands between 12.5 Hz and 20 kHz, were mapped to bandpass filterbanks processing three audio recordings taken above water. This mapping of environmental analysis data to audio bandpass filterbanks was first interactively workshopped in Max software, and later programmed in Csound, to generate soundfiles for the piece. To heighten musical interest, the period between amplitude data samples was compressed to a tenth of a second and linearly faded between points, the 1/3 octave bands were uniformly swept in frequency to create glissandi between pitches, and envelopes were applied to the filtered soundfiles.

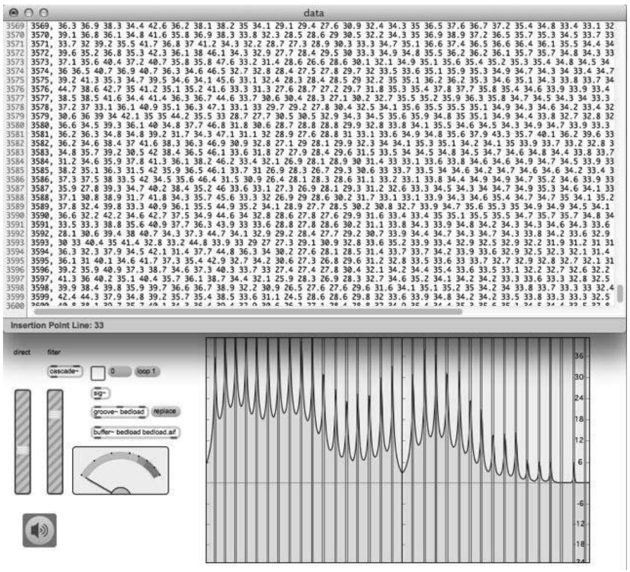

Figure 2. Sonification of environmental data: periodic spectral analysis of ambient noise on the river drives an undulating bandpass filterbank, processing an underwater recording.

Further into the second section, over the harmonic wash produced by the filtered above-water recordings, a bowed-string physical model played a simple melody, driven by sampled data of river velocity and depth, and wind velocity from the North and East, mapped to bow speed, pitch, bow pressure and position synthesis parameters. The synthesized bowed string was processed, in GuitarRig effects software, with five phasers set to different rates, between 0.01 to 0.05 Hz, for overlapping slow sweeps across the spectrum, three reverse delays, two transposed to an octave down and an octave up, and a large room reverb. The resulting effects placed the synthesized bowed string in a watery sonic environment.

In the third section, the live electric violin played phrases based on rhythmic motives and melodic fragments from Jazz standards and Pop tunes of artists mentioned in the poem. First, the violin played the opening riff from Duke Ellington's "Take the A Train," stretched out in slow pizzicato. Next, the violin explored the pitch collection of Dave Brubeck's "Koto Song," in bowed descending lines, that were echoed by the falling motive of Frankie Valli's "Silence Is Golden," further elaborated upon with piercing false harmonics. All of these melodic fragments were played through the same effects that processed the synthesized bowed string, with an additional quadraphonic delay, pinging throughout the hall, spreading the electric violin around the audience.

After each texture was presented separately in the first three sections, they were incrementally combined in the second half of the piece. In a brighter version of the bandpass filterbank texture, three underwater audio recordings of gravel bedload traveling down the river, recorded from the raft, were processed with two separate data-driven filterbanks. In this case, the filterbank parameters were manipulated with data recorded with hydrophones every 5 seconds in octave and 1/3 octave bands, during floats down the Middle Fork Flathead River. Like before, the period between amplitude samples was compressed, this time to .4, .6, and 1 second, and faded between points. Envelopes again were applied to pitch and amplitude, but this time also shaped the bandwidth of the filterbanks.

While the six harmonic background textures built into a full watery soundscape, two bowed-string physical models, driven by river velocity and depth, and wind velocity from two directions, synthesized overlapping melodies with staggered entrances. Again, these synthesized bowed-strings were processed with layers of phaser and delay effects. Over the filtered background and bowed-string lines, pairs of processed recorded text reflected the spoken poem, echoing the narrator in parallel trajectories around the audience.

Finally, in response to the narrator mentioning Lionel Hampton and Charles Mingus, the electric violin entered with dotted-rhythm riffs from "Flying Home" and "Moanin," adding one and two octave doublings below in the effects, mimicking the Jazz bass. As the poem wound down, and the other parts faded, the electric violin slowed the rhythm, changing again to false harmonics, while the computer effects thinned.

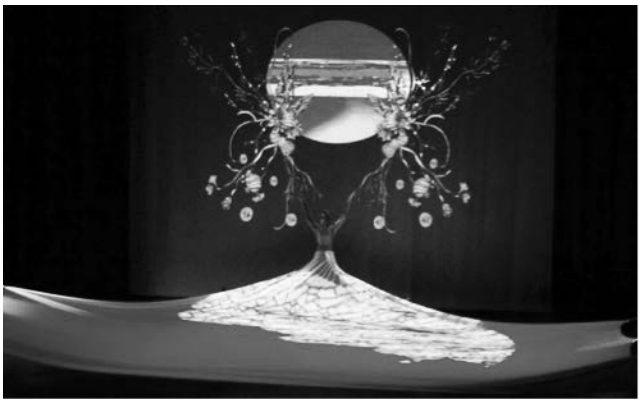

Figure 3. A panel of processed live video, manipulated by the amplitude of the music, projected behind dancer Allison Herther. Photo by Amelia Hufsmith.

The processed recorded text, data-driven bandpass-filtered soundfiles, and bowed-string synthesis were played from audio workstation software, with the electric violin performing through an input track processed with plugins. While the output of the multitracking software was spatialized through the surround-sound system around the audience, it also manipulated parameters of the video software, processing a live feed of the dancer projected on the back of the stage. As the amplitude of the computer-music fluctuated, it agitated striations and shading inside a panel of processed live video, surrounded by animations of river plants and animals.

Conclusion

Sound of Rivers: Stone Drum was performed live, during a week of shows at the College of Visual and Performing Arts at the University of Montana, on the Dance in Concert series. A wide shot of the live performance can be viewed at https://www.youtube.com/watch?v=3IEqF6kKyUo/, and a stereo video of the quadraphonic fixed media piece can be seen at https://www.youtube.com/watch?v=9Rtm6EA29Bw/

Acknowledgments. Thank you to the National Science Foundation and the Montana Institute on Ecosystems, for funding the production of *Sound of Rivers: Stone Drum*, and thank you to scientists Chris Gotschalk, from the Flathead Lake Biological Station, Rob Maher, from Montana State University, and Diego Tonolla, from the Leibniz Institute of Freshwater Ecology and Inland Fisheries, for sharing their environmental data and audio recordings, used to compose the music.

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Figure 4. Electric violinist Charles Nichols, dancer Allison Herther, and video artist Amber Bushnell rehearse *Sound of Rivers: Stone Drum*. Photo by Amelia Hufsmith.

[Abstract in Korean | 국문 요약]
《하천의 소리: 석재 드럼》 호소학을 멀티미디어로 해석하기

찰스 니콜스 / 마크 로랑

컴퓨터음악 작곡가이자 전자 바이올린 연주자 찰스 니콜스는 호소(湖沼)학자 마크 로랑의 연구를 예술적으로 해석하기 위해서, 비디오 아티스트 겸 애니메이터 앰버 부스넬, 안무가 니콜 브레들리 브로닝, 시인 마크 기본스, 무용가 알리슨 헤더, 나레이터 스티브 캄과 협업하였다. 컴퓨터 프로세싱의 오디오, 소리화된sonified 데이터정보, 전자 바이올린, 컴퓨터 프로세싱의 비디오, 애니메이션, 낭독 시, 그리고 춤을 위한 멀티미디어 작품을 만들어 실시간으로 연주하고, 이후 고정fixed 매체의 형태로 재작업하였다. 세 종류의 음악형태가 이 작품을 위해 만들어졌다. 첫째로 낭독하는 시에서 하천의 소리와 움직임을 의성어로 표현하였고, 시인이 이 시를 읊조리는 음성을 녹음한 후 이의 배음과 길이, 음높이를 변조하거나 그래뉼러화(매우 세세한 단위로 나누어 재조합)granularized하여 시의 반주가 되는 에코 효과의 배경음악으로 추가하였다. 둘째로 하천 주변 환경의 소리를 분광 분석한 결과를 대역 필터의 데이터 처리나 하천의 속이나 그 위에서 얻은 녹음 소리를 처리하는 데 활용하여 화음 효과를 만들어 냈으며, 활로 켜는 현의 물리적 모형의 합성 데이터정보로 하천의 속도와 깊이, 북쪽이나 동쪽에서 오는 바람의 속도를 활의 속도, 음고, 활의 압력과 위치에 활용하여 단순한 선율을 생성하였다. 셋째, 시에서 언급되는 음악가의 정통 재즈나 대중음악 선율에서 따온 리듬 동기와 선율 조각들로 만들어진 악구를 페이저, 딜레이, 리버브 효과가 가미된 라이브 전자 현악기가 연주한다.

Mining Sound Semantics:
Urban Soundscape Classification

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This paper explores possibilities for mining urban soundscape semantics and developing soundscape taxonomy. Instead of taking a top-down approach commonly employed by researchers, we approach this problem by crowdsourcing and embracing the notion of "collective listening" that is based on a bottom-up, sono-sematic soundscape taxonomy development strategy. The data acquisition mechanism exploits interactive online user studies to develop and construct an inter-and intra-audio-semantic architecture for electro-acoustic music.

One of the difficulties related to the discourse of electro-acoustic music (EAM) can be attributed to the lack of clarity in taxonomy and standardized nomenclatures that govern it. Some of the semantic ambiguity that not only affect EAM but also all "genres" of music, can be attributed to the fleeting nature of sound itself: sound is not easily contained nor observed without considering temporality, and other than visualizing it via waveforms or spectrograms, there is a scarcity of widely accepted visualization formats. In the EAM community, differing nomenclatures for describing its music are perhaps even more of an issue as its semantic articulation can often be problematic within a strict set of agreed-upon vocabulary related to well-defined concepts such as pitch, intervals, chords, rhythms, and acoustic instrument names. In the area of EAM study and analysis, a constant negotiation between expressive use of nouns, creative application of adjectives, nomenclature confusion and misuse thereof, and newly invented terms exist, which often appear as quickly as they disappear. Observing such interesting issues in EAM discourse, a suggestion was made in employing both quantitative and qualitative techniques to EAM analysis, while addressing the importance of minimizing confusion by careful consideration of nomenclature and of exploiting vocabulary that is useful, consistent, and clear in meaning (Park et al. 2010). When considering the communication and discourse of matters concerning EAM, an interesting question can be posed at this time: what does the EAM "namespace" and semantic space look like, what is its taxonomy, hierarchy of nomenclature, and what terms are being used by its community? Can we develop a set of semantic standards and a taxonomical baseline for communicating and writing about EAM similar to those for traditional pitch-based music? In this paper, we attempt to look at these issues and approach the problem from a semantic data mining angle.

EAM Nomenclature Difficultie*s*

It is not unusual for EAM compositions to be deficient of scores, rendering a situation where one is left with nothing more than program notes or recordings. With the absence of a score, much of the discussion of an EAM composition heavily relies on the work's acoustic signal and the ensuing semantics, nomenclature, and taxonomy, which are developed from the acoustically codified information. Unlike note-based music, where pitches, harmonies, and note durations can guide musical discourse within a horizontal/temporal and vertical/intervallic grid, in EAM, such standard grids are not commonplace, and oftentimes nonexistent. Communicating ideas and engaging in musical discourse thus becomes difficult due to the lack of a well-defined EAM namespace. An agreed upon EAM namespace is still somewhat of a moving target, which is unsurprising given that the music itself is highly dependent of the constancy of technological developments. The topic of an EAM lexicon, taxonomy, semantics, and nomenclature is artistically and humorously articulated in Mark Applebaum's *Pre-composition* (2002). Whether Applebaum intentionally or inadvertently exposes EAM's sono-semantic problems and its namespace issues is unclear as it is not obvious from the music or the program notes. What is clear, however, is that the descriptors and words he uses in a sonified mental, pre-compositional musical theatre, enacted by eight characters that make up his "council of elders," humorously depict various (and unfortunately, somewhat familiar) ways in communicating musical ideas from a number of schools: the scientific community, the conservatory, the audio engineering school, and the general public. When looking at some of the EAM literature, it is evident that there is a scarcity of agreement on the definitions of various terminologies and prevalent misuse of others. In some cases words have more than one meaning; while in other examples similar words are employed to mean different things depending on context.

For example, Lelio Camilleri cites Denis Smalley's noise-node-note continuum in developing a lexicon for EAM (Camilleri 1993). Denis defines the node as "an event having a more complex texture than a single pitch" (Denis 1986). The word node, however, already has an accepted definition in physics and describes resonating waveforms, which includes the *note* as utilized by Smalley. Perhaps taking liberty in modifying the meaning of node from a close discipline of EAM, Smalley is somewhat using the fitting of the word *node* that is more in the spirit of alliteration, rather than precision of meaning. This can, however, add to confusion rather than adding clarity in an already puzzling EAM namespace. On the other hand, EAM-based semantic concepts have also developed to help in defining areas of the music including the concept of *reduced listening*, the notion of the *sound object* and *source bonding* (Schaeffer 1966; Smalley 1986) are such examples that are very helpful for the discourse of EAM. Ever since the invention of the tape recorder as means to capture sound and bring it into the *studio* for manipulation whereby creating a new musical aesthetic, the vocabularies that were so helpful for notated music have been rendered of little use and sometimes completely useless for analyzing and describing EAM works. In such compositions any sound can be modified and modulated, or used without any alteration at all. On the top of this infinitely widened palette of sounds, our inherent contingency of perception further complicates the matter. When addressing the issue of the sound class, sound identity, and name of the sound in a given soundscape, it is not necessarily clear what and how one hears a given sound: i.e. two listeners presented with an excerpt of a soundscape may have the same experience in terms of detecting the same sound classes at the same temporal segments or they may have dissimilar experiences as a function of when, how, and what they hear. This small subset of sound semantics in EAM is one of our current areas of research. In this research, we explore the namespace of urban soundscapes by observing how and what listeners hear within a variety of soundscape recordings.

Soundscape Semantics and the Citygram Project

Our research efforts in EAM taxonomy has recently focused on soundscapes via our sound-mapping project called Citygram (Park et al. 2014; 2013; 2012). Key goals in Citygram are to make sense of soundscapes, their sound classes and their ecology, and to visualize the complexities of urban environments. In order to create real-time soundmaps and automatically identify sounds, we are developing a system to detect sound objects through an urban sensor-network and machine learning system via automatic event classification (AEC) and automatic event detection (AED) techniques. However, in order to engage in AEC, a large number of annotated and labelled sounds (known as ground truth) must be available for developing and training of machine learning algorithms. Before developing ground truth, we need to know the taxonomy that governs it. Urban sound taxonomy, however, is not clearly defined and relying on a small number of researchers' soundscape taxonomy opinions can be problematic as it can bias the AED/AEC outcomes as per the opinions of a few. Furthermore, as our current focus in Citygram is on urban soundscapes, and more specifically noise pollution, developing taxonomy of noise objects is nontrivial. That is, what person A hears and how he/she categorizes a sound can be dissimilar to the way person B hears and categorizes the same sound. In AED research, a number of ML-based applications have been developed to match audio events with their proper semantic affiliations (Heittola et al. 2013). This process has primarily adhered to a top-down model (Heittola et al. 2013; Tran / Li 2011) after defining a limited set of semantic labels, low-level acoustic feature vectors are used as inputs to train ML algorithms. The trained algorithms then attempt to classify any new sound input to its proper class (Ito et al. 2009; Zhuang et al. 2010). However, researchers have often unilaterally, sometimes arbitrarily, and other times with personal bias, led to developing semantic categories and structures that are not necessarily based on general consensus. Furthermore, the descriptive labels are frequently limited to a very specific domain of application such as speech, gunshots, popular music, musical instruments and others (Clavel et al. 2005; Cho / Kim 2011).

Conversely, crowdsourcing the annotation process introduces a more robust repository of sound semantics, whereby reversing this notion of "annotation by decree." Inviting the general public, citizen scientists, researchers, as well as artists to define, refine, and update the pool of semantic concepts in relation to novel sonic inputs ensures that the tags constitute a more consensual taxonomical space. Furthermore, sonic nomenclature crowdsourcing yields much more than an expanded tag pool for organizing audio events as it has the potential of revealing connectivity between sounds and everyday concepts as defined by a "large" community. We believe that Big Data mining of audio semantics is a potentially viable and reliable mechanism in transforming subjective, qualitative associations between sounds and concepts into a communicable structure of quantitative nature. An important assumption that we are making is that everyday sounds will not require expert skills for identification and categorization: sounds of sirens, busses idling, loud talking, and dogs barking probably do not require high level expertise as far as classification is concerned. Of utmost importance in our sono-semantic mining project, however, is to ensure that the scale of the data collected is sufficiently large enough to develop a robust taxonomy. Consequently, the authors are currently developing web scraping tools that pull sound annotations from well-established sources such as the Freesound API, NYC Open Data[1], and the World Wide Web itself using keyword search strategies (Park et al 2014).

While the crowdsourced sound taxonomy forms the basis of the project, a pre-processing stage is required to reduce noise and redundancy in both the audio and collected semantic data. Before attempting to reveal any meaningful connections between them, it is crucial to execute vertical/horizontal structuring by clustering similar sonic/semantic objects and creating a viable hierarchy. Once the pre-processing is properly implemented, future evaluations should be focused in terms of sound-to-sound structuring, concept-to-concept structuring, and sound-to-concept structuring: analysis of connectivity between the two networks. Several projects in the past are relevant including work by Fink et al. who suggested use of *WordNet* – a relational database of English-language semantics – for generating an audio/concept hierarchy (Fink et al. 2010). After such a network of concepts is clearly defined, there are many ML algorithms that can be employed to classify sound using techniques such as Hidden Markov Model (HMM) and Gaussian Mixture Model-based (GMM) algorithms (Heittola et al. 2013). Although such methodologies appear promising, they have not yet been tested on a sufficiently large set of sonic/semantic dataset. As such, we are currently exploring what taxonomical space we can derive from existing soundscape databases and how we can use what we have learned to develop and introduce a soundscape taxonomy crowdsourcing system to contribute, improve, and also evaluate other frameworks and methodologies for soundscape annotation and taxonomy development.

Soundscape Annotation System and Datasets

There has been growing interest in research of soundscape AED/AEC in the last decade, but only a handful of databases have been developed for this specific purpose. The most notable efforts include the IEEE AASP Challenge[2], CLEAR (Stiefelhagen et al. 2008), SEC[3] and DARES[4]. In addition, there are a number custom-designed datasets that have not been systematically managed and archived (Chu et al. 2009; Heittola et al. 2013). Although the aforementioned datasets have been developed and customized for varying purposes, their utility as a resource for outdoor soundscape ground truth in the context of AEC is still very limited.

One of the noticeable drawbacks is that only a few include outdoor environmental soundscape samples; the datasets generally focus on indoor environments and typically include recordings from meeting rooms. Another observation is that the aforementioned databases were annotated by a small group of experts (typically one to two persons), exclusively segmenting and annotating events based on a "custom" taxonomy developed from opinions of a few researchers. Outside the lab environment, detecting an acoustic event can be subjective: factors such as foreground, middle-ground and background events likely need to be considered. Thus, if the research goal is to bridge the acoustic events and the corresponding semantics, the aforementioned databases can perhaps become even less effective as resource for ML of soundscape events. If we heavily rely on results that opined by one or two persons, there is a risk of yielding an outcome that can be detached from the collective reality of how "we" hear soundscapes.

These problems are non-negligible. The acoustic events, the namespace, and the match between the acoustic events and the labels should be considered with great care and reasonably validated as they serve as "ground truth." In other words, they will impact all the aspects of AED/AEC design in the context of a garbage-in-garbage-out structure. To address these issues, we have developed a crowd-sourced annotation system as part of a larger subproject within Citygram called the Sound Analysis Toolbox (SATB). This research focuses on approaching the ground truth development issue through crowdsourcing with multiple-annotators-per-soundscape-segment strategy.

Our soundscape namespace research serves as a necessary stage for developing our AED/AEC algorithms for the Electro-Acoustic Mine (EAMM) (Park et al. 2012) and Citygram projects (Park *Sensing Urban Soundscapes* 2014; *Towards Soundscape Information Retrieval* 2014). The aim is three-fold. One is to infer statistically significant agreement on what is an acoustic event and what is not. In our user study, a listener is provided with a randomly selected urban soundscape and asked to define acoustic events via start/end timestamps. Another aim is to extract the corresponding common semantics and mood evaluations per event as opposed to matching each event to a certain node of a pre-composed top-down semantic tree (e.g. (Brown et al. 2011)).The third is to develop a sense of *presence* of the acoustic event in terms of how present one perceives the sound to be.

The web-based interface[5] is loosely modelled after modern digital audio workstations' user interface design paradigms whereby it includes an audio transport section, "tracks," zooming features, a cursor depicting temporal location of the monitored sound, and punch-in/punch-out features. One of the initial decisions we made early on was not to provide visual cues about the sound (no waveforms or spectrograms) so as to minimize visual bias in the acoustic event detection process. A typical session is as follows: (1) user is presented with a two minute long soundscape segment, (2) user identifies acoustic events using the punch in/out feature while in playback mode or selects the start/end time by selecting a region, (3) user then annotates and labels each of the acoustic events with the most relevant terms using their own vocabulary, (4) user additionally evaluates each event with respect to mood (arousal and valence) and presence (foreground-background) on 9-point integer scale. A screenshot of the interface is shown below.

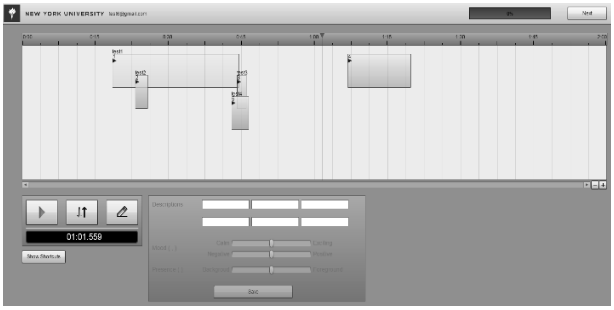

Figure 1. Interface of Urban Soundscape Event Classification.

We employed a total of 44 hours of urban soundscape recordings from Seoul, Korea and New York City in the United States. Our data collection efforts is a collaboration between NYU and Seoul National University, Yonsei University, Korean National University of Arts, Ewha Woman's University, Sangmyung University, Hanseo University, and Kyemyung University. A key goal in our data collecting effort is to have both breadth and depth of soundscapes and annotations: annotation of a diverse set of soundscape types and multiple annotators for each soundscape segment. Our current design allows for growth and flexibility in the soundscapes we choose to include in the pool of sound segments provided to users: one can simply add/replace/delete soundscape database and collect additional AED/AEC responses through the same mechanism that is currently accessible via the Citygram server.

Conclusion

This paper detailed how we exploited the vast ocean of sono-semantic data contained in cyberspace to develop an inter- and intra-audio-semantic network for EAM via custom web-crawling software, a web-based user study application (tentatively named Urban Soundscape Event Classification), and sono-semantic analysis tools. Our hope is to contribute to the development of taxonomy, nomenclature, and vocabulary that is clear, unambiguous, consistent, and informative for the discourse of electro-acoustic music.

Acknowledgments. We would like to thank Doojin Ahn, Sungho Hwang, Jaeho Jang, Donoung Lee, Inkwon Lee, Kyogu Lee, Seny Lee, Jerok Park, Seongah Shin, and Woonseung Yeo for their contributions to the soundscape dataset and Pyungryang Ko for his editorial efforts.

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[1] https://nycopendata.socrata.com/

[2] http://c4dm.eecs.qmul.ac.uk/sceneseventschallenge/

[3] http://www.sound-ideas.com/

[4] http://www.daresounds.org/

[5] http://citygram.smuisc.nyu.edu/?q=node/18/

[Abstract in Korean | 국문 요약]
소리 의미 발굴: 도심 소리풍경 분류

박태홍 / 유재성 / 유민준 / 이준희 / 조나단 터너

이 글은 도심의 소리풍경soundscape 의미를 탐구하고 소리풍경의 체계적인 분류법을 발전시킬 방도를 모색한다. 연구자들이 보통 사용하는 일반적이 사항에서 시작해서 세부적인 것으로 접근하는 하향식 방법 대신, 이 문제는 상향식 접근의 소리경계적sono-sematic 소리풍경 분류학 발전전략에 기반한 "집단 청취collective listening"의 입장에서 많은 사람들의 의견을 수용(크라우드소싱)crowdsourcing하고 아우르는 방식을 택한다. 데이터정보 수집 시스템을 통해 전자음악의 상호적, 내부적 소리의미이론의 양식체계를 개발 및 구성할 상호작용누리꾼interactive online user에 대한 연구를 활성화한다.

The Emancipation of Referentiality through the Use of Microsounds and Electronics in the Music of Luigi Nono

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This paper focuses on the exploration of Luigi Nono's electroacoustic music from the 1980s, represented in works such as *A Pierre Dell'azzurro Silenzio Inquietum* (1985) and *Post-Prae-Ludium per Donau* (1987). Nono's use of electronics was quite different from what other composers were doing, especially those from the musique concrète and elektronische musik scene. Nono's music explores the possibility of the emancipation of perception by putting sound in a different perceptual perspective, that of microsounds (audibility limit, microtones, etc.). The use of live-electronics was crucial to the development of this music, as the microphone literally worked as a magnifying glass on sound capture: it transposed traditional instrumental sounds, such as woodwinds for example, into a different reality. Nono took advantage of this 'collateral effect' and made it a central compositional tool, in contrast to the electroacoustic music made in a contrapuntal manner, such as in Mario Davidovsky and his Synchronisms by using instruments versus tape. Nono selected sounds that were marginalized, such as aeolian and pppppp sounds, and putted them in the foreground. This change resulted in a music rarely heard before. It also reinforced a different kind of electroacoustic approach, that which the source is already complex enough, while the electronic apparatus displaces the sounds properties (spacialization, pitch shifting, filtering, etc.). This research aims to diffuse the music of Luigi Nono and to investigate his use of electronics. As mentioned before, Nono does not make live-electronic music with instrument versus tape. More precisely, he works with both forces in order to build a meta-instrument. This type of music was highly criticized, not only by performers that were asked to develop 'abnormal' playing techniques but also since it presented a simple electroacoustic profile.

"Except for Luigi Nono, leading composers of yesterday have exhausted their resources" (Lachenmann 1980). The music of Luigi Nono's late period (1980s) has a peculiar characteristic in the world of electroacoustic music. Works such as *Post-prae-ludium per Donau* [eschingen] and *A Pierre Dell'azzurro Silenzio Inquietum* are examples of this aesthetic. The title of this last work touches on the essence of what this paper is about: to explain an unquiet music that deals with silence and complexity. Part of this research was accomplished during my PhD at the State University of New York at Buffalo (USA), and in consultation with the EXPERIMENTALSTUDIO des SWR (Germany) staff and archives, mostly regarding the performance of *Post-prae-ludium per Donau.*

Nono's aesthetic

Post-prae-ludium per Donau (1987) and *A Pierre Dell'azzurro Silenzio Inquietum* (1985) are works by the Venetian composer Luigi Nono (1924-1990). Both pieces make use of live-electronics realization developed by Nono in collaboration with Rudolf Strauss, Hans Peter Haller, André Richard, and Marco Mazzolini. These works are fruit of Nono's research on live-electronics at the *Experimentalstudio der Heinrich Strobel Stiftung des SWR* – now EXPERIMENTALSTUDIO des SWR – in Freiburg, Germany, where Nono worked as a composer in residence during the 1980s.

Previously to that, Luigi Nono lived part of his professional career immersed in the aesthetics of the Darmstadt school. He was known during the 1950s for his *Il canto sospeso* (1955-56) as well as for *Polifonica - monodia - ritmica* (1951). Both pieces reflect Nono's use of serialism, technique in which the composer was not entirely satisfied with. During the 1960s, Nono expanded his sonic palette by working on tape pieces such as *Omaggio a Emilio Vedova* (1960) and *Ricorda cosa ti hanno fatto in Auschwitz* (1966). Later on, he takes another step by incorporating tape plus acoustic instruments in pieces such as *La fabbricca illuminata* (1964) for mezzo-soprano and tape, and *…sofferte onde serene…* (1976) for piano and tape. Up until this point, tape and live instruments were mainly two separate entities with different natures: live instrumental sound versus loudspeaker. Those 20 years of research illustrates a rich aesthetic evolution, between his initial professional years as a Darmstadt serialist composer up until his adventures on electronic music.

This short chronological background leads to the fact that during the 1980s the composer finally fused both realms into a single meta-instrument. He finally creates a new dialect. Pieces such as *Das Atmende Klarsein* (1981) for choir, bass flute and live electronics, *Omaggio a György Kurtág* (1983, 1986) for contralto, flute, clarinet, tuba and live-electronics, *A Pierre (Dell'azzurro silenzio, inquietum)* (1985) for contrabass flute, contrabass clarinet, and live-electronics, and finally *Post-prae-ludium no.1 per Donau [eschingen]* (1987) for tuba and live-electronics, all share this characteristic of live-processing: instrumental sounds and electronics sharing the same realm. By doing that, he does not only unite acoustic and electronic domains but also incorporates the acoustic of the room and spacialization techniques as crucial elements in his compositions.

Post-prae-ludium and A Pierre

Nono's works from the 1980s are different from his initial serial style. In *Post-prae-ludium per Donau* and *A Pierre*, he explores unorthodox instrumental playing techniques aiming to generate complex non-referential sounds. Having said that, the pitches in the score do not indicate the entire structure of the final sonority. As mentioned in the *Post-prae-ludium* score performance instructions, it is an *action* score, not an *effect* score. For instance, by writing a low pedal note in this piece (Figure 1), Nono was not interested in a pure frequency. Rather, he was interested in the *physicality* implied by that pitch in that specific instrument (tuba). Nono was always fascinated with mobile timbres at the threshold of audibility. That is why he worked with contrasting values, such as an extremely low note sustained for almost an entire minute, but with six *piano* dynamic marks.

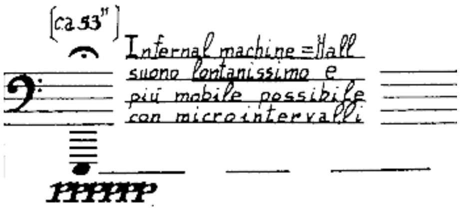

Figure 1. Low pedal note in section B of Post-prae-ludium per Donau.

Conceptually speaking, *A Pierre* and *Post-prae-ludium* are similar pieces. Both are constructed around the same atmosphere and proposal. It seems that Nono worked as if he was in search of sonic shadows and sound experiences in electroacoustic music, almost as an archeologist digging unexplored territories. As we will see in *Post-prae-ludium* and *A Pierre*, Nono investigates fragile sonorities such as: sustained sounds, vanishing aeolian sonorities, clusters and multi-phonics, high partials within a sustained fundamental, whistle sounds, micro-intervals, etc. It is interesting to view how important it was to Nono the interaction and strong connections established with certain performers. Most of these unusual playing techniques emerged from rehearsals and private meetings with the players: "Practically all these musicians, including Roberto Fabbriciani (flute), Ciro Scarponi (clarinet), Giancarlo Sciaffini [sic] (trombone and tuba) and Susanne Otto (contralto), also took part in his works for larger forces" (Stenzl 2010: 6).

One will fail to analyze Nono's music, from this period, by using pitch oriented analysis techniques of serial and atonal music. The composer's approach comes from a different perspective. In this piece, there is no concentration on linear narrative, as it happens in tonal music, where the path can be expected throughout the performance. Nevertheless, one can perceive that Nono is aware of the memory effects implied by his music, as we will see when analyzing the work's schematics. In *A Pierre*, for instance, Nono concentrates on temporal and timbral parameters, and not necessarily on pitch networks in the traditional sense (Figure 2).

Figure 2. Beginning of *A Pierre Dell'azzurro, Silenzio, Inquietum*: aeolian sounds and multi-phonics.

Jürg Stenzl describes the historical origin of these works and their main essence:

> All the works that originated in and with the Freiburg EXPERIMENTALSTUDIO, beginning with *Das atmende Klarsein*, are rooted to a considerable extent in this long-term direct collaboration with particular musicians. In turn, each new work formed a fresh point of departure for its successor. In an initial "experimental" phase Nono was at first chiefly concerned with exploring the timbral potential of each instrument and voice, taking advantage of the studio's equipment. The resultant written-out scores are based on these experimental and improvisational materials and their potential transformation through live electronics. No less significant were the ensuing rehearsals; Nono often postponed certain decisions in his written scores for this period of rehearsal. The joint elaboration of a piece with the musicians and the employees at the EXPERIMENTALSTUDIO fundamentally altered not only his method of composition en route to *Prometeo* and beyond, but also the relation between composer and performer (Stenzl 2010: 6).

Because *Post-Prae-Ludium* and *A Pierre* have no strict centralization on pitch structures, the composer explores other parameters such as timbre and time. Throughout the entire performance, the listener is invited to concentrate on the instant, rather than to be cognitively directed to goals. In Nono's *Post-prae-ludium*, as well as in *A Pierre,* one might sense time as non-teleological driven. The absence of a clear network of pitch statements allows the composer to explore different sonic dimensions. Because time in this piece is, as previously stated, non-teleological, Nono creates other ways of listening, some similar to other cultures, other closer to acoustic effects and processes rather than music as classical Western tradition thought us to understand. That seems to be what Nono was searching for during his pieces from the 1980s, to *not belong*, and to create new categories of listening.

Nono concentrates on timbre and time most specifically on the moment, the instant. For the composer, time is an important element, and because of that, his sonic materials need to provide an aura capable of emancipating a timelessness quality. In order to achieve that, Nono works with an interesting balance of concepts of sophisticate and naive. One might say that Nono's music has many similarities with Stockhausen's theory of *Momentform*, which presents a mosaic quality.

On the one hand, Nono avoids the banal. He experiments with different playing techniques in order to achieve new timbres. In order to produce unique sonorities from a single instrument, the composer's departing points are sophisticated techniques and contexts. For example, *Post-prae-ludium* presents this atmosphere in the first page of the score, from the beginning of the piece until 5'20" (Figure 3).

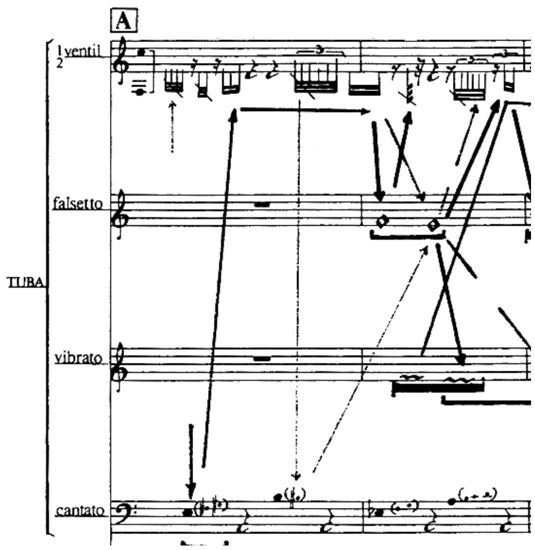

Figure 3. Tuba part: multi path score where the player is invited to choose the execution order of seven different paths.

In this first part, Nono builds a pointillistic network of sounds. Nono requires the instrumentalist to execute several techniques in a sort of improvisation with given materials. The first page of the performance score presents four of them: half-valve, falsetto, vibrato, and multi-phonics (*cantato*). The second page, first system, presents pure pitches at the extremes of the playing range, always with microtonal inflections. It is important to notice the rhythmic freedom given to the player in this system. Finally, the second system at page two presents a synthesis of the previous ideas: a range of possible pitches, with half-valve technique and light vibrato. This major gesture is shaped in a long fade out process, from *fff* until *niente*. When added to the electronics (reverb and four delays), he creates a canon out of a complex line. The original source for this first section does not come anymore from a tuba, rather from a meta-instrument. This new medium includes, other than ordinario tuba pitches, male voice (Giancarlo Schiaffini), unnatural male voice (falsetto), vibrato, and half valve technique. Once fed into the live-electronic processes, the permutation of techniques applied in this section results in a complex texture.

On top of that, the score of *Post-prae-ludium* presents a random characteristic. The first page of the tuba part has a set of colored arrows that represent paths in which the player has to choose, almost as a labyrinth. Each color represents a different path and tempo (Table 1).

Green	Quarter-note = 30 bpm = ca. 4'16"	Total: 5'20"
Blue		
Yellow		
Red		
Grey	Quarter-note = 60 bpm = ca. 1'04"	
Blue		
Orange		

Table 1. Colored arrows and tempo schematics in *Post-prae-ludium per Donau.*

The player is supposed to start the piece by choosing one color, play the line according to the arrows of the same color, and by reaching the end of the system, return and play everything again with a different color. By playing all seven paths with the given tempo, the instrumentalist should reach the total desired length of 5'20", as prescribed in the score.

The two sound technicians, controlling the input and output levels separately, are asked to randomly and independently turn the levels up and down. By doing that, part of the live source will be incorporated or ignored by the electronics (one sound selection made by the microphone, another by the loudspeakers). As a result, the piece is a fragmented version, remains of the notated score. The tuba player never performs each line separately, and because of the nature of this plan, every performance is different. The electronic part receives a fragmented version of the complete score and, with the intervention of the technicians, transform into an even more fragmented version. This distortion of the written score is taken to a further step by the delays, which juxtapose four out-of-phase reproductions of the fragmented material selected by the technicians. It is a three-layer process of ruination: the written score, the tuba performance, and the electronic version. Finally, at 4'30" the feedback control is slowly increased for the next section.

On the other hand, each "atom" of this complex network of sound presents a naive essence. Within this complex texture in section A, each element does not provide any musical potential by its own, if one compares to the final sum of these fragments. In order words, the meta-instrument previously mentioned is made of simple materials, such as a vibrato, diatonic *falsetto* singing (Re, Mi, Fa, Sol, La), etc. It is also important to note the duality implied by this meta-instrument. Time and timbre are tied in a strict fashion. Every line in this first part provides its own pacing, or its own density. The first line (half-valve) presents the most active playing if compared to the other three. The *falsetto, vibrato* and *cantato* lines always present an average of two events per bar. Nono sets a different pacing and dynamic according to each timbre (line).

By analyzing Nono's music from his late period, one can affirm that the composer was interested in instrumental sounds produced at the threshold of audibility. In section A of *Post-prae-ludium* the dynamics oscillate between *ppppp* and *p*. In section B, one finds events with *pppppp* and *fff possente.* Finally, section C embraces both extremes: a long decrescendo from *fff* to *niente*. What seems to have interested Nono about this radical approach to perception was the implied potential for mistakes and unpredictability during the performance – an example of this is the use of the Larsen effect in *Post-prae-ludium*. This uncontrolled world was truly appealing, as one can presume from the score of *Post-prae-ludium*. The amount of freedom given to the player — i.e. the ability to choose the path (colored arrows) and the pitches — in contrast to strict aspects such as dynamics and playing technique, points to a dialectic existence in *Post-prae-ludium*. The piece has a set of inner rules that are crucial for its existence. The controlled part of this piece forces the player to a world of uncertainty.

This quasi-aleatoric realm leads the player to produce what traditional musicians would classify as *mistakes*. For Nono, those errors are part of his language. As he once said: "Error as necessity" (Stenzl 2010: 6). One can affirm that there are no mistakes in these works. According to Nono himself, the players are expected to produce different versions of the piece for every performance. That is why Nono's scores from the 1980s are *action* scores, and not *effect* scores. The instructions are given, and it is up to the performers to engage and create a musically meaningful interpretation. This approach reduces the control (score) one might have with written instructions. Because of that, Roberto Fabbriciani (1999) talks about creating a 'Nono performance tradition' in order to play Nono's music.

Part of Nono's decisions are rooted in his experience with the players. The process of composing a new piece started in a quasi-improvisatory manner. Most of his sonic materials were created with the assistance of certain players (in this case, with Giancarlo Schiaffini, Roberto Fabbriciani, and Ciro Scarponi). Nono's music from the 1980s was highly based on intuition and instrumental errors. As stated by Roberto Fabbriciani (1999), Nono would first exhaustively experiment with the players, record, listen to all the material, and only then he would start writing the music. In contrast to other composers of his time, especially those from the serial school, Nono was a composer highly motivated by intuition.

Based on what have been said so far, it is consistent to affirm that in the Nono tradition music requires a performer with certain qualities. This type of music is not about being able to play in a traditional way, as the way it is done and taught in traditional conservatoires. It is not the type of music where the composers focus on the player's ego and abilities. He does not seek for a unilateral technique. Nono incorporates in his music many marginalized instrumental techniques by orthodox conservatoires, and the ideal player needs to understand that.

The music of Nono requires a player with the ability to create different colors within a single instrument. He incorporates aspects formerly seen as unmusical, sometimes by employing (allowing) 'errors' in his tone palette. For instance, in the Nono tradition players have to develop a way to control the amount of air production, since this element is crucial for the music. The ability to control the way the harmonic series sounds within a single held note is also vital for Nono. Instruments like flute often control both overtones and amount of air generating a complex network of possible timbres: ½ air pianissimo, ½ air overblown, full air (noise), etc. In *A Pierre*, one can see these techniques in Figure 4:

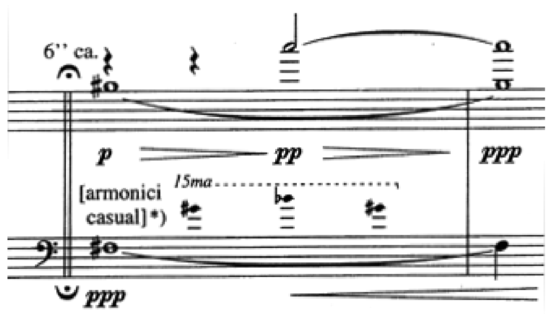

Figure 4. Flute and clarinet multi-phonics and overtones in *A Pierre* (measure 53).

In other words, the notated pitch is a starting point, but the ability to create musical phrases using those other parameters is the real interpretational issues on Nono.

Live-electronics strategies. Historically speaking, the electronics in *A Pierre* and *Post-prae-ludium* are of a simple nature, even if compared to Nono's others electronic works. The equipment consists of reverb, delay, spacialization, filters, harmonizers, and phasing (Figure 5 and 6).

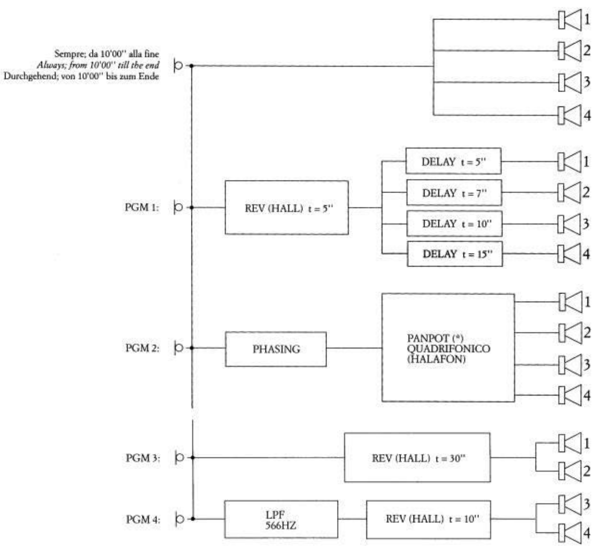

Figure 5. *Post-prae-ludium* live-electronics schematics.

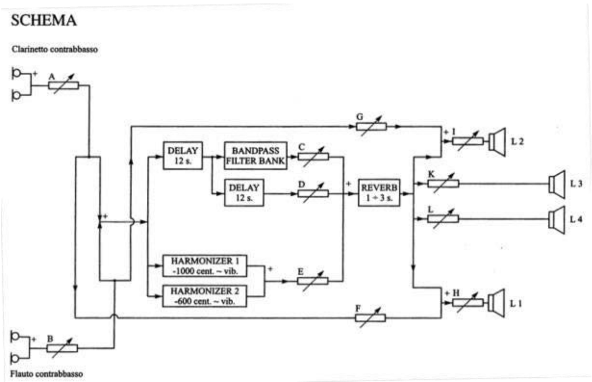

Figure 6. *A Pierre* live-electronics schematics.

The composer arranges combinations of these techniques with specific parameters according to different sections of each piece. Both pieces require a four-channel diffusion system: four loudspeakers placed around the audience (Figure 7 and 8).

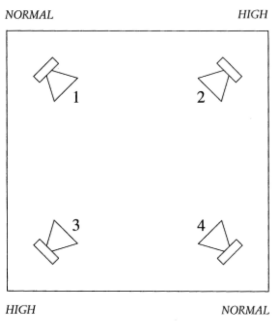

Figure 7. Loudspeakers placement in *Post-prae-ludium*.

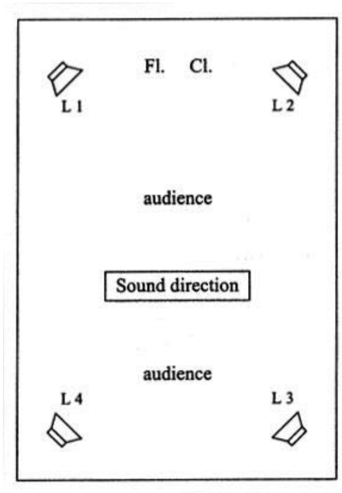

Figure 8. Loudspeakers placement in *A Pierre*.

In order to understand the live-electronic apparatus in *Post-prae-ludium*, Nono provides clear instructions in the score on how to trigger all electronic processes. He divides the parameters changes in four groups: program 1, program 2, program 3, and program 4. During the performance of this piece, those programs are used in a specific order (Table 2).

Section A	0’ — 5’20”	Program 1
Section B	5’20” — 7’00”	Program 2
	7’00” — 7’53”	Program 3
	7’53” — 10’00”	Program 4
	10’00” — 10’55”	Program 1
	10’55” — 11’12”	
Section C	11’12” — 12’15”	
	12’”15 — end	

Table 2. Program changes in *Post-prae-ludium*

In order to integrate instrument and electronics, a dynamic microphone is required (two microphones for *A Pierre*). It is important to notice how important was the microphone for Nono. For him, a microphone was an instrument itself. It had the capacity to shed light in acoustic sonic materials in the limit of audibility. In *Post-prae-ludium*, two technicians are required to operate the levels, one for the input (microphone) and another for the outputs (to the loudspeakers) – both randomly. This approach creates a complex atmosphere in the piece.

According to the scheme provided in *Post-prae-ludium* and *A Pierre*, the electronics programs have many similarities. Both take the live source, passes it either through a pitch shifting equipment – *Publison DHM 89 B2* (Figure 9) –, a reverb unit – *Publison Infernal Machine* (Figure 10) –, or a spacialization device – the *Halafon* (Figure 11). In the case of *Post-prae-ludium*, Nono asks for two slow speed parameters, in opposite directions, for the *Halafon*.

Figure 9. *Publison DHM 89 B2* (photo taken at the EXPERIMENTALSTUDIO des SWR by the author)

Figure 10. *Publison Infernal Machine* (photo taken at the EXPERIMENTALSTUDIO des SWR by the author)

Figure 11. *Halafon* (photo taken at the EXPERIMENTALSTUDIO des SWR by the author)

The next paragraphs give an explanation on each program parameters of *Post-prae-ludium*. Most of these processes are a development of what was done two years before in *A Pierre.*

Program one consists of a 5 seconds reverb going into four distinctive channels, each one with a different delay time and loudspeaker (Figure 5). The delay times for program one are 5, 7, 10, and 15 seconds. That means that a ten seconds note produced at instant 0" will be reproduced from the loudspeakers at instants 15" (delay 5"), 17" (delay 7"), 20" (delay 10"), and 25" (delay 15") creating a 'strict' canon.

In program two, there are neither delay nor reverb. Instead, Nono makes use of phasing and quadraphonic spacialization. Up until this point, the four channels were independent of each other. With the *Halafon*, they start to interact. Also, at the top part of the score's second page, Nono indicates the following values after the word *phasing:* 0.98, 1.01 // 0.99, 1.02. These instructions are the parameters used in the Publison Infernal Machine 90. Almost 30 years after the completion of this score, it is clear that it was meant to be used by Nono and his assistants/performers, rather than a score just for commercial purposes. The exact interpretation and knowledge for the performance of this piece lives nowadays with people who worked closely to Nono, such as the staff from the EXPERIMENTALSTUDIO des SWR in Freiburg, Germany. At this institute, one of the priorities is to fulfill composers' projects for new pieces. In this case, the EXPERIMENTALSTUDIO des SWR had developed an important piece of equipment for spacialization: the *Halafon*. It was created specially for situations where 8-channel spacialization was required (Figure 11).

Program three is the simplest of all. It produces a long reverb with a thirty seconds decay time. Also, the number of loudspeakers is reduced to the front stereo pair. Nono indicates the type of reverb in the score: infernal machine. That reference to the *Publison Infernal Machine* is an interesting aspect of the dependence on which live electroacoustic music have. It is quite complex to reproduce this piece nowadays without knowing what a *Publison Infernal Machine* sounds like. On the other hand, Nono gives some textual explanation that helps achieving the final sonority.

In program four, the source is processed by a low-pass filter and reverb, and this time outputted only in the back stereo pair. Nono sets the cutoff frequency to 566 Hz, so everything below this number will be directed to loudspeakers three and four and everything above will be gradually attenuated. Finally, after going through the low-pass filter the signal goes into a ten seconds reverb.

The last instruction for the live-electronics is a simple amplification of the tuba: at instant 10'00" until the end, to be reproduced by all loudspeakers.

Conclusion. Musical analysis is a necessary tool to understand and *perform* this type of music. Performers (instrumentalists and sound-technicians) must understand this music in a much deeper level. They need to interpret it as a type of composition that combines instrumental acoustic performance *as* electroacoustic music. One needs to understand it as a kind of music that requires a different attitude. In order to achieve that, it is important to be aware of distinct musical manifestations. *A Pierre, Dell'azzurro, Silenzio, Inquietum* and *Post-prae-ludium no.1 per Donau[eschingen]* are two of the latest pieces of

Luigi Nono. Aesthetically and historically speaking, they reflect Nono's use of electronics in a different way, specially if compared to the music produced until that time at IRCAM (Boulez *…explosante-fixe…, all* versions with electronics between 1972 and 1993), CEMAMu (Xenakis' *Analogique B* in 1958-59), and GRMC (Pierre Schaeffer's *Etude aux chemins de fer* in 1948). However, what Nono did in *A Pierre* and *Post-prae-ludium* was done before in a similar way by Stockhausen in *Mikrophonie I* (1964) for tam-tam and live-electronics, where a complex sound material was fed into a "simple" live-electronic setup. It appears that Stockhausen's approach was a bit more from the experimental aspect, as in Nono the consciousness was on a different and more mature level.

These pieces represent genuinely well what the composer was in search for during the decade of 1980. Although a recording of *Post-prae-ludium* performed by Giancarlo Schiaffini, supervised by Nono himself, exists nowadays, it is always a challenge for new performers to execute this piece. As stated by Roberto Fabbriciani, people who worked with Luigi Nono need to start a pedagogical tradition on how to play these pieces (Fabbriciani 1999). Most of his scores with live-electronics reflect only part of the music. Here, the player and sound technicians *are* part of the creative process, which started with the composer himself. Hans Peter Haller explains: "Nono required his interpreters to participate in the same active way as he himself did. Therefore, the interpreter had to agree to play or sing Nono's music in such a way that the sound result corresponded with its compositional model, its musical statement. Nothing was more to Nono's dislike than the star cult of the musician. He demanded — and this seems important to me — a creative reproduction" (Haller 1999: 13).

Finally, I would like to end with the words of Helmut Lachenmann, a former student of Nono: "I went to Nono because in his presence I experienced a freedom of a new, different quality. […] Studying with Nono was all about discovering new realities and exposing oneself to an ongoing and permanent process of inner insecurity, just as he himself was, right to the end. One had to be prepared, moreover, to follow his example and spend the rest of one's life exposed to internal and external conflicts and crises" (Lachenmann 1999).

Acknowledgments. Many heartfelt thanks to all who introduced me to the music of Luigi Nono – the EXPERIMENTALSTUDIO des SWR team, Dániel Péter Biró, Max Murray, Kirk McNally – and to the institutions that made the presentation of this work possible through their generous support – Universidade Estadual do Paraná, CAPES, Grupo de Pesquisa Núcleo Música Nova, and the Korean Electro-Acoustic Music Society / Emille Journal.

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[Abstract in Korean | 국문 요약]
루이지 노노 음악에서 매우 작은 소리와 전자기술의 사용을 통한 지시적 특성의 해방

필립 드 알마이다 리베이로

이 글은 루이지 노노의 1980년대 이후 전자음악을 중심으로, 《피에르. 푸른 고요, 미동A Pierre. Dell'azzurro Silenzio, Inquietum》(1985)과 《다뉴브를 위한 후-전-주곡Post-Prae-Ludium per Donau》(1987) 등의 작품을 논의한다. 노노의 전자음 사용 양식은 특히 구체음악이나 전자음악 현장에서 다른 작곡가들이 쓰고 있는 방식과 꽤 다르다. 노노의 음악은 가청 경계의, 미분음 같은 매우 작은 소리microsounds에서처럼 남다른 지각 관점으로 소리를 활용함으로써 기존의 감각을 벗어나 새로운 인지 가능성을 추구한다. 마이크가 말그대로 돋보기로서 소리를 확대하는 역할을 한다면 목관악기 연주 같은 기존의 음악이 전혀 다른 환경에 놓이게 되듯, 실황으로 전자장치를 사용하는 것은 이러한 음악의 발전에 있어 결정적이다. 마리오 다비도브스키Mario Davidovsky나 악기와 테잎을 대응시킨 그의 작품 《동시성Synchronisms》과 같이 대위적 방식으로 구성한 전자음악과는 대조적으로, 노노는 이러한 '이차 효과collateral effect'를 이용해 가장 중요한 작곡 도구로 삼았다. 노노는 바람에 스치는 소리나 피아니시시시시시모(매우 작은 소리)처럼 무심히 지나쳐왔던 소리들을 채택해 작품의 전면(前面)에 내세웠다. 이 변화로 이전에는 거의 듣지 못한 음악이 생겼다. 전자장치가 공간화spacialization, 음고조절pitch shifting, 필터링 등으로 소리의 요소를 바꾸어놓는 동안, 이러한 음악의 발전이 이미 복잡할대로 복잡해진 전자음악에 다가갈 다른 방도의 접근법을 종용하는 효과도 있었다. 이 연구의 목적은 루이지 노노의 음악을 널리 알리고 그의 전자 기술 사용법을 살펴보는 것이다. 앞서 언급했듯, 노노는 악기와 테잎을 구별한 라이브 전자음악을 쓰지 않았다. 보다 정확히 말하면, 그는 그 둘을 초월하는 다른 악기a meta-instrument를 개발하는데 둘 모두의 효력을 썼다. 이런 형태의 음악은 연주자들에게 '비정상적인' 연주법을 만들어내도록 요구한다는 점뿐 아니라 전자음향에서 단순한 외형을 보인다는 점에서 강도 높게 비판받았다.

PART II: Reviews

제2부: 참관기

Seoul International Computer Music Festival 2014

Kim, Minkyu

This year as usual, the Korean Electro-Acoustic Music Society (KEAMS) held the 21st Seoul International Computer Music Festival from 6th to 9th of October, where the selected thirty one composition works were presented out of over 130 entries from 25 countries. One of the oldest and most distinguished contemporary music ensemble in Europe *Avanture*, Based on Freiburg, was featured on the last day of the festival with six multifarious musical projects. Along with the concerts, the Korean Electro-Acoustic Music Society Annual Conference (KEAMSAC) has twelve papers discussed on the latest and productive topics.

서울국제컴퓨터음악제 2014

김민규

올해로 스물 한 번째를 맞는 서울국제컴퓨터음악제Seoul International Computer Music Festiva(SICMF)l(이하 서울음악제)가 지난 10월 6일부터 9일까지 예술의전당 자유소극장에서 한국전자음악협회(KEAMS)의 주관으로 열렸다. 올해는 스물 다섯 나라로부터 백삼십 여 개의 작품이 지원했고 이 중 서른 한 작품이 선정되어 나흘 간에 걸쳐 소개되었다. 특히, 마지막 날 9일 저녁 연주회는 독일 프라이부르크Freiburg를 중심으로 활동하는 현대음악 앙상블 아방튀르Ensemble Avanture의 초청 연주회가 열렸다. 음악제와 더불어 8일과 9일 이틀간 한국전자음악협회가 역시 주관하는 국제 학술대회(KEAMSAC)가 서울대학교에서 개최되어 기존 연설과 논문 발표 및 토론을 통한 학술교류가 이루어졌다.

음악회 1

첫 번째 순서는 일본 작곡가 하루카 히라야마Haruka Hirayama의 테잎tape곡《신화2 Myth2》였다. 이 곡은 각각 독자적인 사운드와 악기편성으로 구성된 세 개의 악장 중 두 번째 악장이다. 그는 프란치스코 고야Francisco Goya의 그림 《마녀들의 집회Witches' Sabbath》에서 영감을 얻었는데, 사람들의 무지로 무고한 여성들을 마녀사냥하는 모습과 어떻게 파국으로 치닫게 하는지 보여주는 그림이다. 그는 고야의 경고와 무지의 새로운 현대적 양상(언론이나 정부가 사람들을 무지하게 만들고 사람들 또한 허구인 줄 알면서 믿어 버리려는 현상 등) 사이의 유사성을 찾아 곡의 주제로 삼았다. 상징적 성격을 가지는 음형들은 긴 호흡으로 곡 전반에 걸쳐 반복되고 변형되는데, 이러한 소리들은 논리적 개연성보다는 특정 분위기나 느낌을 전달하기 위한 의도로 여겨졌다.

이어지는 곡은 일본 작곡가 코토카 스즈키Kotoka Suzuki의 피아노와 라이브일렉트로닉을 위한 《반짝이다, 나무2 Shimmer, Tree2》였다. 쉼 없이 이어 연주되는 두 개의 악장으로 구성된 이 곡은 조나단 하베이Jonathan Harvey의 음악 《박티Bhakti》와 《모르투스 플랑고Mortuos Plango》의 일곱 번째 악장을 인용하여 만들어졌고, 첫 악장의 시작과 둘째 악장의 끝은 대칭을 이룬다. 첫 악장의 피아노는 수직적인(높고 낮은 음높이의) 화음연주와 수평적인 움직임을 번갈아 반복하고, 피아노의 고음으로부터 비롯된 전자음을 중심으로 확장하다가 이어 수평적인 움직임과 더불어 반응한다. 두 번째 악장은 피아노의 저음에서 갑자기 멈춤과 동시에 시작된 수직적인 움직임이 인상적이다.. 뒤이어 짧은

휴지부가 찾아오고 특정 고음을 중심으로 전자음이 엷게 퍼져 나가면서 피아노는 반복적 화음을 연주하기 시작한다. 이와 더불어 높은 종소리(글로켄슈필 혹은 크리스탈)와 같은 음이 계속해서 울린다. 피아노의 화음 박동이 멈추고 나면 고음의 종소리도 서서히 사라진다. 간결하고 짜임새 있는 구조가 돋보이는 곡이었다.

다음 순서는 한국 작곡가 신성아가 2007년 이래 작업한 다양한 형태의『검고 가는 선 프로젝트The Black Thin Line Project』 중 2014년의 작업으로, 실험적 영상과 전자음악을 위한 곡이다. 흑백의 실험 영상은 멀리서 촬영된 정적인 풍경과 근거리에서 움직이는 대상을 담은 장면이 교차되며 시작한다. 흑백의 강한 대비처럼 전환되는 장면이 거침없이 진행되었다. 특히 마지막 부분에 침묵 속 영상으로 검은 화면과 특정 장소를 담은 장면을 반복적으로 교차시키는데, 마치 큰 북을 반복적으로 때리는 듯한 강렬한 인상을 준다. 음악은 영상과의 구조적인 결합보다는 그로부터 얻은 영감을 자유롭게 표현한 듯 하였다. 영상 전반에 걸쳐, 녹음된 작은 종소리(예를 들면 카우벨 소리)를 변형한 사운드가 저변에 얕게 얽혔다가 풀어지기를 반복하며 깔려 있다가 사라진다. 음악이 직접적인 표현에서 시작되어 간접적이고 추상적인 영역으로 확대되듯, 영상도 동일한 확대, 재해석의 개념을 공유한다고 작곡가는 설명한다.

네 번째 순서는 그리스 작곡가 레프테리스 파파디미트리우드Lefteris Papadimitrioud의 8채널을 위한 테잎곡 《새콤한 사탕Acid Drops》이었다. 이 곡의 음원은 대부분 합성된 전자음이며 녹음된 악기의 소리도 사용되었다. 이 곡의 주제는 8채널의 스피커 시스템이 만들어 내는 다양한 음향과 공간의 변화이다. 초반에 등장하는 저음의 움직임은 점차 반복, 확장을 통해 짧은 음가를 가진 다양한 음고로 흩어진다. 이 짧은 음들이 여러 스피커 사이를 빠르게 넘나들며 계속해서 공간 구조를 변화시켜 나간다. 작곡가는 이러한 표현 기법이 영상의 '몽타주 기법'에서 영감을 받았다고 설명한다. 이 곡의 또 다른 특징 중 하나는 곡의 중간 중간 짧지 않은 적막(쉼)이 자주 등장한다는 것이다. 이 적막이 작곡가 나름의 의도에서인지 확실치 않지만 (작곡가의 작품해설에 의하면 특정 현악사중주 곡과 함께 연주될 수 있다고 언급되어 있다.), 쉼이 있음으로 해서 음향 구조의 전후 관계 및 변화된 결과를 좀 더 명확하게 인식시키는 것 같았다. 이 적막은 중반 이후 점점 짧아지고 잦아지면서 결국 없어진다. 음향의 전개도 이처럼, 전반부는 어쿠스틱한 소리가 뚜렷이 나타나지만 후반부로 갈수록 날카로운 고음의 파쇄와 분쇄가 짙어진다. 작품의 전체적인 구조는 낮고 긴 어쿠스틱한 음에서 높고 짧은 날카로운 소리로의 점차적인 변화 과정이라 할 수 있다. 주제의 일관된 방향성과 그에 따른 설득력이 잘 조화된 곡으로 간주된다.

다음 곡은 홍콩 작곡가 친 팅 찬Chin Ting Chan의 B♭클라리넷과 라이브 일렉트로닉을 위한《템포라 무탄투르tempora mutantur》였다. 제목 '템포라 무탄투르'는 라틴어로 '시간은 변한다'는 뜻으로 보격의 시구 형으로 사용되는데, '우리는 또한 그 속에서 변한다'라는 구절, '노스 데 무타투르 인 일리스nos et mutamur in illis'와 함께 쓰인다. 사전에 녹음된 클라리넷의 다양한 음색과 이를 합성한 음향을 음원으로 사용하였고, 딜레이, 코러스, 플렌징, 하모나이저, 그래뉼러 합성법 등의 실시간 제어기술을 활용하였다. '시간의 변화'는 작곡가에게 늘 흥미로운 주제이기에 제목에 대한 기대감이 있었지만 아쉽게도 이에 대한 소재나 주제에 관한 특별한 접근은 찾을 수 없었다. 대신 시시각각 변하는 다양한 사운드와 효과를 볼 수 있었는데, 오히려 이러한 다양성이 곡의 주제성과 통일성을 잃어버리게 만드는 것 같았다.

다음 순서는 한국 작곡가 이은화의 8채널을 위한 테잎곡《구름 속으로Into a Cloud》였다. 복잡하지 않고 간결한 표현과 형식이 특징적인 곡이었다. 소리는 다양한 엔벨로프envelop를 보이며 천천히 흘러가는 거대한 덩어리를 연상시키는데, 그 과정에서 미세한 소리들이 모였다 흩어졌다를 반복하며 색다른 공간감을 형성하였다.

다음 곡은 포르투갈 작곡가 주앙 페드루 올리베이라João Pedro Oliveira의 오디오 비주얼 작품《하이다토스Hydatos》였다. 제목인 그리스어 '하이다토스'는 '물'이라는 뜻으로, 구약성서 창세기 1장 2절 "땅이 혼돈하고 공허하며 흑암이 깊음

위에 있고 하나님의 영은 수면 위에 운행하시니"'에서 영감을 얻었다고 한다. 영상은 작곡가가 직접 만들었다고 하는데 기술력과 세련됨이 돋보였다. 수중에서 촬영된 장면들(빛이 투영되는 수중 다양한 형태의 물방울 등)과 지상에서 촬영된 장면들(화산 폭발, 폭풍우)이 계속해서 겹쳐지고 변형되다가 후반부에는 화면이 분할 및 분산되거나 압축된다. 음악은 자연에서 녹음된 소리(물 소리, 바람 소리 등)를 변형, 합성하여 소재로 사용하였으며 영상을 위한 삽화적 역할을 하였다. 예를 들어, 물 한 방울이 떨어질 때 한 높은 음이 울린다든지 좌우로 흔들리는 이미지들에 트레몰로나 트릴같은 소리가 맞추어지는 등 전반적인 음악의 내용이 영상의 움직임을 따라가고 있다. 앞부분은 잘 다듬어진 영상과 그에 어울리는 음악으로 감상에 큰 어려움이 없었지만, 중반 이후부터는 변하지 않고 반복되는 내용으로 영상과 음악 사이에 거리를 두어 지루하게 느껴졌다.

마지막 순서는 한국 작곡가 김종현의 두 개의 위-리모콘Wii-Remote과 라이브 퍼포먼스를 위한 《장난감 1번 – 점점 가속화하여Spielzeug #1 - poco a poco accelerando al sinus》였다. 작곡가의 아이디어는 슈톡하우젠의 책 "시간이 어떻게 지나가는지...wie die Zeit verging..."의 서두에 언급된 내용과 흡사하다. 적당한 정도의 시간차를 두고 빠르게 반복하는 동일한 펄스는 연속되는 음으로 들리지만, 더 빠르게 (약 초당 20회 이상) 반복되는 음은 하나의 음으로 인식되고, 이보다 더 점점 빠르게 반복하면 높은 음으로의 글리산도가 된다는 내용이다. 마찬가지로 녹음된 샘플의 재생 속도를 점점 빠르게 하면 원본의 흔적은 사라지고 사인파 같은sine wave-like 소리만 남게 된다. 반복속도를 높이는 과정에서 사운드의 구조가 미세하게 뒤틀리며 변화하기 때문이다. 작곡가는 무대에서 직접 양손에 위-리모콘을 가지고 프로그래밍한 패치를 운용하며 라이브 연주를 선보였다. 위-리모콘을 점점 위로 들어 올리면 점차 샘플의 재생 속도가 올라가고 (음고가 올라가고) 결국에는 변형 및 글리산도하면서 최고음에 도달한다. 들어 올리는 사이 리모콘을 흔들면 수직 운동에서 수평으로 힘이 분산되듯 (도는 팽이처럼) 소리들이 얽히며 사방으로 흩어진다. 그는 이러한 행위를 통해 다양하게 프로그램된 패턴을 즉흥적으로 연주하였다. 그의 작품에 대한 깊은 이해를 바탕으로, 스스로 최적의 소재를 선택하고 연주 과정을 통해 원하는 바를 정확히 구사하였기 때문에, 그 어느 작품보다 관중에게 작곡가의 아이디어가 명확히 전달된 공연으로 여겨진다. 더욱 다양한 실험과 음악으로 짜여진 그의 다음 작품이 기대된다.

음악회 2

첫 번째 순서는 영국 작곡가 조세프 타그Joseph Tagg의 오디오 비주얼을 위한 《반음계적 색조Chromatic Hues》였다. 작곡가는 영상과 음악의 관계에 대해, 먼저 '색상 스케일(아이작 뉴턴으로부터 시작된 색상과 음의 관계에 대한 개념)'을 떠올렸다. 이 작품은 음향과 시각적 요소들이 가질 수 있는 여러 다른 관계성뿐 아니라 음향재료가 독립적으로 변형하는 방법, 그리고 다양한 시각적 정보가 구성되고 결합되는 방법을 탐구하는 작품이다. 첫째 날 보았던 포르투갈 작곡가 주앙 페드로 올리베이라의 오디오 비주얼 작품 《하이다토스》와 비교해 보면 좋겠다. 먼저 《하이다토스》는 외부적 소재, 성경 구절에서 느껴지는 상상의 이미지에서 착안된 반면, 《반음계적 색조》는 소재가 가지고 있는 내적 잠재성(이미지와 소리의 결합성)이 동기가 되었다. 두 작품의 영상은 상당히 다른데, 《하이다토스》는 실제 촬영된 사물과 풍경을 합성, 변형하였고 무채색이 주를 이루고 있지만, 《반음계적 색조》는 추상적 도형들로 화면을 분할 구성하며 사용된 원색은 검은색의 배경과 대조를 이룬다. 두 작품의 영상과 음악의 진행 방식은 상당히 유사한데, 즉 보이는 대로 들리고 들리는 대로 보인다. 그럼에도 불구하고 음악의 역할이 크게 대조되는 점이 흥미롭다. 왜냐하면 《하이다토스》의 영상과 음악은 특정 이미지에 대한 구체화라는 틀에서 쉽게 이해될 수 있지만, 《반음계적 색조》에서는 소리와의 결합 가능성을 고려하면서 감상해야 하기 때문이다. 즉 《하이다토스》의 영상과 음악은 서로 다른 감각을 요구하는 미디어로서 상상적 이미지의 구체화라는 동일한 목적으로 서로 상호보완할 수 있지만, 《반음계적 색조》에서는 두 미디어가 서로를 대체할 수 있기 때문에 (적어도 그 가능성을

모티브로 삼았기 때문에) 보이는 대로 듣고 들리는 대로 보는 경우 두 매체의 정보가 중복되는 것처럼 느껴질 수도 있다.

두 번째 순서는 미국 작곡가 미켈 쿠엔Mikel Kuehn의 《악구의 제전Rite of Passage》이었다. 스트라빈스키의 《봄의 제전Rite of Spring》 도입부로 유명한 베이스 클라리넷 악구를 이 작품의 기본 소재로 사용했기 때문에 제목으로 붙여졌다. 이 곡은 크게 네 부분으로 나뉘고 각 부분은 서로 다른 방법으로 소재를 다룬다. 베이스 클라리넷과 라이브 전자음향은 음색의 변화와 강약의 성형과 같은 기법으로 다양함을 보이는 데 초점을 두어 결합되었다. 작품의 기본 진행은 베이스 클라리넷의 정체성과 스트라빈스키의 선율과의 연관성을 찾는데 있다. 초반부에는 클라리넷의 정적인 멜로디와 키클릭keyclick 음향이 주로 제시되고 딜레이를 이용한 두터운 조직구성texture으로 발전한다. 곡의 중반에는 긴 음들이 연결되면서 다양한 화음으로 진행하다가 키클릭과 숨소리의 음향으로 전환된다. 중후반부는 스트라빈스키의 멜로디가 변주, 확장된다. 후반부는 재현부릐 양상을 보이다가 스트라빈스키를 인용한 짧은 코다로 종결된다.

다음 순서는 독일 작곡가 클레멘스 폰 로이스너Clemens von Reusner 의 테잎곡 《건조한 마찰dry friction》이었다. 제목처럼 이 곡의 음향 재료로 단단한 금속 표면에서 만들어 지는 마찰 소리를 합성, 변형하였다. 금속성의 음향은 때론 액체의 느낌이 더해지긴 하지만 금속성의 공간감과 공명이 느껴졌다 음향의 연속적인 변화는 곡의 진행에 주요한 요소 중 하나로서 초반의 금속성 질감은 점차 액체감으로 변질되었다가, 다시 건조하게 변해갔다. 또 다른 중요한 요소는 규칙적이거나, 점점 빨라지고 느려지는 등 다양한 형태의 펄스로 리듬 동기의 재료가 되었다.

이어지는 순서는 한국 작곡가 김태희와 영상디자인 아티스트 전상언의 첼로와 라이브 드로잉을 위한 4채널 오디오 비주얼 퍼포먼스 작품 《그리는 응창가Drawing Responsory》였다. 이 작품은 첼로의 선율 독주solo와 실시간 드로잉으로 제어, 구현하는 실시간 영상 및 오디오 프로세싱의 응답response에 따라 만들어지는 라이브 인터랙티브 미디어 아트다. 음악에 의해 비주얼화되는 그래픽이 아닌 실시간 드로잉을 통해 음악을 제어하고 만들면서 동시에 실시간으로 처리되는 영상을 그려 가는 작업이었다. 보통 사용하는 센서나 미디 기기를 통한 퍼포먼스가 아닌, 드로잉 작업을 실시간으로 녹화, 분석하여 소리를 제어하고 변형시키는 방법을 시도한 흥미로운 곡이었다. 첼로의 음악은 주로 구분하기 쉬운 요소들(스케일, 글리산도, 트레몰로 등)을 이용하여 전개되는데, 이후 딜레이되고 변화, 합성된 결과물이 드로잉을 통해 어떻게 실시간으로 변화되어 가는지 명확히 인지시키기 위한 의도로 보인다. 드로잉은 다양한 색상의 점과 선으로 이루어져 있는데, 이들이 구체적으로 무엇을 의미하고 음악에 어떠한 영향을 미치는지는 명확하지 않다. 드로잉은 실시간으로 영상을 통해 비춰지지 않고 녹화, 확대, 편집, 딜레이되면서 화면에 비춰지기 때문에 관객은 사실 드로잉한다는 사실만 인지하면서 화면에 비춰진 결과물(녹화, 편집된 드로잉)과 음악을 시청할 뿐이다. 이는 드로잉의 중요한 역할을 축소시키는 결과를 낳았다.

다섯 번째 순서는 한국 작곡가 장준호의 듀오(플루트, 첼로)와 라이브 일렉트로닉을 위한 《강박관념Obsessive-compulsive act》이다. 큰 구성은, 강박증과 이를 극복하려는 두 가지 심리적 형태가 교차하는 주제와 응답이다. 주로 사용된 재료는, 강박증 특유의 거칠고 노골적인 펄스이고, 이에 기초한 다양한 변주 형태와 소재가 이 곡을 이끌어 간다. 첼로의 피치카토와 함께 시작된 반복 펄스는 두 악기의 다양한 연주 기법(트릴, 악센트, 콜레뇨 바투토 등등)을 통해 변주되었다. 작가가 의도한 강박증이 반복에 대한 집착으로 명확히 표현되었으나, 의미가 비슷한 음향 소재들만 중복적으로 제시되거나 재현되는 진행과정은 아쉬웠다. 음악에서 반복이란 꽤 친숙한 도구이다. 소나타와 론도 형식만 보더라도 '제시와 재현' 은 오래 전부터 주요한 음악어법이었다. 하지만 그 재현을 더욱 의미 있게 해주는 것은 사이사이에 다른 성격의 음악이 등장하면서 전체 안에서 시너지 효과를 내기 때문이다. 강박증이 어떤

대상으로부터 벗어나려는 의지와 도무지 벗어날 수 없는 심리가 상충되는 상테를 일컫듯, 주제의 의미나 표현과 상반된 부분이 등장하며 의지와 심리의 상충을 표현했다면 어땠을까?

다음 순서는 한국 작곡가 김효주의 테잎곡 《소리공포증Misophobia》이었다. 작곡가는 일상생활 속에서 듣게 되는 소리들에 대한 사람들의 반응을 관찰한다. 자판 두드리는 소리, 껌 씹는 소리 등 특정하게 반복하는 소리에 신경이 쓰이게 되고 심지어 작은 시계소리에도 예민해진다. 어떤 소리는 집중할수록 더욱 크게 들리기도 한다. 이렇게 흔히 들을 수 있는 다양한 종류의 소음이 이 곡의 주요 소재로 흥미로운 아이디어였다.

이어지는 순서는 멕시코 작곡가 페르난도 알렉시스 프랑코 무릴로Fernando Alexis Franco Murillo의 테잎곡 《퀄리아Qualia》이었다. 작곡가의 작품해설에서는 이 곡이 하나의 음향적 사건에 대한 서로 다른 개인적 반응과 경험에 대한 것이라고 이야기하고 있다. 하지만 이러한 작곡가의 의도를 음악에서 찾기 쉽지 않았다. 우선, 테잎곡은 연주회에서 벌어지는 개인적 반응을 담아낼 수 있는 형식이 아니다. 그래서 음악의 내용에서 찾으려 했지만 이 또한 어려웠다. 불규칙 리듬의 도입부 첫 1분과는 달리 이후 8분 동안 하나의 화음이 지속될 뿐이다. 마지막 1분은 도입부와 동일한 내용과 길이로 대칭적 구조를 가진다. '상이한 개인적인 반응'을 내용으로 담아 표현하기 위해서는 주제와 다양한 변주 기법이 어울릴 것 같다.

마지막 순서는 이탈리아 작곡가 파올로 파스콜로Paolo Pascolo의 플루트, 라이브 일렉트로닉, 영상을 위한 《예측할 수 없는 상호작용Unpredictable Interaction》이었다. 이 곡에 대한 해설이 실려 있지 않아 작품에 대한 작곡가의 의도를 미리 알지 못하고 감상했다. 이 곡의 제목으로 플루트와 라이브 일렉트로닉, 영상, 이 세 가지의 미디어가 함께 즉흥적인 퍼포먼스를 보여줄 것을 기대했었다. 플루트는 다양한 음향 재료(숨소리, 입술로 마우스피스 부딪치는 소리, 스타카토, 플라터 텅잉, 아르페지오 등)를 번갈아 제시했고 전자 음향은 그것을 합성, 분쇄하여 좀 더 화려하게 퍼뜨려 주는 역할을 했다. 영상은 전자음향과 동기화되어 전자음의 신호(음고 혹은 볼륨)를 실시간으로 디코딩한 것을 시각 매체(보라색 다이아몬드 모양의 결합들)로 보여 주었다. 작곡가가 플루트 연주자로서 다른 한 명의 컨트롤러와 함께 무대에 나와 악보 없이 눈빛으로 호흡을 맞추며 즉흥 연주를 보여 주었다. 첫째 날 마지막 작품 《장난감 1번 – 점점 가속화하여》도 작곡가가 직접 무대에 나와 사운드를 조절했는데 이 두 곡 모두 다른 작품들에 비해 음량이 작았다. 사운드 조절을 무대 위에서 한다는 것은 스피커의 뒤편에 서는 것이기 때문에 실제 청중들이 듣는 소리와 상이하다. 좀 더 정확한 연주를 위해 가능하면 메인 데스크에서 다시 한번 사운드를 조절하는 것이 바람직할 것이다. 하지만 이번 연주회에서는 메인 컨트롤 데스크의 위치도 앞좌측(무대 쪽)이어서 음향 테스트를 하기가 쉽지 않았을 것이다. 메인 데스크는 좌우 스피커 정중앙에, 그리고 관객석 중앙에 위치해야 더욱 정확한 사운드 조절이 가능하다.

라이브 일렉트로닉스 작품은 일반적으로 길고 복잡한 세팅과정을 필요로 하기 때문에, 진행시간 단축과 안전한 준비를 위해 프로그램 순서 처음이나 중간휴식 다음에 배치된다. 오늘의 콘서트처럼 여러 라이브 작품이 연주될 경우, 미리 무대 위에 여러 작품들을 위한 세팅을 해 놓은 뒤 순서에 따라 스포트라이트를 이동해 진행한다면 좀 더 원활한 진행이 가능하지 않을까 생각해 보았다. 사실 세팅 문제로 오늘 연주 시간이 십여 분 정도 지연되기도 했다. 서울국제컴퓨터음악제 2014 프로그램 책자를 찬찬히 살펴보니 날짜별 프로그램과 곡소개가 잘 정리되어 있었는데, 초연 또는 재연 여부에 대한 정보가 없는 것이 아쉬웠다.

음악회 3

첫 번째 순서는 이탈리아 작곡가 니콜 모노폴리Nicola Monopoli의 첼로와 라이브 일렉트로닉을 위한 《정적, 도망, 무질서La Quiete, La Fuga, Disordine》였다. 증폭된 첼로와 미리 만들어진 2채널 오디오 사운드를 위한 작품으로 소리 재료의

변형 과정을 주제로 한다. 작곡가는 이 변형 과정을 고요한 상태로부터 점차 혼돈의 상태로의 변화됨으로 기획했다. 이러한 변화를 기준으로 전체 구성을 세 개의 부분으로 나누고 마지막 짧은 코다가 더해진 형식으로 볼 수 있다. 긴 음가를 가진 여러 음으로 표현된 첫 부분의 고요함은 점차 빠른 트레몰로와 거칠고 두터운 음향으로 변화되는데, 이를 '두렵게 하는 무언가로부터 도피하려는 시간에 대한 강박적 경쟁, 혼돈의 상태로 가는 경쟁'으로 작곡가는 설명한다. 거친 트레몰로가 산을 넘듯 정상에 이르면 짧은 적막 후 첼로의 피치카토가 나타나고 뒤이어 합성된 짧은 음의 불규칙적 리듬으로 전자음향이 시작된다. 그리고 전자음향과는 대조적으로 첼로 연주자가 한동안 몸통을 문지르는 부분이 나오는데 소리가 너무 작아서 연주하는 사람을 곤혹스럽게 했다. 작곡가로부터 의도를 듣고 토론할 수 없는 경우(작곡가가 직접 참석하지 못하는 경우)에는 대충 넘어갈 수도 있겠지만, 이 연주자는 리허설에서 이 부분의 첼로 소리가 전자음향에 묻히지 않도록 진행자와 꼼꼼히 확인한 후, 작은 음량이지만 더 큰 행위로 표현을 극대화시켰다. 라이브 일렉트닉 음악은 전자음향의 음량에 따라 연주자의 강약이 변하는 경우가 있는데(전자음향이 커지면 같이 커지다가 전자음향이 작아지거나 사라지면 이에 따라 연주자의 볼륨도 작아지는 경우), 이것은 연습할 때 전자음향에 대한 사전 지식 없이 자신의 소리만 들으며 연습했기 때문일 것이다. 이 곡의 연주자는 이런 문제 없이 프로다운 모습을 보여 주었는데, 풍부한 경험을 엿볼 수 있었다. 뒤이어 다시 등장하는 첼로의 피치카토에 전자음향이 함께 나타나고 사라지기를 반복하는 부분이 있는데, 첼로의 음량이 변함없이 독주 선율을 이어가는 모습에서 더욱 그렇게 느꼈다. 전자음향은 샘플링과 리샘플링 기법과, 관습적, 비관습적 방법으로 다양한 첼로 음색의 샘플을 녹음하였고, 알고리듬 기법을 사용해 변형하였다.

이어지는 곡은 일본 작곡가 료 이케시로Ryo Ikeshiro의 오디오 비주얼을 위한 《구성: 흰 네모, 흰 동그라미Composition: White Square, White Circle》였다. 영상은 간단한 추상 디자인을 담고있는데, 밀가루 반죽을 하는 것처럼 사각형으로 접거나 원형으로 늘리는 것에 기초하여 만들어졌다. 이러한 모양은 앞뒤로 움직이고 복잡한 구조로 변환되었다가 다시 원래대로 되돌아온다. 음악은 사인파 합성으로 이루어진 소리로 구성되어 있으며 영상과 철저히 동기화되어 있다(특정 움직임, 예를 들어 좌우로 이동하는 움직임과 스피커의 좌우 소리 이동과의 동기화, 원근적 이동과 볼륨 크기와의 동기화 - 화면 가까운 곳으로 이동하면 소리가 커지는 것 등). 작곡가는 이 동기화에 대해, 미셸 시온이 그의 이론 저서에서 언급한 '싱크레즈synchesis'의 예를 들었는데, 영상과 소리의 밀접한 결합(동기화)을 통해 서로 다른 두 미디어를 하나의 것(오디오-영상의 독립체)으로 인식하도록 한다. 이 작품을 보면서 영상과 음악의 동기화를 전제로 하였다 해도 그것이 꼭 상식적일 필요는 없을 것 같다고 생각했다. '무엇이what 보여지고 어떻게how 들려질까?'라는 선택은 매우 다양해질 수 있다. 단순한 예로 시각의 움직임(좌에서 우로)에 청각은 반대 방향(우에서 좌)으로 동기화 될 수 있고, 이에 담긴 의도, 전개의 가능성과 기대가 생긴다. 하지만 일반적인 동기화의 경우 하나의 정보 즉 '무엇이 보이고 들리는가?'밖에는 담을 수 밖에 없게 된다.

다음 작품은 프랑스 작곡가 프란시스 도몽Francis Dhomont의 오디오 비주얼을 위한 《블루 타임Temps Bleu (Blue Time)》으로, 음악은 도몽이, 미디어비디오는 이네스 비크만Inés Wickmann이 담당했다. 모래시계에 담긴 파란 모래가 거꾸로(아래에서 위로) 떨어지는 장면으로 시작하고 마지막 장면은 다시 원래대로 위에서 아래로 떨어지면서 첫 장면과 대칭을 이루는데, 다소 진부한 표현 기법으로 느껴졌다. 영상은 직접 촬영한 장소와 사물을 옴니버스 방식으로 편집한 것인데, 작가의 주관적인 기억이나 경험에 의해 연관성을 가지는 대상이나 장소 등을 담은 장면들이 연결되어 겹치면서 진행한다. 음악은 주로 사인파를 합성하거나 영상에 등장하는 장소나 대상을 녹음한 소리를 편집하여 사용하였다. 소리는 주로 장면이 바뀔 때 마다 변형 혹은 추가, 감소되지만 영상보다 긴 호흡(몇몇 장면 전환들을 하나로 묶는다든지)으로 진행된다. 이로 인해 동일한 대상이나 장면이 다른 소리와 함께 겹치면서 같은 영상에 다른 음악으로 다른 느낌을 주는 효과가 흥미로웠다.

다섯 번째 순서는 한국 작곡가 김지현의 테잎을 위한 《추적 – 재구성할 수 있는 기억track - reconstructable memory》이었다. 이 곡은 짧은 충격음과 각종 소음으로 구성된 여러 개의 리듬적인 고리들이 계속해서 변화하는 과정을 담은 곡이다. 소리의 소재는 일상에서 들을 수 있는 여러가지 소음들을 녹음하여 변조한 것으로서 각 리듬적 고리들을 이루는 샘플로 사용되었다. 이 고리들은 비슷한 패턴으로 묶여 집합체를 형성하는데, 하나의 리듬적 고리는 그 집합체 안에서 다양한 방법으로 변형된다.

다음 순서는 일본 작곡가 후쿠다 다쿠토Takuto Fukuda 의 더블베이스와 라이브 일렉트로닉스를 위한 《동화Assimilation》였다. 이 곡은 특정 소리로 예비되는 타격음(손바닥으로 현을 두드리는 소리)과 이어지는 긴 음가들의 결합이 반복되면서 일정한 구간이 설정되며, 이 구간의 길이와 음향이 곡 전반에 걸쳐 지속적으로 변주되는 것이 특징이다. 초반부에 등장하는 베이스의 글리산도는 점차 전자음으로 이어지며 긴 상승과 하강을 통해 서서히 음역을 확장한다. 중반 이후 반복 구간은 점점 짧아지며 더 극적인 움직임으로 발전하다가 긴 하강 글리산도와 함께 마무리된다. 작곡가는 연주자에게 클릭 트랙click track없이 연주하도록 지시했다. 작곡가는 연주자와 함께 호흡을 맞춰 샘플링된 소리들을 제어하는 방식을 택했다. 이 곡이 반복되는 뚜렷한 구간을 가지고 있으며 전자음이 특정 소리로 그 구간의 시작을 예비해 주기 때문에 연주자가 듣고 위치를 쉽게 파악할 수 있다는 판단으로 그렇게 진행했겠지만 연주자 입장에서는 자신의 연주 속도를 전자음을 동시에 들으면서 제어해야 하는 부담감도 있고 자신의 위치를 정확하게 판단할 수 없다는 점에서도 부담이 크다. 실제로 연주에서 몇 군데 전자음악과 맞지 않는 부분들이 보여서 아쉬웠다.

다음 순서는 미국 작곡가 미첼 헤르만Mitchell Herrmann의 8개의 채널을 위한 테잎곡 《케틀드럼 오르간Kettledrum Organ》으로 파울 클레의 1930 큐비스트 페인팅을 음악적인 언어로 재해석해 만든 작품이다. 입체주의 영향을 받은 이 작품에서 악기들이 여러 사각형의 입체적 형태들로 해체되어 있는데 작곡가는 이런 아이디어를 소리로 옮겨와 오르간, 마림바, 비브라폰과 같은 악기들에 내재하는 음색적인 엔벨롭을 해체 변형하고 있다고 이야기한다. 또한 이런 소리가 가지는 물리적 현상과 결과물을 실험하는 작품으로 소개한다. 이 곡은 3분 정도의 짧은 길이의 곡인데, 곡 전체가 마치 하나의 긴 통로(혹은 길고 큰 오르간의 파이프)를 통과하는 듯한 느낌을 준다. 8채널이 가지는 소리의 입체감과 공간감이 잘 표현된 곡이다. 전자음향은 여러 악기들을 녹음, 합성하여 사용하고 있다.

이어지는 순서는 이탈리아 작곡가 마우릴리오 카치아토레Maurilio Cacciatore의 증폭된 플루트와 라이브 일렉트로닉스를 위한 《IV 이중적IV Anfibio》이었다. 2011년도에 작곡된 이 곡은 그의 인성에 대한 시리즈인 암피비안Amphibian의 네 번째 곡으로 플루트를 기악과 성악 사이의 존재로 다루고 있다. 플루트 취구를 통한 연주자의 목소리 사용은 기대하지 않았던 음색 결과를 보여주는데, 소리 자체를 새롭게 하는 데 끝나지 않고, 라이브 전자음악을 통해 그것의 색채와 특징들을 확대 시키고 있다. 전자음악은 매우 가볍게 사용되는데, 어쿠스틱 소리를 디자인하거나 키 슬랩을 증폭시키는 역할로 사용된다. 이 곡은 조용한 목소리와 숨소리로 시작해서 음향적으로 점차 두터워지고 또 호흡이 빨라지며 날카로운 바람소리, 숨소리, 휘파람, 트릴, 빠른 스케일 같은 움직임이 지속적으로 반복된다. 후반부에는 다시 느린 목소리가 지배적으로 등장하며 조용한 휘파람 소리로 마무리된다. 실제 연주에서 중요한 것 중의 하나는 무대 세팅이다. 연주자가 어느 위치에서 어떻게 연주하느냐에 따라 청중은 다른 느낌을 받을 수 있기 때문이다. 이 곡은 여러 개의 보면대를 세워서 악보를 넘기지 않고 이동하며 연주하도록 설정되어 있는 곡이다. 연주자는 무대 중앙 약간 뒤쪽에서 선 채로 연주했고 보면대는 연주자 주위로 넓고 둥글게 반원을 그리며 배치되었는데, 보면대가 살짝 뉘어 있어서 청중들이 연주자를 보면서 감상할 수 있다는 점이 좋았다. 넓은 배치는 동굴 속 울림 같은 곡의 콘셉트를 잘 반영했다.

다음 순서는 한국 작곡가 김미정의 네 개의 채널을 위한 테잎과 라이브 일렉트로닉스를 위한 《태극과 사괘Taeguk and Four Kwaes》였다. 제목인 태극은 '궁극의 근원'을 뜻하는 동양 철학 용어로 만물의 조화와 근원을 상징한다. 이 곡에서는 여기에 태극기의 사괘를 접목하여 음양 조화를 꾀하고 있다. 곡에서 울려 퍼지는 징 소리는 근원을 상징하는 작곡가의 주제 의식을 잘 표현하고 있는데, 사괘에 대한 아이디어를 4채널에 접목하여 그 안에서 이루어 내는 하모니가 인상깊었다.

마지막 순서로는 한국 작곡가 안두진의 기타, 춤, 라이브 일렉트로닉스를 위한 《춤 – 움직임을 위한 음악》이었다. 이 곡은 전자음악 소리에 반응하는 움직임을 탐구하는 작품으로, 음악과 춤의 개념을 단순화하고 즉흥적인 표현의 도구로 사용하고 있다. 작곡가는 춤을 다른 시각에서 바라보고자 하였는데 신체, 몸의 움직임, 움직이는 신체를 신체가 아닌 생물로 바라보고 생물의 움직임으로 생각하고 질문한다. "감정이 있는 생물인 인간. 인간의 감정은 얼굴로 잘 보여지겠지만 생물의 감정은 어떻게 보여질 것인가?" 이 곡에서 주목할 점은 기타와 춤, 전자음악의 상호 관계이다. 전자음향은 곡 전반에 걸쳐 배경적 역할을 하며 작곡가가 직접 컨트롤한다. 기타 연주는 전자음악과 춤을 매개하는 역할을 한다. 춤은 소리들 속에서 매우 자유로운데, 기타 연주에 간혹 반응하는 듯하지만 얽매이지 않는 듯 보인다. 춤의 동선은 매우 자유로운 듯 보이지만 사실 미리 작곡가와의 상의 하에 정해진 것인데, 마지막 부분에 조명 밖으로 벗어났다가 다시 돌아오는 퍼포먼스가 인상깊었다.

음악회 4

이 날은 독일 프라이부르크Freiburg의 현대음악 앙상블 아방튀르Aventure의 연주로 총 여섯 곡이 연주되었는데, 앙상블의 리더인 바순 연주자 볼프강 뤼디거Wolfgang Rüdiger가 연주회 전 청중들 앞에 나와 인사하고 직접 앙상블을 소개해 주었다. 이 날에는 프로그램 순서 변경도 있었는데 아래 리뷰는 연주 당일 바뀐 순서대로 작성되었다.

첫 번째 순서는 한국 작곡가 문성준의 클라리넷, 바이올린, 첼로, 피아노, 타악기, 일렉트로 어쿠스틱 사운드를 위한 《평온하게, 서슴없이tranquilly, unhesitatingly》였다. 곡의 초반에는 짧고 역동적인 움직임과 보다 절제된 긴 음가들이 교대로 반복되어 등장한다. 중반에 이르러 패턴의 변화가 뚜렷하게 나타나는데, 점차 역동적 움직임이 많아지고 길어진다. 역동적 움직임에는 또 다시 패턴의 변화가 일어나는데 점차 빠르고 규칙적인 펄스의 움직임이 악기들 사이에 지배적으로 등장한다. 상당히 인상적인 것은, 이러한 패턴의 변화가 뚜렷한 방향성을 가지고 있으면서 한편으로는 예측하기 어렵다는 점이다. 연속성과 비연속성, 그리고 규칙성과 불규칙성을 가지는 패턴 변화에 대해 작곡가는 장식미술 기법 중 하나인 '모자이크' 기법으로 설명한다. 여러 형태의 테세라tessera(모자이크를 이루는 작은 조각)를 패턴화하여 구성하거나 해체함으로써 재구성하는 방식의 전개가 흥미로웠다. 전자음악은 절제되어 사용되고 있는데, 마치 하나의 테세라같이 취급되어 작게는 악기들과 결합되거나 앙상블 전체와 구별되는 소리로 사용되고 있다.

다음 순서는 한국 작곡가 임영미의 플루트, 비플랫 클라리넷, 첼로, 라이브 일렉트로닉스를 위한 《그림자 놀이Shadow play》였다. 이 곡은 투명한 막 뒤에서 손이나 몸을 이용해 불빛으로 비춰 만든 그림자 아트를 보고 느낀 점을 표현한 작품이다. 막 뒤에서 일어나는 부산한 움직임이 앞에서는 단순한 실루엣으로 압축되어 표현되듯이 이 곡의 음악적인 관념적 특성은 각 악기들의 연주를 통해서 표현되도록 설계되었다. 각 악기의 멜로디가 서로 모방, 응답, 확장, 응용하며 형성되는 다양한 음형들의 진행이 흥미로웠다. 전자음악은 테잎을 통해 특정 구간들이 반복하거나 하모나이저를 통해 실시간으로 소리를 변조, 확장되기도 하는데, '그림자 놀이'에서 여러 사람이 얽혀서 순간적으로 형태가 바뀌는(동물이나 사물로 바뀌는) 장면같이 순간적인 소리의 퀄리티 변형을 모색하고 있다.

1부의 마지막 순서는 스페인, 독일 작곡가 호르헤 가르시아 델 발레 멘데스Jorge García del Valle Méndez의 《석양종seok yang jong(The Bell of Twilight)》이었다. 작곡가는 종 소리에 대한 선택에 대해 다음과 같이 설명한다. "황홀하면서도 깊은 이 종소리들은 시적인 이론들을 현실로 바꾸었다. 나는 낮고 안정적인 특징 때문에 이 종소리들을 선택하게 되었다." 녹음된 종 소리들은 프로그램을 통해 분석되었으며 각 배음의 주파수들이 계산되어 음악적인 재료들로 사용될 음높이로 바뀌어졌다. 음악적인 재료들은 종의 최초 종이 갖는 엔벨롭과 유사한 조그만 웨이브에서 조직되고 이러한 요소들은 발진 형태 (다양한 톤들의 트레몰로와 선택적인 반복)와 진동형태 (한가지 톤의 트레몰로), 그리고 몇 가지 글리산도(활의 압력과 마찰 지점을 변화시켜 구현한 글리산도)를 구성한다. 이러한 재료들의 변화는 서로 다른 음향을 가지는 여러 개의 작은 섹션들을 구분짓게 만든다. 전자음향은 종소리의 샘플들로 만들어졌고 이것은 다시 이르캄IRCAM의 오디오스컬프트AudioSculpt와 다이폰Diphone, 맥스엠에스피MaxMSP의 그래뉼러 합성Granular Synthesis과 공간화Spat를 통해서 변조되었다.

2부 첫 곡으로는 한국 작곡가 이돈응의 플루트, 클라리넷, 바이올린, 첼로, 타악기, 실시간 전자 프로세싱real-time electronic processing을 위한 《사운드 트레일Sound Trail》이었다. 몽환적 느낌의 곡 제목은 연주자들이 연주한 소리의 흔적을 이어지는 연주 소리로 추적하여 실시간 변조시키며 곡을 만들어 가는 것을 의미한다. 다섯 연주자가 연주하는 소리는 실시간으로 분석되어 변조된다. 변조된 소리가 연주장에 울려 퍼지는 동시에 분석된 데이터의 일부가 현재 울리고 있는 소리를 선택적으로 다시 변조하여 소리를 합성하는 과정을 거치면서 곡이 진행된다. 전자음악의 리버브와 보코더 이펙터는 동굴 속 자욱한 안개를 연상시킨다. 불규칙적으로 반복되는 포르테의 짧은 뚜띠 액센트는 전반적으로 조용하고 느린 악기들의 움직임들과 대조를 이루며 긴장감을 더해 준다. 보코더는 앙상블과 더불어 색다른 음향 효과를 주는데, 이를 위해 독일 프라이부르크Freiburg에 소재하고 있는 실험 스튜디오Experimental Studio의 48개의 2도 필터로 만들어진 보코더Vocoder를 맥스엠에스피MaxMSP로 프로그래밍하여 사용하였다.

다음 순서는 오스트리아 작곡가 올가 노이비르트Olga Neuwirth의 《낯설게 하기 / 소외시키기Verfremdung / Entfremdung》이었다. 곡의 시작은 플루트의 작은 바람 소리로 시작되는데 바로 다음에 나오는 테잎은 마지막까지 이 소리를 배경으로 계속 유지하고 있다. 여섯 개의 테잎 채널은 소리 공간을 만들고 이들은 라이브 악기와 상호작용하며 여러 방식으로 결합된다. 어쿠스틱과 전자음악의 교차는 제목의 뜻과 잘 어울리는데, 이 곡에서 두 소리는 상호 보완적 관계지만 서로를 낯설게 만들고 소외시키는 결과를 낳는다. 플루트와 피아노의 반복되는 리듬 형태는 중간 중간 갑자기 멈추는데, 그 적막 속에서 전자음이 서서히 존재감을 드러낸다. 테잎은 전반적으로 녹음된 어쿠스틱 사운드 위주로 편집되었고 전자음은 사인파들을 합성하여 사용하였다. 어쿠스틱과 전자음의 조화와 대비가 인상적인 작품이다.

마지막 순서로는 독일 작곡가 롤란드 브라이텐펠트Roland Breitenfeld의 플루트, 오보에, 클라리넷, 바순, 피아노, 타악기, 바이올린, 첼로, 전자음악을 위한 《사건들V Ereignisse V》이었다. 앙상블 아방튀르를 위해 작곡된 이 곡은 작곡가의 연작 《사건들Ereignisse》 중 다섯 번째 작품이다. 전체 여덟 곡으로 계획된 이 연작은 일종의 '위성 작품'의 성격을 띄는데, 《사건들I》로부터 다른 작품들이 독립되어 나오기도 하고 건반악기가 중심에 놓이는 특징은 《사건들I》에서 처럼 《사건들V》에서도 마찬가지여서, 피아노가 어느 정도 독주적인 무게를 갖기도 한다. 이 곡은 피아노 현 위에 탁구공을 떨어뜨리며 시작되는데, 현 두드리는 소리가 테잎으로 이어져 계속해서 반복되어 나오고 그 위로 다양한 선율이 앙상블 전체로 퍼져 나갔다. 피아노는 전체 음색 변화를 위한 중심 악기인데, 탁구공의 현 두드리는 소리(운동폭이 서서히 작아지면서 빠르게 두드리는)에서 현을 문지르는 소리로 이어지고 긁는 소리(피아노 현에 감긴 코일)로 이어진다. 더불어 다른 악기들에서도 음색 변화가 일어나는데, 관악기에서는 플라터 텅잉flutter-tonguing, 텅램tongue ram,

키클릭keyclick으로 현악기에서는 피치카토, 트레몰로, 콜레뇨 바투토col legno battuto로 나타난다. 테잎과 실시간 변조도 앙상블의 음색 변화 속에서 유사진행한다.

앞으로 서울국제컴퓨터음악제가 내용면에서도 더욱 발전되기를 희망한다. 앞으로 계속 좋은 작품들을 소개하고 알려주는 한국전자음악의 메카가 되기를 기대해 본다. 마지막으로 좋은 작품을 창작한 작곡가, 수고해 주신 연주자들, 모든 연주회의 스태프를 맡아 원활한 연주의 진행을 도와주신 분들과 음악제 기획과 운영을 위해 수고해 주신 한국전자음악협회 관계자 분들께 감사와 존경을 보낸다. 다음 해에도 계속될 2015년 서울국제컴퓨터음악제를 기대해 본다.

New Life into a Can Music:
Festival Futura 2014

Cho, Jinok

Every summer, Crest, a small town in the Southeast France, has a special festival. It presents electroacoustic compositions based on 'Acousmonium' that consists of a hundred of loudspeakers and controllers distributed in a large barn with a high ceiling. This year, more than fifty compositions were played through over twenty concerts for four days and three nights of August 21 to 24, 2014. The acousmonium system is built by linking a various kinds of speakers including popular-brand studio monitors, old and crude hi-fi ones, and seemingly personal megaphones, which impressed me with multifariously colorful sonorities. The speakers are placed closely one another and not too far from the stage for keeping the auditory space. By controlling all positions, directions, and intensities of sound, they realize the three-dimentional sound in the truest sense of the term. Such a music called tape music or fixed-media music is often despised as a dead music or a tin can for its extremely limited affordability. However, it would take back life by a creative spatialization as shown in *Festival Futura 2014.*

깡통 음악에 새 생명을:
포투라 음악제 2014 참관기

조진옥

전자음악Electro-acoustic Music의 여러 연주 형태 가운데 테잎 음악tape music 또는 고정매체음악fixed-media music으로 불리워지는 음악들은 그 음악적 결과물이 청중에게 전달되는 과정에서 변형되거나 변화될 여지가 극도로 제한되어 있는 까닭에, 음악계 일부에서 죽은 음악 또는 깡통 음악이라는 비난을 받는 경우가 종종 있어 왔다. 하지만, 미리 녹음되어 재생되는 이러한 음악이 '공간감 창조spatialization'에 집중하고 이를 추구하는 경우 전혀 다른 의미를 갖게 된다. 음악사를 살펴보면 '나뉘어진 합창단'이라는 뜻의 르네상스 후기 베네치아 다중합창 양식Venetian polychoral style의 《분리된 합창단Cori Spezzati》에서부터, 네 개의 동일한 편성 앙상블을 각각 다른 위치에 나누어 배치한 크세나키스Iannis Xenakis의 《몬트리올의 다면체Polytope de Montréal》(1967)까지 재생 또는 연주되는 소리의 위치를 제어하여 특별한 공간감을 창조하고자 시도한 예는 무척 많다. 그 중에서도 전자음악의 경우, 여러 대의 스피커를 한정된 공간 안에 배치하고 각 스피커에 재생되는 소리를 정교하게 제어해서 공간감을 더욱 적극적으로 만들고자 한 예를 쉽게 찾아볼 수 있다. 칼하인즈 슈톡하우젠Karlheinz Stockhausen은 1956년 작품 《젊은이의 노래Gesang der Jünglinge》에서 네 개의 스피커로 청중을 둘러싸고 한 개의 스피커를 청중 머리 위에 매달아 배치하고자 했으며, 에드가 바레즈Edgar Varèse는 1958년 작품 《전자 시Poème Électronique》에서 사백 여 개의 스피커를 브뤼셀 세계박람회 필립스관에 배치하여 사진 슬라이드, 빛과 더불어 입체적인 음향을 선보인 바 있다. 이러한 시도들은 여러 전통있는 연구소 또는 스튜디오로 이어져 그들만의 특색있는 멀티채널 사운드 시스템을 개발하는데, 1970년대 영국의 마이클 거존Michael Gerzon과 피터 펠게트Peter Fellgett가 개발한 '앰비소닉스AmbisonicS,' 1973년 프랑스 부르즈Bourges의 실험음

악팀Groupe de Musique Expérimentale에 의해 개발된 지메바폰(사이버네폰)Gmebaphone(Cybernéphone), 파리음악연구팀Paris Groupe de Recherches Musicales의 '아쿠스모니움Acousmonium'(1974), 영국 버밍엄 대학교의 '비스트BEAST'(1982)가 그 대표적인 예들이다.

이들 사운드 시스템 중 '아쿠스모니움'이 만들어내는 소리 공간을 체험할 기회가 있어 프랑스 남동부의 작은 도시 크레Crest(Drôme)에 다녀왔다. 이 곳에서는 매년 여름 널찍하고 천장이 제법 높은 헛간에다가 백 여 개의 스피커와 컨트롤러 등으로 구성된 '아쿠스모니움'을 설치하고 이를 이용하여 전자음악을 연주하는 음악축제가 열린다.

2014년 음악제는 8월 21일에서 23일까지 (23일 마지막 콘서트는 다음 날 아침까지 이어진다) 크레에 위치한 에스파스 소베이랑Espace Soubeyran에서 개최되었으며, 밤과 낮은 물론 아침까지 가리지 않으며 스무 개의 연주회가 열렸고, 오십 여 명 이상의 작곡가 작품이 연주되었다. 먼저 설치된 시스템을 면밀히 살펴보았는데, 우리가 흔히 접하는 대중적인 브랜드의 스튜디오 모니터에서부터 오래 전에 봤음직한 커다랗고 낡은 하이파이Hi-fi 스피커들, 공연 무대의 개인 모니터로 쓰는 모델, 메가폰이 아닌가 싶은 제품 등 실로 다양한 종류의 스피커들이 눈에 들어왔다. 이렇게 많은 종류의 스피커는 다채로운 음색을 만들어 내기 위한 필수적인 조건이 아닐 수 없다. 백 여 개의 스피커 배치를 살펴보니 청중의 공간을 따로 크게 분리하여 설계하지 않고 전체 공간을 촘촘하게 메우고 있었는데, 각 스피커의 높이 및 지향각 또한 다양하게 배치하여 소리의 방향과 높이를 모두 제어해서 진정한 의미의 3차원 입체음향을 구현하고 있었다. 각각의 작품은 해석자interprète라 불리는 연주자가 CD 등 2채널 스테레오 작품을 실시간으로 믹싱 콘솔의 페이더를 움직여 원하는 스피커를 통해 소리를 내보내는 연주 방식을 취했다. 많은 채널을 실시간으로 제어하다 보니 해석자가 여러 대가 연결된 콘솔들 앞에서 마치 춤을 추듯 몹시 바쁘게 움직이는 것을 볼 수 있었는데, 각 페이더와 스피커는 직관적으로 제어가 가능할 수 있도록 서로 매칭된 것으로 추정되었다. 이렇게 연주된 작품의 결과물은 도저히 스테레오 파일로부터 만들어진 것이라고는 믿을 수 없을 정도로 입체적이었다. 소리가 마치 생명을 가지고 있는 듯 꿈틀대며 공간을 휘젓고 다니고 여러 겹의 소리층으로 인해 다양한 밀도 및 볼륨감을 느낄 수 있었다. 이 입체적인 소리층은 일부 스피커들의 경우 밴드패스필터bandpass filter를 거친 소리만 재생하도록 장치하여 더욱 다양한 음색층을 얻을 수 있게 한 것으로 생각되었다. 청중들은 준비된 의자뿐만 아니라 설치된 스피커들을 피해 바닥의 매트에 앉아서도 음악을 감상할 수 있었다. 여기서 매우 놀라운 점은 누워서 음악을 듣는 사람들도 꽤 되었다는 것이다. 특히 무박 2일 동안 진행되는 마지막 콘서트에서는 모든 의자를 치우고 대부분의 사람들이 바닥에 앉거나 누워서 음악을 감상했는데, 아예 본인이 침대 매트리스와 이불을 준비하여 음악을 벗삼아 잠을 청하는 사람들도 있을 정도였다. 일반적인 음향 청취 공간은 정확한 소리를 들을 수 있는, 이른바 '명당sweet spot'이 매우 한정적일 수밖에 없다. 그래서 많은 수의 청중들은 작곡가의 의도와는 동떨어진 왜곡된 소리를 듣게 된다. 그러나, 모든 공간을 적극적으로 활용한 이와 같은 음향 시스템(아쿠스모니움) 안의 청중은 본인의 청취 위치마다 각각 다른 매력의 독특한 소리 경험을 할 수 있다. 명당이 따로 존재하지 않는 것이다. 또 한 가지 인상적이었던 점은 백 여 대의 스피커는 큰 소리를 내기 위해 남용하지 않는다는 것이다. 해석자는 본인이 연주하는 곡을 정교하게 분석하고 계획한 대로 연주하기 위해 시스템을 능수능란하게 다루고 있다는 생각이 들었으며, 결코 크고 자극적인 소리를 연출하고자 시스템 자원을 과도하게 사용하지 않는다는 인상이 들었다.

3박 4일 동안 경험한 아쿠스모니움은 황홀했다라는 표현이 부족할 정도로 몹시 인상 깊었다. CD 안에 담긴 그 음악들을 누가 깡통이라고 비웃었는가? 해석자와 아쿠스모니움을 통해 새 생명을 얻은 음악들은 '듣는 행위'가 얼마나 즐거운 일인지 새삼스레 느끼게 해주었다. 아울러, 이 즐거운 경험을 더 많은 사람들과 함께 하고 싶다는 욕구가 들게했다. 한 해에 한 번 들을 수 있는 서울컴퓨터음악제의 8채널 사운드 시스템은 그 갈증을 해소하기에는 아쉬움이 진하게 남는다. 앞으로, 대한민국에 스피커관현악단loudspeaker orchestra을 좋아하고 연구하고 시도하는 음악가들이 많아져서 멀지 않은 미래에 해갈의 기쁨을 맛보길 고대한다.

CALL FOR WORKS / Seoul International Computer Music Festival 2015

The Korean Electro-Acoustic Music Society is proud to announce the Seoul International Computer Music Festival (SICMF) 2015. SICMF 2015 will be held from September 30 to October 3 at Jayu Theater in Seoul Arts Center.

CATEGORIES

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

RULES & REGULATIONS

1. The submitted work has to be composed after 2011.
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 5.
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.

SUBMISSION DEADLINE (ONLINE)

Thursday, 2 February 2015, 6 pm (UTC+9)

HOW TO SUBMIT

* We recommend that you use your own file server or web services such as dropbox.com and wetransfer.com to send the required information to us via email (festival@keams.org) instead of using the webhard service described below.

1. Only online submissions are allowed.
   - Connect to this site: http://www.webhard.net/
   - Login as ID: computermusic / password: guest
   - Click the "Upload Only" folder to open it
   - Create a folder with your name eg. DoeJohn

2. Upload your work as follows:
   - Audio files must be stereo mp3.
   - For the category #2 and #3: Upload mp3 file and/or related files(patches, documents, programs, etc.)
   - For the category #2: You must upload the score(PDF)
   - For the category #4: Upload the video file in any format (mpeg, mov, avi, etc.). Size of the file should, however, not be bigger than 200MB.

3. Upload a document file (format can be TEXT, RTF, PDF, or DOC) that includes the following information:
   - Name
   - Gender
   - Nationality
   - Email
   - Mailing Address
   - Homepage (if any)
   - Title
   - Duration
   - Category
   - Instruments (if any)
   - Number of Audio Output Channels
   - Program Notes
   - Profile
   - Special Requirements for the Performance (if any)

4. Additional Notes
   - The uploaded files can only be downloaded by the administrator. So, please do not worry about illegal downloads of your work.
   - It is not possible to delete or modify uploaded files. If you need to modify anything please go through the upload process with a different name.
   - The uploaded files will be deleted from the site within a few days after your submission process is completed.
   - If you wish to submit offline, please contact us via email as early as possible.
   - You may use your own file server or web services such as dropbox.com and wetransfer.com instead of using the webhard mentioned above.

SUPPORT POLICY

1. We agree to pay all costs for performing selected works (performer fees, instrument rental, etc).
2. We offer lodging cost during the festival for the composers of the selected works.
3. In case a composer needs bring his/her own performer(s) for specific reasons, we agree to also offer lodging cost for the performer(s).

* This policy may be subject to change.

FOR FURTHER INFORMATION

festival@keams.org

http://www.computermusic.or.kr

서울국제컴퓨터음악제 2015 작품 공모

한국전자음악협회는 서울국제컴퓨터음악제 2015에 연주될 작품들을 공모합니다.
서울국제컴퓨터음악제 2015는 9월 30일(수)부터 10월 3일(토)까지 열릴 예정입니다.

공모 분야

1. 테이프 음악
2. 악기(5명이내)와 전자음악 (테이프 혹은 라이브)
3. 라이브 전자음악
4. 오디오-비주얼 미디어 작품

공모 규정

1. 작품은 2011년 이후 작곡된 것이어야 함
2. 작품의 길이는 12분 이내여야 함
3. 악기를 동반한 전자음악일 경우 연주자는 5명 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 공모 분야의 작품이어야 함

공모 접수 마감 (온라인)

2015년 2월 2일 (월) 오후6시 (서울 시각, UTC+9)

접수 방법

1. 접수는 온라인 접수만 가능함
   - 웹하드(http://www.webhard.co.kr/)에 접속
     아이디: computermusic / 비밀번호: guest
     '올리기 전용' 폴더에 자신의 이름으로 폴더를 만든 후 아래와 같은 파일 업로드

2. 작품 파일 업로드
   - 오디오 파일은 반드시 mp3, 스테레오 버전으로 올릴 것
   - 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 mpeg, mov, avi 등의 포맷으로 올리되, 전체 용량이 200MB를 넘지 않게 할 것

3. 다음 정보를 담은 문서 파일 업로드
   (포맷: TEXT, RTF, PDF, DOC, HWP 중 택일)
   - 성명
   - 성별
   - 국적
   - 전화 (휴대전화)
   - 이메일
   - 홈페이지 (있을 경우)
   - 작품 제목
   - 작품 길이
   - 공모 분야
   - 악기 (있을 경우)
   - 오디오 아웃풋 채널 수
   - 프로그램 노트
   - 프로필
   - 연주 시 특별히 필요한 요구 사항 (있을 경우)

4. 기타 사항
   - 올려진 파일은 다른 사람이 절대 다운로드할 수 없으니 안심하세요.
   - 올려진 파일은 수정하거나 지울 수 없습니다. 파일을 다시 업로드해야 할 필요가 있다면, 다른 이름으로 다시 올려 주시기 바랍니다.
   - 올려진 파일은 접수가 완료된 후 며칠 안에 웹하드에서 삭제됩니다.
   - 온라인 제출이 불가능할 경우 이메일로 문의 바랍니다.
   - 웹하드 대신, 대용량 첨부 파일이 가능한 이메일이나 dropbox.com, wetransfer.com 등의 서비스를 이용하여 제출하여도 무방합니다.

지원정책

1. 당선된 작품의 연주에 필요한 비용(연주자 사례비, 악기 렌탈비 등)은 본 회가 지불합니다.
2. 공모에 당선된 해외 거주 작곡자가 한국에 방문하는 경우, 음악제 기간 동안 숙박 비용을 지불합니다.
3. 특별한 이유로 작곡자가 연주자를 대동하는 경우 연주자의 숙박 비용 또한 지불합니다.

* 이 정책은 본 회의 사정에 따라 변경될 수 있습니다.

문의 및 기타 정보

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

fest-m 2015 작품공모

fest-m은 젊고 개성있는 작곡가들의 컴퓨터 음악이 공연되는 축제입니다. fest-m은 한국전자음악협회가 주최하고 (주)미디랜드가 후원해오고 있으며 매년 공모를 통해 선정된 작품이 연주됩니다. 올해에도 젊은 작곡가 여러분들의 많은 응모 바랍니다.
fest-m 2015는 5월에 열릴 예정입니다.

응모 작품 분야

1. 테이프 음악
2. 라이브 전자 음악 (인성 혹은 악기와 전자 음악)
3. 오디오-비주얼 작품

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

2015년 3월 6일(금) 오후 4시 (당일 우체국 소인 우편물은 유효합니다.)

보낼 곳

서울특별시 성동구 행당동 17번지 한양대학교 1층 전자음악조교실 Tel. 02-2220-1709

응모 규정 및 참고 사항

1. 1980년 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 3월 17일(월) 한국전자음악협회 홈페이지(http://www.keams.org)에 공지됩니다.
6. 공연당일 실연 심사를 통해 공연의 최우수작은 ‘서울국제컴퓨터음악제 2015’에 초대될 수 있습니다.

더 자세한 문의 master@keams.org

Call for Proposals

The Korean Electro-Acoustic Music Society (KEAMS) is pleased to announce a call for proposals for the 2015 KEAMS annual Conference and its journal *Emille*. KEAMS was formed to promote active research and discussion on electro-acoustic and computer music, and will hold the next year's conference during the Seoul International Computer Music Festival (SICMF 2015: http://www.computermusic.or.kr/) from September 30 to October 3, 2015. Selected papers from the conference will be published in *Emille* Vol. 13 (December, 2015). If you want your paper or workshop idea to be considered for the 2015 KEAMS Conference, please send an abstract or proposal (maximum of 2,000-characters including spaces) and curriculum vitae as PDF documents to <emille@keams.org>.

Conference Language

English

Categories of Topics

For the KEAMS conference, the following topics are encouraged, but are not limited to:

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

Important Dates

- Deadline for Proposal Submission: February 5, 2015 (Korean Standard Time, UTC+9)
- Notification of Acceptance of the Proposal: March 1, 2015 (Korean Standard Time, UTC+9)
- Deadline for Paper Submission before Conference: August 31, 2015 (Korean Standard Time, UTC+9)
- Conference: September 30 - October 3, 2015 (Korean Standard Time, UTC+9)
- Notification of Selected Paper for the Journal Emille: October 15, 2015 (Korean Standard Time, UTC+9)
- Deadline for Final Paper Submission: November 10, 2015 (Korean Standard Time, UTC+9)

SESSION FORMATS

Each session will consist of up to four presentations. Each paper will be presented in person for about 25 minutes followed by ca. 5 minutes of discussion. If you want to give a keynote presentation, you will be given about 50 minutes to present, followed by ca. 10 minutes of discussion. Please include the word *keynote* in your submission if you are planning on applying for a keynote presentation. The length of each workshop will be about 90 minutes. *Video conferencing over the Internet is also available.*

As demonstrated by the following examples, participants may submit more than two proposals, making a whole presentation session or an additional workshop session:

Example 1: *Presentation Session Plan* *

Session	***Sample topic: Spatialization*** *(4 x 30 min. = 25 min. presentation + 5 min. Q&A)*
Presentation 1	*Spatialization methods using less than 8 channels*
Presentation 2	*An overview of the design of a Loudspeaker Orchestra*
Presentation 3	*Applications of Ambisonics and Spherical Acoustics*
Presentation 4	*A proposal of multi-3D audio reproduction system for the multi-functional concert hall*

* *You may submit several proposals without a session plan.*

Example 2: *Workshop Session Plan* **

Session	***Sample topic: Using controllers for composition and acoustic installations*** *(3 X 90 min.)*
Workshop 1	*Controllers using various sensors and Arduino*
Workshop 2	*Use of Smartphones and Tablet PCs as controllers*
Workshop 3	*Inter-application uses of Controllers* *(Using Processing to Control Csound, MaxMSP, PD and SuperCollider)*

** *You may submit a single proposal for a workshop. You also may submit multiple proposals for individual workshops without a session plan.*

Fees

Thanks to funding from the Korean Arts Council, the registration fee and publication fee will be waived.

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.

Your ideas are critical in making an enriching, important and substantial conference and *Emille*. We look forward to reviewing everyone's entry.

2015년 한국전자음악협회 학술대회 및 컴퓨터음악저널 에밀레 원고 공모

한국전자음악협회는 해마다 학술대회를 개최하는 것과 병행하여 <컴퓨터음악저널 에밀레>를 발행함으로써 전자음악에 관련된 다양한 연구 발표의 장을 마련하고 컴퓨터 음악의 저변 확대를 꾀하고 있습니다. 2015년 학술대회는 9월 30일부터 10월 3일에 열릴 2015 서울국제컴퓨터음악제(Seoul International Computer Music Festival 2015, SICMF 2015: http://www.computermusic.or.kr/)와 때를 같이 하여 열릴 예정이며, 이때 좋은 반응을 얻은 연구 결과들을 중심으로 2015년 12월에 <컴퓨터음악저널 에밀레> 제13호를 발간할 예정입니다. 관심 있으신 분들은 공백을 포함하여 2000자(음절) 이내로 된 제목과 계획안을 PDF로 작성하여 약력과 함께 <emille@keams.org>로 보내주십시오.

학술대회 언어

영어

주제 분류

한국전자음악협회는 다음과 같은 다양한 분야의 연구물에 귀를 기울이고 있습니다:

a) 음악과 과학의 창조적인 만남
b) 학제간 연구 (따라서 여러 저자의 공동 연구물도 포함됨)
c) 체계적 음악학 (전산 처리를 기반으로 하는 음악학, 음악 이론)
d) 전자 음악 및 컴퓨터음악 작품의 분석
e) 음색 합성법
f) 음악 심리학
g) 악기론
h) 전자적 수단을 통한 새로운 악기의 개발
i) 음악 소프트웨어 공학
j) 음악 인공지능
k) 컴퓨터의 도움을 받는 작곡 및 분석
l) 자동 작곡
m) 미학 등.

주요 일정

- 계획안 제출 마감일:	2015년 2월 5일
- 계획안 승인 통보일:	2015년 3월 1일
- 학술대회 이전 원고 제출 마감일:	2015년 8월 31일
- 학술대회:	2015년 9월 30일 - 10월 3일
- 논문 게재 여부 통보일:	2015년 10월 15일
- 최종 원고 마감일:	2015년 11월 10일

세션 구성

하나의 세션은 1-4개 정도의 발표로 구성될 수 있습니다. 개별 발표 시간은 약 25분이며 약 5분간 질의 응답 시간이 뒤따릅니다. 키노트 발표자에게는 약 50분의 발표 시간과 약 10분의 질의 응답 시간이 주어집니다. 키노트 발표를 원하시는 분들은 계획안을 제출할 때 키노트를 희망한다고 명시하십시오. 워크숍은 대략 90분이 주어집니다. 인터넷 화상 채팅을 이용한 발표도 가능합니다.

다음의 예와 같이 두 개 이상의 원고 계획안들을 묶어 하나의 세션에 대한 계획안을 제출하거나, 워크숍 성격의 계획안을 제출하는 것도 가능합니다:

유형 1: 세션 계획안*

Session	**Spatialisation** (4 X 30분 = 25분 발표 + 5분 질문)
Presentation 1	8채널 이하에서의 방법들에 대한 고찰
Presentation 2	Loudspeaker Orchestra의 활용 예에 대한 고찰
Presentation 3	Ambisonics와 Spherical Acoustics의 활용 예에 대한 고찰
Presentation 4	여러 형태의 3차원 오디오 재생 시스템이 가능한 유동적인 연주회장 마련의 기획안

* Session에 대한 계획 없이 여러 개의 원고 계획안들을 제출할 수 있습니다.

유형 2: 워크 성격의 세션 계획안**

Session	**작곡 및 음향 설치에 필요한 개별화된 Controller를 만드는 다양한 방법들** (3 X 90분)
Workshop 1	다양한 Sensor들과 Arduino를 이용한 Controller
Workshop 2	Smartphone과 Tablet PC를 Controller로 이용하기
Workshop 3	Interapplicational Controller (Processing에서 MaxMSP와 SuperCollider, PD, Csound를 제어하기)

** 세션이 아닌 하나의 워크숍에 대한 계획안도 가능합니다. 세션에 대한 계획 없이 여러 개의 워크숍 계획안들을 제출할 수 있습니다.

참가비

이 사업들은 한국문화예술위원회(ARKO)의 지원으로 이루어지며 참가비와 원고 게재료가 없습니다.

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 만듭니다. 많은 응모 바랍니다.