Portfolio of Compositions

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Contents

Written Commentary

List of Tables and Figures

Portfolio of Musical Works and USB Content

1. Tints of July (2011) ……………………………………………… ca. 10’00”
    - Score
    - Audio (stereo, 16bit/44.1k)
    - Max/MSP patch
    - Instruction for Max/MSP (movie)
    - Video (performance)
2. Translucency I (2013) …..…………………………….…..…. ca. 8’00”
    - Score
    - Audio (stereo, 16bit/44.1k)
    - Max/MSP patch
    - Video (performance)
3. Translucency II (2013-14) ……………………………………… ca. 16’00”
    - Score
    - Video (stereo, 16bit/44.1k)
    - Max/MSP and DIPS patches
    - Demonstration for performance (movie)
4. Miriam (2011) ……………………………………………….....… 5’45”
    - Score (paper-based)
    - Audio (8-channel, 24bit/48k)
    - Max/MSP patch (dynamic score and audio materials)
    - Demonstration for performance (movie)
5. Myth (I: Aquelarre, II: Textile) (2012-2014) …………………… ca. 20’22”
    - Score
    - Audio (I-II: stereo, 16bit/44.1k, II: stereo, 24bit/48k)
    - Video (performance)
6. FRISKOTO (2014) ……………………………………………… ca. 10’00”
    - Score
    - Audio (4-channel, 16bit/44.1k)
    - Max/MSP patch
    - Instructions for Max/MSP
    - Video (performance)

Abstract

This PhD portfolio focuses on research across interactive computer music composition and live performance involving instrumental players and instrumental sounds. It examines methods of disjoining original connections between performers' actions, the instrument as sound sources, and musical outcomes, and also methods of reconstructing new connections between them via electronic intermediation. At the same time, the portfolio of creative works presented in this study proposes multiple performing styles and explores innovative electroacoustic music as well as its context.

Through this portfolio, the composer invites readers to her original sound world and individual musical concepts, which are informed by visually-related ideas such as imaginary views, colours, scenes of a story, and art paintings, alongside their associated titles.

Declaration

I hereby declare that no portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

Copyright Statement

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Finally, a special thank you to my family for encouragement.

Chapter 1. Introduction

1.1 Research Objective

This portfolio includes a collection of six interlinked compositions making use of various media and instrumentation, to explore the potential offered by electroacoustic composition in the context of interactive computer music and media. This research mainly deals with interactive computer music systems, but also includes a composition that consists of acoustic instruments only and fixed media. This provides a framework for comparison of performance styles across different compositions and media.

In order to discuss the definition of interactive music widely and in depth, this portfolio contains interactive computer music compositions with several different configurations (Table 1). This is closely related to the main research focus as explained below.

Title		Insturmentation	Control Device	Electronics	Number of Channels	Computer Software	Score
Tints of July		Flute, guitar, live electronics	———	Real-time audio signal processing [1]	2	Max/MSP	Conventional
Translucency I		Bass clarinet, live electronics	Foot pedal	Real-time audio signal processing, fixed media playback	2	Max/MSP	Conventional
Translucency II		Fixed media, live image processing	Computer keyboard	Live image processing with fixed sound source	2	Max/MSP, DIPS	Gesture-based notation
Miriam		Piano, electronics	Foot pedal or computer keyboard	Fixed media playback	8	Max/MSP, Jitter for score	Conventional, embedded in a patch
Myth	I	Flute, bassoon, accordion, percussion, cello	———	———	———	———	Conventional
	II	Fixed media	———	Fixed media	2	Pro Tools, GRM tools, Max/MSP, others	———
FRISKOTO		Fixed media, live electronics	Leap Motion (sensor)	Real-time audio signal processing with fixed sound source	4	Max/MSP, GECO, Jitter for score	Graphical, gesture-based notation, embedded in a patch

Table 1: A comparative table of six compositions

The main focus of this research is to study various methods of intermediation of electronics in the performance of instrumental music when composing interactive computer music: it examines how to disjoin the original connections between performers' actions, the musical instruments as sound sources, and the final musical output, which will be commonly observable from the audience point of view as one-to-one-to-one direct correspondence in the case of (acoustic) instrumental music. At the same time, it observes how to reconstruct their relations with fresh modes of connectivity, which will not necessarily be in one-to-one-to-one correspondence[2]. As a consequence, the portfolio introduces a novel discussion across interactive computer music systems and their framework.

This research also addresses the related questions below:

- What kind of electronic technology and techniques can cause what sort of disjunction

[1] The analogue data (instruments' sound) is converted to digital signal data (Analogue to Digital conversion) so that the computer can alter the original properties of the sound. Then it is re-converted to analogue sound (Digital to Analogue conversion) in order to be heard. Processing of digitized signals is called Digital Signal Processing (DSP).

[2] *cf.* Chapter 2.1.

in the inherent relationships between instrumentalists, musical instruments (sound sources) and sonic outcomes? Also, how is it possible to reintegrate the disjoined materials as new interactive compositions?

- Can the procurement of new connectivity among performers, instruments, and outcomes affect the style of performance?
- Is it possible to enrich the audience's experience of interactive music creation by designing strategies to construct new connections between performers' gestures, instruments' sound worlds, and musical outcomes? Can the design of the connections between them (on the time axis) contribute to control of perception of time by audiences?

Conceptually, musical pieces in this portfolio aim to realise the composer's original sound world, which is informed by a wide range of visual stimuli such as imaginary views, colours, scenes of a story, or paintings, as well as the associated titles of a number of art works. Therefore, various compositions deal with the potential of converting images and visuals into musical representations. For example, in *Translucency I* and *II,* the same concept is explored aurally and visually. Similarly, *Myth* investigates the same theme across different compositional media, whilst sharing aural materials.

1.2 Methodology and Aims

My starting point when creating compositions is the analysis of the characteristic attributes of each instrument (*e.g.* timbres, envelopes and even the shape of instrument) and their possible performing idioms[3], since they demonstrate the fundamental links between performers' actions, instruments and sound (*e.g.* the flute and guitar in *Tints of July*). Then, with the assistance of electronic intermediation, diverse techniques to separate those organic elements have been experimented with. The exploration of methods to interconnect performers, sound sources and musical outcomes through the incorporation of freshly-designed links is an important issue investigated in this portfolio. More specifically, I study this in the context of interactive computer music which often requires a different listening attitude compared to instrumental music and fixed media composition[4]. Disjoining fundamental connections and rejoining them as part of the focus of the portfolio

[3] Hirayama (2014)
[4] *cf.* Chapter 2.1.

represents key artistic and compositional concepts for this author. Thus, it is also essential for me that interactive computer music systems help the audience to perceive these reintegrated connections. For instance, which elements of the instrumental performance (inherent to the acoustic medium) have been transformed by the electronics in which way and to what extent. Conversely, when designing fresh connectivity, my preoccupation as a composer is to consider how precisely the work is performed, as well as how clearly it is perceived by the audience. Hence, it is plausible to provide listeners and the audience with contrasting musical dialogues and processes to broaden and enrich their listening experience, involving the perception of aural and visual information, which is one of the composer’s aims in this research.

Whilst various performing styles are demonstrated in each composition of the portfolio, this research also aims to redefine the role of human performance. Therefore, to explore its nature not only interactive computer music, but also other media of music are contained: *Myth* consists of two sections with different medium. The first section, *Myth I* involves the use of instruments in an ensemble, and its performance relies completely on human interaction. The second section, *Myth II* is a fixed-media part which does not include any of human interaction (in the context of live sound generation or human-human communication in performance). By comparing these bipolar works with interactive works it is anticipated that different meanings of the act of performance in different musical media become more apparent.

On the other hand, a piece of 100% free improvisation was intentionally not included in the portfolio, because although it could have explained some aspects of interactive music and taken advantage of interactive systems[5], it goes beyond the compositional boundaries of the portfolio. Compositions in the portfolio are concerned with how the composer can control their musical ideas, including the audience's perception of time through performance of each work. In fact, this point has been regarded highly when the composer constructed strategies for creating new connections between separated materials. In addition, reproducibility of pieces was also highly important to this research. However, the observation on free improvisation was partly reflected in the composition of *FRISKOTO*. This piece applies a sensor device for developing an innovative style of performance

[5] *cf.* Chapter 2.2.

improvisation, and it includes a discussion about the use of Human Computer Interfaces (HCI) and their impact on interactivity, visuals as well as audible perception. These examinations are based on another important aim of this research, which is to observe the possibilities of extending musical expression through computers and machine musicianship provided by musicians as part of explorations of methods for performance. For the purpose it looks at alternative manners of interaction between performers and materials by examining different interactive computer music systems from other works (Table 1).

1.3 Other Related Studies and Documentation

Exploring alternative methods for musical notation is a closely related issue to my research focus: according to the development of interactive music systems, new performance and music styles are proposed, which requires to extend the language and information found in rather conventional scores.

The documentation of interactive works for performance purposes is highly regarded as good performance practice by the composer. As a result, the thesis includes important materials in support to the compositions such as musical scores and detailed technical instructions including software. The former provides key information as the means for communication of the musical language between composer and performer(s). The latter includes valuable technical information for the realisation of these works (including software required and instructions); *i.e*. equipment requirements, detailed diagrams for set up, software and interface controllers, *etc*. Recordings of works (audio and video) are also included as evidence in the form of research outcomes.

Chapter 2. Interactive Music

2.1 Differences in Listening Attitudes According to Musical Media

When composing interactive music, it is always important to take on board the audience's perception of a live performance, because I feel that each compositional medium, including interactive music, requires a different listening attitude compared to any other musical media.

For example, when people listen to instrumental music, it is possible to see straight relations between performers' actions–sound source (musical instruments)–played sound. Therefore, when the audience can see that a performer plays an instrument in pizzicato, we can listen to such sound, and match it with the visual information. (In instrumental music such connectivity between them will be so ordinary that the audience may not pay attention to it.) Therefore, the relationship between the performers' actions, the sound sources, and the heard-sound are mapped as one-to-one-to-one. On the other hand, when people listen to fixed-media works, for example, in acousmatic music, the required listening attitude is also quite unique. In contrast to the music which has a performer on stage like instrumentalists, the audience for fixed media will be able to concentrate on the listening experience in greater depth and to explore aurally the sound world of concrete music further, purely and freely. That is, the audience are in the situation of being released from visual information such as the performer's actions, which can appeal to the audience's vision, and also from the origin of the sound materials by concentrating on the nature of the sound itself.

When listening to interactive computer music, we can have both visual (performers and sound sources) and aural information as found in instrumental music. However, the relations between the performer's gestures and the audible sound are not necessarily linked as a one-to-one relation, and it is also possible to be linked as one-to-many[6]. There is also a wide range of possibilities for connections: even if visual and sound materials are connected directly, the interactivity between them can be too ambiguous for the audience to notice. Therefore, when composers create interactive computer music, they can freely

[6] Keislar (2011)

design the relationships between performer's gestures, sound sources, and musical outcomes via electronic intermediation. In addition, we can also highlight the contrasts of visual connections among them. As a result, it will be possible to influence the performance attitude and the structure of musical materials.

As a consequence of the observations above, the composer addressed interactive music composition by considering the linking strategies between performers' behaviours, sound sources, and their musical outcomes. The next section describes what kind of relationships between them have been researched by the composer, including a discussion regarding the definition of interactive music.

2.2 Framework and Definitions: Interactive Computer Music Systems

In musical terms interactive music basically means that 'software interprets a live performance to affect music generated or modified by computers'[7], but the term has been often associated with different types of concepts. In this portfolio what Rowe's descriptions that 'the responsiveness of interactive systems requires them to make some interpretation of their input'[8], and 'low-level signals, such as MIDI data and audio signals, are interpreted and structured into higher-level representations'[9] are the most relevant. However, the term can also lead to different interpretations.

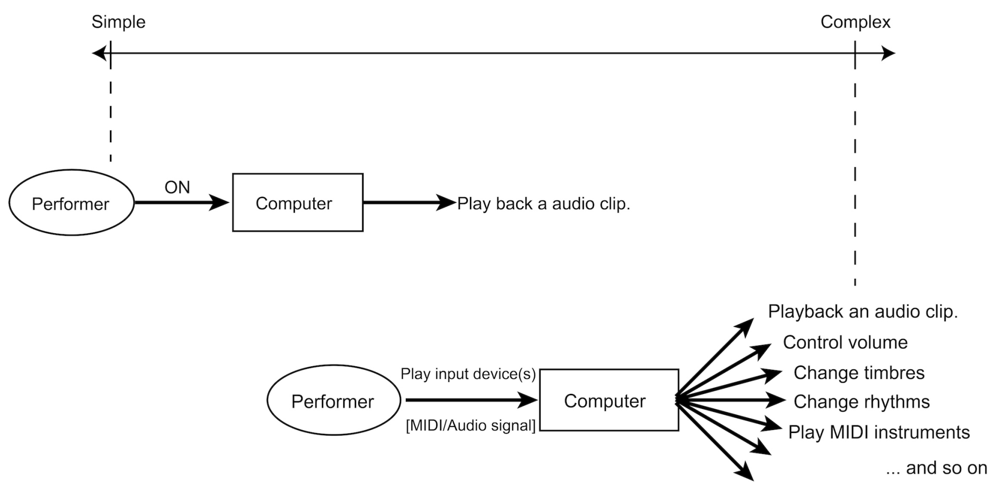


Diagram 1: An example of interactive music flow (A)

[7] Winkler (1998, p.4)
[8] Rowe (1993, p. 2)
[9] Rowe (1993, p. 3)

For example, Lippe discusses a wide range of musical perspectives on interactive music in his paper [10]. He first introduces interactive relationships from the viewpoint of the complexity of the connections between performer’s input (actions) and computer’s output (responses), referring George Lewis’s descriptions; that is, interactivity is measured by evaluating the visible/traceable relations between them (Diagram 1). This type of interaction ranges from a simple form, such as triggering[11], in which the relationship between performer's input and computer's output is easily traceable, to a complex form, where it is difficult to chase the cause when observing the performer's actions (input) because they are processed intricately, and applied in multi-directional ways via software[12]. The level of perception of such degrees of interactivity is also introduced by Rokeby: ‘Interaction transcends control, and in a successful interactive environment, direct correspondences between actions and results are not perceivable’[13].

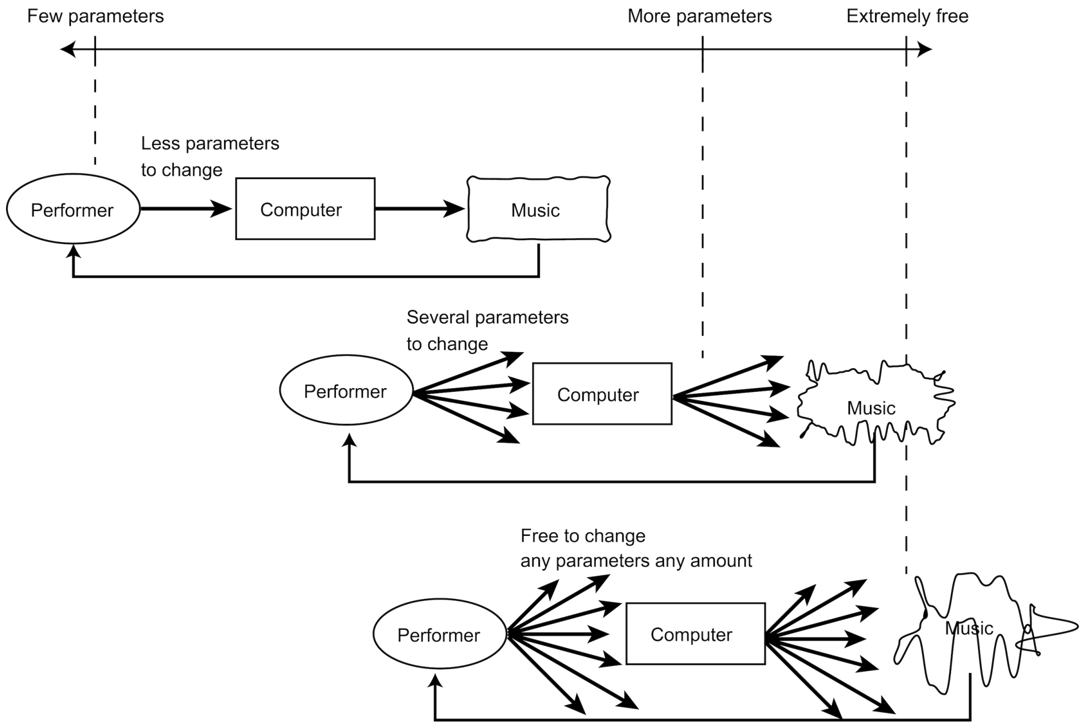


Diagram 2: An example of interactive music flow (B)

[10] Lippe (2002, pp. 1-6)
[11] George suggests that the meaning of interactive music does not merely include ‘triggering with real interaction’ and he states that ‘“triggering”, which does not involve interaction except on the most primitive level. ... Since (Euro-centric) composers often strive for control over musical structure and sound, this leads many composers to confuse triggering with real interaction.’ (Rowe *et al.*, 1992-93, cited in Lippe, 2002, p. 2)
[12] Lippe (2002, pp. 1-6) citing views of Moon, Lewis and Rowe *et al*.
[13] Rokeby continues ‘in other words, if performers feel they are in control of (or are capable of controlling) an environment, then they cannot be truly interacting, since control is not interaction.’ (Rokeby, 1997, cited in Lippe, 2002, p. 2)

Winkler, on the other hand, explains interactive computer music from the viewpoint of the flexibility of the performer's behaviour (Diagram 2). He states that there is little interaction when performers play with a fully notated predetermined score, because here, the musical parameters that the performer can control are clearly restricted. Winkler mentions that a complex interactive environment consists of a performative situation where the performer can control various parameters, so that the music can be dramatically changed by the performer's input. In an extreme example, he says that the performer is allowed to play any music freely, and that the computer system is intelligent enough to be able to give appropriate responses to such input in real time. Under this definition, interactivity is measured by the number of parameters, which a performer can control throughout the sound output of the computer. In other words, the more interactive the music is, the more improvisational a performer becomes[14]. By comparing these definitions so far, it is not straightforward to measure and define what we understand by 'interactivity'.

In this portfolio my exploration aims to include and investigate the possibilities of expression of a broad range of approaches to the definition of interactive music (Table 1). In terms of the methods developed when I construct interactive music systems, I generally think about what kind of information (*i.e.* sorts of data and characteristics of materials) the computer is listening to, and as a result, I think about what sort of interpretation and translation I can apply to the system in order to construct dialogue between materials. In addition, when designing a system, I also assign a variety of roles (performer/ conductor/ composer/ instrument) to a computer, which can often play several roles simultaneously. These roles can be dynamically shared with the performer and passed to one another.

The following is a different perspective of interactive computer music from above by Puckette. He states that it is revealed in the significance of displaying a direct and comprehensible relation between human input (controls) and sound output from the point of view of durability[15] of computer music. This concept strongly resonates with the idea of interactive music, especially in the system development that I have pursued through this

[14] When interactive music is understood from Winkler's viewpoint, I would be able to say that interactive music has high affinity to improvisational performance.
[15] The *durability* referred to here has two aspects: one is regarding the compatibility of computer soft/hard-wares in order to make the computer music playable for a long time. The other is concerned with how computer music can be included in the repertory of various performers, who are unlikely to share the same equipment with others, in a similar fashion to the other acoustic instrumental music. In other words, how can composers make computer music an established genre and make it outlive the hardware of our day? (Puckette, 1991, pp. 65-69)

portfolio. He also suggests that what-you-play-is-what-you-hear synthesis [16] (easily perceivable relations between input and output) enables the composer to observe and imitate relations between software and different types of input devices, by which reveals the whole idea of an interactive composition on a level higher than software (computer language). Such an approach is important to tackle the problem of compatibility of computer music systems which should last from the past, to the present and to the future, and it can make computer music meaningful. At the same time, performance based on close gesture sound correlation can encourage musicians to be able to personalise their sound world since it represents their actions directly. Consequently, it can urge musicians to include the interactive music in their repertory alongside traditional instrumental music[17].

In addition to agreeing with Puckette's indication, I also understand the importance of composing an interactive work which clearly reflects the relation between the performer's input and the sound output through the audience's listening experience. More specifically, in situations where the audience can grasp the computer's varying roles and tasks in relation to a performer who is playing in front of it. At the same time, I feel that the situation is even more desirable when the observation of these relationships can be an added factor to enjoy and understand an interactive work, regardless of the degree of consciousness in the perception. Therefore, one of my strategies for creating new relations between performers, instrumental sounds, and music, is to consider what kind of relationship has been made between visual and sonic elements, and how much visibility each of the connections portrays.

In this musical context I would like to introduce an interactive music system as a device that can create innovative sound worlds and create new relationships between performers, instruments, and music by exceeding all sorts of limits (inherent characteristics) found in musical instruments, their sound world and performance practices. In particular, depending on the type of electronic media and techniques employed, different methods for modifying the connectivity among them are examined. Therefore, the phenomena which are generally described as *disjoined* and *reconnected* in this research differ, depending on the methods applied.

[16] Puckette explains that the action which 'a performer pushes a button to start a sequence is not showing us how the music was really made. But if the performer's actions correspond more closely to the sounds themselves, then we can see something about the music's gestural content and our own music can be better informed by it.' (Puckette, 1991, p. 67)
[17] Puckette(1991, pp. 65-69)

More importantly, when I compose interactive music by means of designing these connections, my great concern is to control the perception of time as perceived by audiences. This idea is influenced by the concept of the *experiential time* which was proposed by Stockhausen[18].

2.3 A reflection on Live Performance with Computers

Professional music performers have sensitive ears and a critical understanding of the instrument they play so that they can clearly distinguish the subtle differences and nuances in sounds suggested by composers, thanks to their musical knowledge, instrumental techniques, and practical experience[19]. For me as a composer, musical instruments are certainly not just sound generators. When composing for instruments, I not only care about such sonic subtleties, which are produced via acute control of pitch, dynamics and timbre, but I am also thoughtful about performance practice and its possibilities for musical expression and the interpretation of my musical ideas[20]. Therefore, such interpretation which incorporated delicate differences by each performer, including articulation and phrasing, should not be ignored in interactive music also. When developing each interactive music system I have aimed to retain each performer's interpretation, personal attributes and identity. This is also important from the viewpoint of durability of computer music as Puckette indicates[21].

This research started with an interactive work for instruments and live electronics (*Tints of July*), from which the style of performance has constituted the basis for comparison with subsequent works in the portfolio. As my research progressed, the pieces involved more than just musical instruments: for instance, several devices including sensors for live computing or mixer faders for fixed media works. At the same time, changes in the role of performance and the possibilities for musical expression were also observed throughout the comparison of the meanings of performing and controlling the instrument.

[18] Stockhausen (1958, pp. 64-74)
[19] Kimura (2003, p. 295).
[20] This is why, at the same time, it is yet sceptical for me whether computers will be able to fully substitute the role of performer.
[21] *cf*. Chapter 2.2

Chapter 3. Interactive Music for Instruments and Live Electronics

Tints of July for Flute, Guitar and Live Electronics

This piece for trio with live electronics is the first work in my portfolio and it is the form of interactivity I had explored more actively before my doctoral studies. Here, interactivity is created mainly through the use of a real-time audio signal processing system[22], that is, the characteristics of instrumental sounds are transformed in real-time. In the performance the action and response of the computer to live materials, as well as the notes to be played by instrumentalists, are clearly pre-defined.

Rowe suggests that transformative usage in interactive systems produces variants of original input source (often in real-time), and its variants may or may not be recognisably related to the original[23]. In this method (real-time audio signal processing/real-time sound transformation), the *disjoined* and *reconnected* phenomena arise at almost always the same time: while a player is playing an instrument, the electronics provide a transformed sound, which is separated from the original attributes of the instrumental sound, but at the same time, new relations arise between the performer's incoming behaviour and the modified sound from the audience's viewpoint. For example, if the intermediation of electronics introduces only a simple reverb effect, we can say that the variation is not too much disjoined from the original sound attributes and the performer's gestures: we will still be able to observe great similarity between original characteristics of sound (input source) and transformed sound. On the other hand, if the electronics changes the original attributes in many ways, then we can say that it is extremely disjointed. Therefore, in this piece we can say that the more transformed the electronic variants are, the more they are separated from the original sound and performer's gestures.

[22] *c.f.* footnote 1. In my research Max/MSP, which is a graphical programming language for music and multimedia by Cycling '74, and it was originally developed by Miller Puckette, has been employed to implement.
[23] Rowe (1993, p. 7)

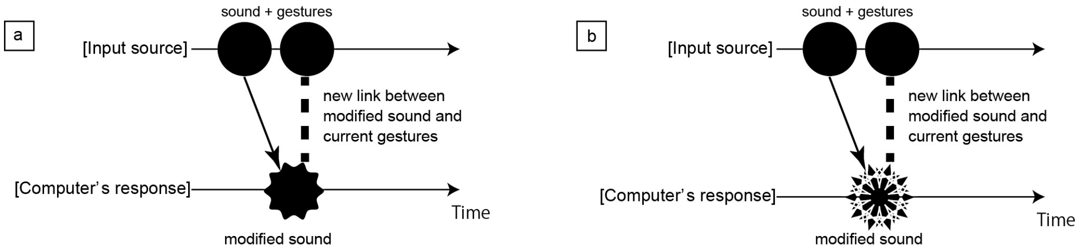
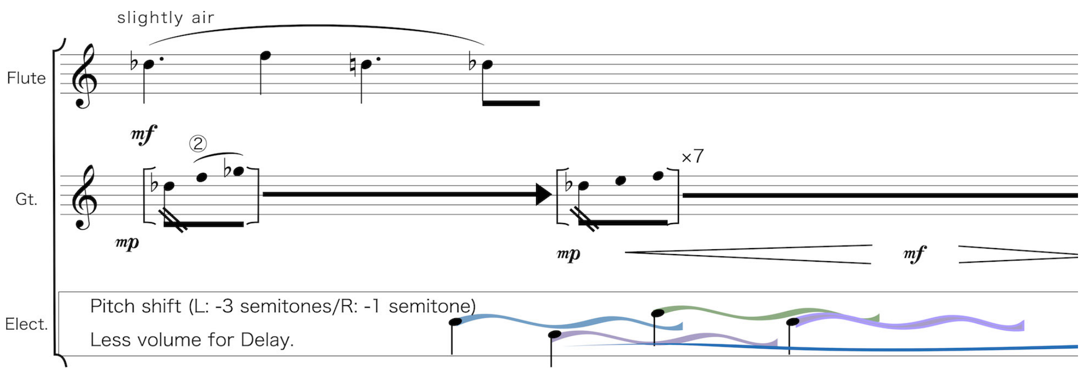


Diagram 3: The connectivity between modified sound and incoming gestures

In the process of *reconnection* in this piece, because of the effect of real-time processing, as soon as the modified sound is produced, new connections with the next current performer’s gestures will be created, and those connections can be observable by the audience, though there will be a range of degrees of difference/similarity between them (Diagram 3). Therefore, sometimes it could be very easy for the audience to find differences (gaps) between electronically modified sound and seeing performer’s gestures, and sometimes it could be difficult. As a composer, I desired to utilise such nature of live audio transformative method in the way to design the visibility of links between current electronic sound and performer’s gestures for audience. The example found in score 4 illustrates this strategy clearly: when the feedback (modified sound) is sounding, there are no playing gestures being heard anymore. That is, original performers’ gesture-linked acoustic sound as the source for feed-backed effect has been *separated* from the original attributes, and instead, the performers’ acts of *not playing* are the gestures to be (newly) linked with modified, that is the feedback sound. Conversely, by applying different sound effects continuously to the same series of gestures, it can also influence the construction of the relationships between modified sound and gestures (as seen in score 2).

Therefore, for composers it is possible to connect new gesture to the modified sound that occurs after being disjoined from the inherent characteristics in input source, and by using these techniques it can emphasize the roles and tasks of the computer. At the same time, it is also intended to draw the scenery of *Tints of July*, which is like a watercolour with changeable texture and colour of sound.



Score 1: Extract from *Tints of July* p.1 (A)

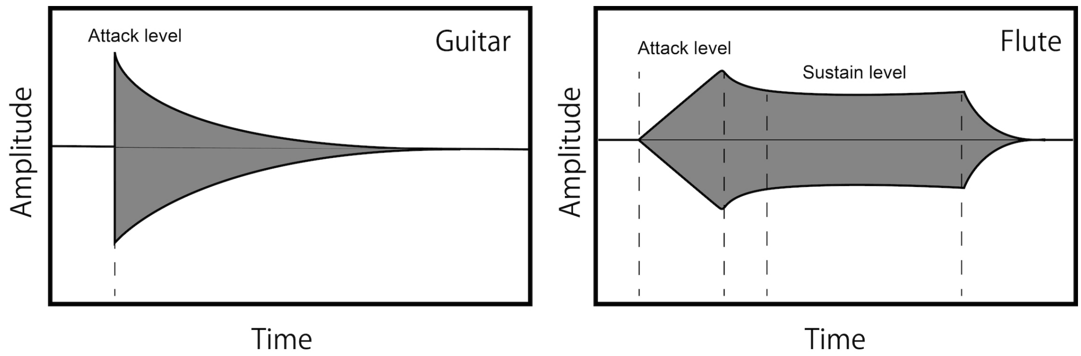
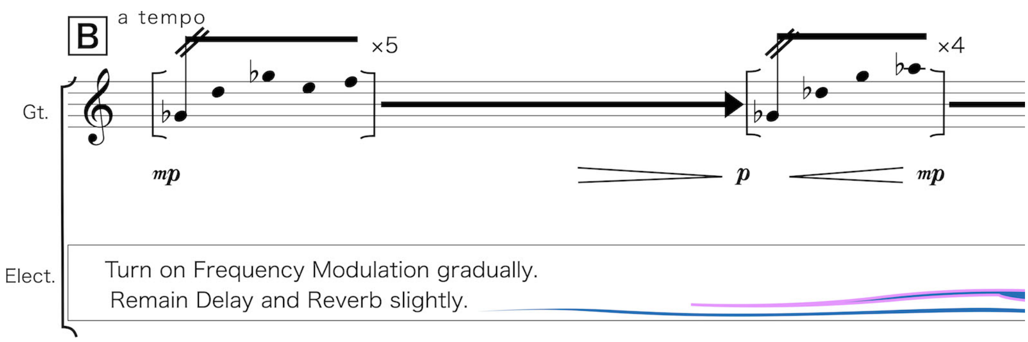


Diagram 4: Difference of envelopes

In this part (Score 1), the flutist's gestures, which appear to be quite normal gestures, are altered by the programmed electronic responses: harmonised (chord) sounds are created by emphasising and elongating the tones of the flute with a pitch-shifter[24]. Therefore, by exceeding a limitation in the acoustic domain (monophonic instrument), it disjoins a one-to-one relationship and reconnects their normal gestures with abnormal sounds inducing to counter the audience's predictions. We will be able to hear the chord with a gentle guitar sound in the background, and this is the sound image striven for. Although exactly the same sound transformation is applied to both instruments simultaneously, the electronic responses are not necessarily equally audible or predictable for the audience[25]. For instance, the delay effect[26] applied onto successions of tremolo sound in the guitar is quite effective, though it does not introduce noticeable results in the flute sound, one reason is

[24] Altering the pitch without affecting the duration of sound.
[25] According to my experience regarding this work, to apply different effects to each instrument simultaneously has not brought favourable results. Thus, I decided to introduce the mixture of different types of sound effects for the mixture of input sound.
[26] Input sound is played back with a certain time delay.

because of the difference of envelopes (Diagram 4)[27] [28]. Therefore, by taking advantage of these features, the contrasts between the modified sounds of the flute and the guitar are designed.



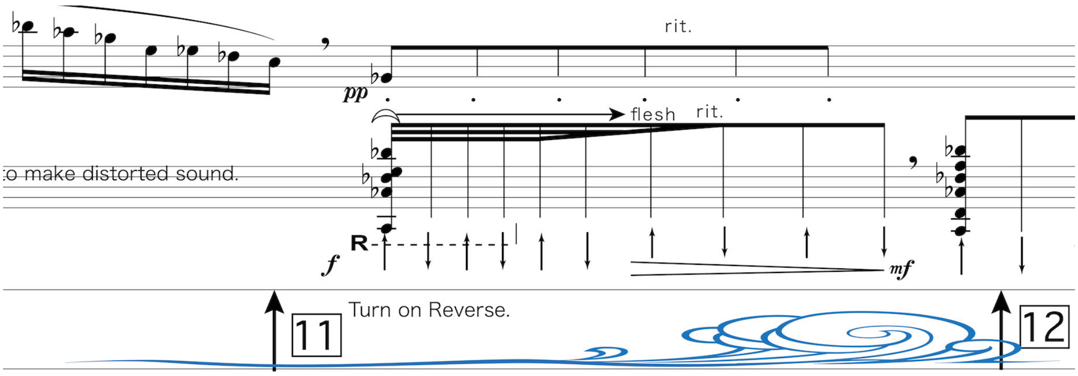
Score 2: Extract from *Tints of July* p.1 (B)

In another example, at rehearsal mark B (Score 2), frequency modulation of the incoming instrumental sound is introduced gradually. The guitarist has been playing a tremolo effect for about 45 seconds until this part, storing a fixed expectation within our aural memory. By gradually introducing real-time modulation in part B, it can bring a slow alteration or a slight break to the fixed aural expectation constructed up to this point, though there is no difference in the guitarist's behaviour. In other words, the electronics change the relation between performer and sound slowly and gradually, in order to appeal to the audience. As a result, the change of sound colour is similar to the visual effect of paper marbling[29], which is enabled by the vibrato effect on the successions of tremolo.

[27] The guitar has an intensive attack, but attenuates quickly. On the other hand, the flute does not have a strong attack, but it can maintain the sustain level longer. Thus, at this part, pitch shifter is not as much effective for guitar as it is for flute, and delay is not so much effective for airy flutes sound as it can catch successions of steep rise/decline in amplitude of the guitar.

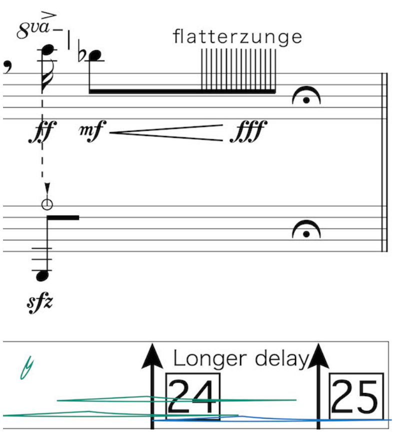
[28] Reverb effect is also employed for this part just to make whole sound wet in order to mix acoustic sound and electronic sound naturally.

[29] A method of aqueous surface design that can produce patterns similar to marble. (Wikipedia).



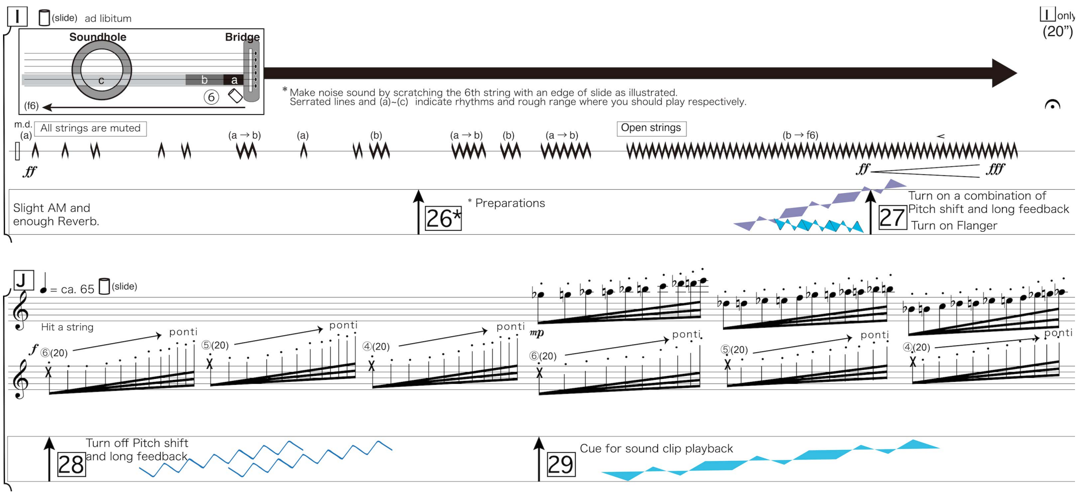
Score 3: Extract from *Tints of July* p.3

At rehearsal mark D (Score 3), as the illustration of the electronic part indicates, a sound image such as a strong wind was firstly sought. To embody this idea[30], *rasgueado*[31] technique for the guitar, and a reverse effect for electronics were introduced. The timing for triggering the reverse effect (cue 11) is crucial, being placed before the first note of the *rasgueado* so that the electronics does not miss the strongest attack of the guitar sound, and when the reversed electronic sound arrives, the guitarist is playing the next less energetic passage. This is a very clear example of electronic intermediation caused by disjunction and reconnection: the characteristics of reversed sound have been hugely separated from the original sound attributes and from the performing gestures. Then, a sense of meaning is immediately suggested in the development of the music, whilst showing a contrast between the current player's gestures (less energetic) and the reversed sound (more powerful).



Score 4: Extract from *Tints of July* p.5

[30] To make an estimate of embodied sound by electronics, various existing compositions for guitar or flute are tested with electronics before own composition. This simulative step often makes composers realise the sound which they need. (Hirayama, 2014)
[31] A guitar finger strumming technique. The notation in the score is from *Sequenza XI* by Berio (1987-88).



Score 5: Extract from *Tints of July* p.6

In the score 4 excerpt, there are pitch-shifted and feedback sounds which aim to enhance the fluttering effect and the Bartók pizzicatos. It lasts for about five seconds (during the fermata) and it releases of the most intense periods of tension in this piece. On the other hand, the audience will be able to see the contrast between players' gestures (not performing) and feedback (currently sounding). In contrast, the next quiet guitar-solo part starts after the previous electronic sound (during the fermata) disappears completely (Score 5). However, once the guitarist starts to play the long glissando (the middle of rehearsal mark D), the computer starts to follow the passage with the pitch shifter and feedback (cue 27 in the score, where the electronics changes its behaviour significantly), so that the emerging electronic sounds can provide a bridge between the current part and the next section during the fermata. After that, instruments start the next passage by imitating the electronic gesture.

As described in these examples above, the computer provides transforming features related to pitch, rhythm, dynamics, timbre, and the timing of events between original and electronic sounds, as a result of disjoining the fundamental attributes found in musical instruments and their performance. Also, newly linked connections between modified sound and performers' gestures can suggest to the audience the nature of the computer's roles and its tasks within the musical dialogue.

Computer, Performers, and Score

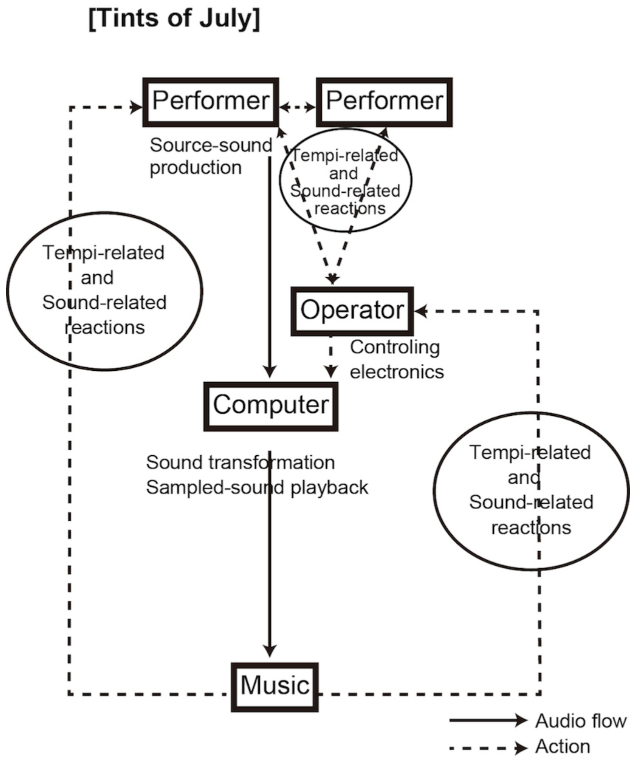


Diagram 5：Human-Computer Interaction in *Tints of July*

My approach to Human Computer Interaction[32] in *Tints of July* was not just to use the computer to mainly modify the acoustic instruments. I also envisioned the computer as an instrument in itself, capable to interact, imitate and dialogue with the other players. This may include providing cues and hints for the timing of events or providing musical directions.

The score of this piece presents in detail every required piece of information for performance without providing extreme accuracy for tempi. A certain amount of flexibility addressing the concept of tempo provides a degree of elasticity in the behaviour and response of the electronic element in every performance, and it facilitates 'musical interactivity'[33] from both the instrumentalists and the electronic 'interpreter'. Thus, it is expected that some routines in the electronic part are already pre-programmed, converting

[32] The input-output devices for transmitting the exchanges of information between humans and computers. It also includes computer programs or concepts. It is described here with the focus on the roles of the computer.
[33] Lippe (2002. P.2) states that 'This relationship involves a subtle kind of listening while playing in a constantly changing dialogue among players, often centering on expressive timing and/or expressive use of dynamics and articulation. We often refer to this aspect of music as "phrasing"'.

the performer to an operator of the electronic part to some extent. However, there is still room to act extempore. The graphical description for the electronic part aims to suggest abstract sound images to facilitate this process.

In the performance of my live electronic pieces, I always find it challenging to construct an ideal sonic environment between the incoming audio signal from the stage setup, including microphones and loudspeakers and especially the acoustic conditions of the hall. I believe that this is a distinctive feature at the core of live interactive music[34] which I am particularly aware of, when composing and designing the interactive system.

List of Performances

Tokyo Sound Space Ark, 20th April, 2016, Perth, Australia
Spectral Crossings, 27th March, 2014, Perth, Australia
Seoul International Computer Music Festival 11th November, 2013, Seoul, South Korea
International Computer Music Conference, 12th August, 2013, Perth, Australia
Australasian Computer Music Conference, 13th July, 2012, Brisbane, Australia
International Festival for Innovations in Music Production & Composition, 26th April, 2012, Leeds, UK
INTER/actions: Symposium on Interactive Electronic Music, 11th April, 2012, Bangor, UK
University of Manchester Lunchtime Concert, 22nd March, 2012, Manchester, UK
MANTIS Festival, 10th June, 2011, Manchester, UK

[34] Voorhees (1986, pp. 32-36)

Chapter 4. Exploring Live Electronics vs. Fixed Media and Multimedia in *Translucency*

A material is said to be translucent when it allows the transport of light through with some degree of scattering. *Translucency* for bass clarinet plays around with this metaphor when considering alternative styles of performance, as well as the texture of sound, and they are independently explored in two different pieces:

Translucency I for bass clarinet and live electronics and

Translucency II for computer and live image processing

In *Translucency*, the approach of the electronic part is to intervene the instrument sound world and its performance from a fixed media point of view, via image processing as well as audio-signal processing. Hence, those techniques explore how to disjoin the fundamental connections between the bass clarinettist, the bass clarinet and the sound in a different manner from when using only audio-signal processing techniques. As a result of rebuilding the new relationship between the disjoined materials, I created two compositions highlighting the different performance styles.

Translucency I and *II* also push different degrees of musical expression using alternative media, while sharing the same instrumental source, the bass clarinet (a very rich instrumental resource for a composer).

4.1 *Translucency I* for Bass Clarinet and Live Electronics

Translucency I was commissioned by, and composed for, Dutch clarinettist Marij van Gorkom[35], on the premise that both the performance of the instrument and the control of the live electronics would be the responsibility of the bass clarinet player[36]. With regard for her own devices and approach to interactive music, I aimed to design a method for the performance of the instrument and the electronics in which all materials seem to be unified, where the performer deals with materials (both instrumental and electronic) as naturally as she plays the bass clarinet. On the other hand, I added fixed-media materials, which can disjoin the inherent elements of the sound resources in a different way from live transformation, to the electronic part. This is because of the aim to build a co-motivating

[35] http://sonicspaces.eu/info_sonic_spaces_marij_van_gorkom
[36] Score of *Translucency I* pp. V-VII

relationship between the performer and the electronics, in which the computer could exceed the role of being a sound ‘transformer’ in response to a live input signal, and where the computer could behave equally in terms of musical production and hierarchy, in relation to the acoustic instrument (Diagram 6).

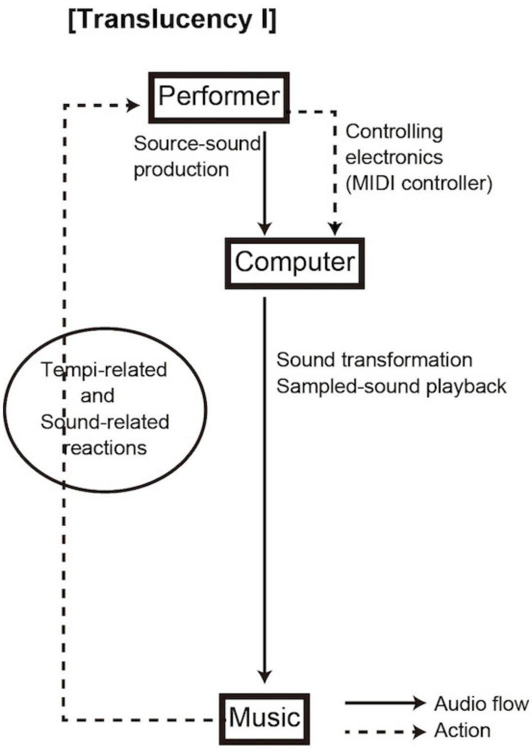


Diagram 6：Human-Computer Interaction in *Translucency I*

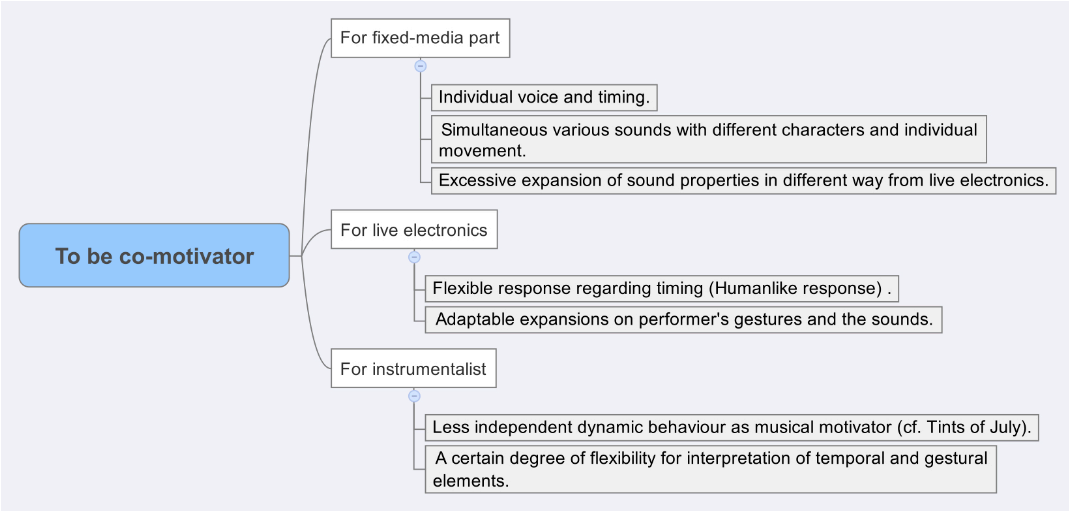
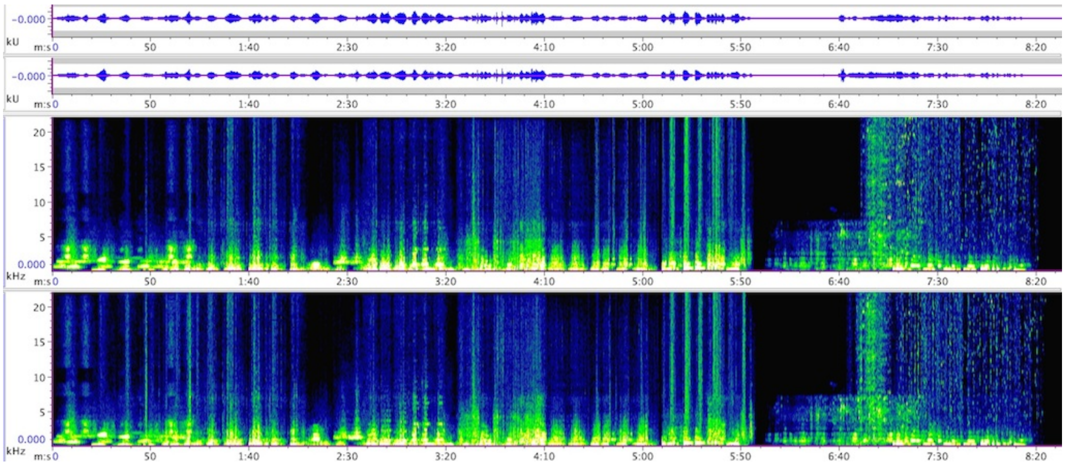


Diagram 7: Assigned roles and media

Diagram 7 highlights the required roles to be assigned to each medium and the strategies for building co-motivating relationships between them. At the same time, it suggests that different electronic media have different advantages in disjoining elements from the bass clarinet and in utilising them after disjoining and transforming.

Whereas it was pursued to create interesting contrasts between performers' gestures and electronic sound in *Tints of July*, the construction of reciprocal relations across acoustic and electronic media (diagram 7) is sought in *Translucency I:* it aims to produce associations that can urge musical development across media (*i.e.* instead of the situation where instruments' parts work as strong stimulants to lead musical development like the case of *Tints of July*), while the computer alternates its roles as a sound-transformer and live-controller at the disposal of the performer.

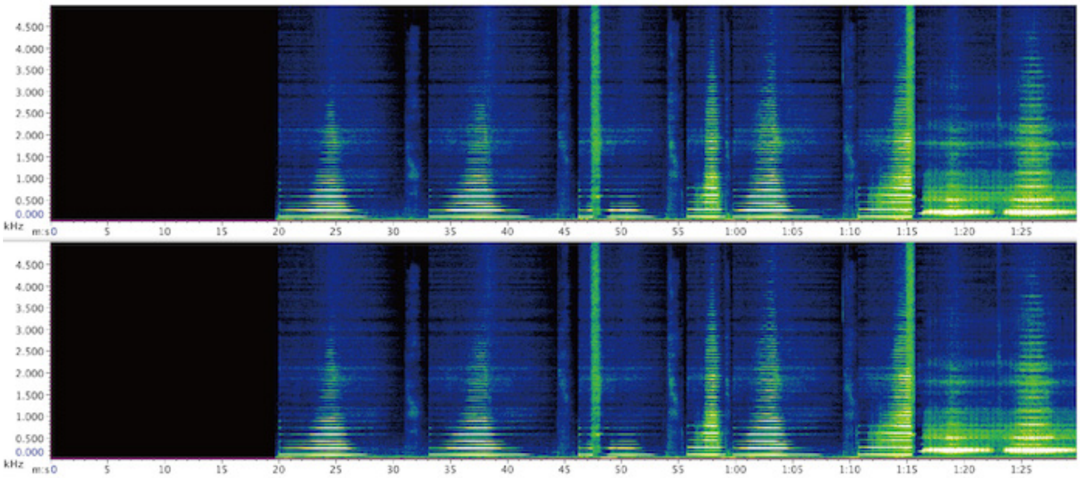
The following analysis exposes how to link materials to build mutual relations between the instrument, the live sound processing and the fixed media from an aural perspective.



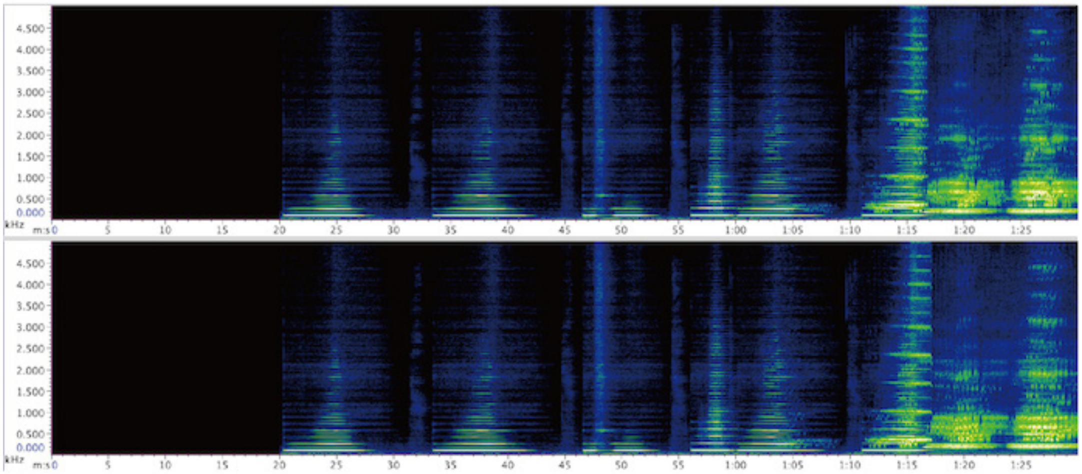
Picture 4.1: Frequency Spectrum of *Translucency I*

[Spectrum analysis at 0:00-1:30 (1A)]

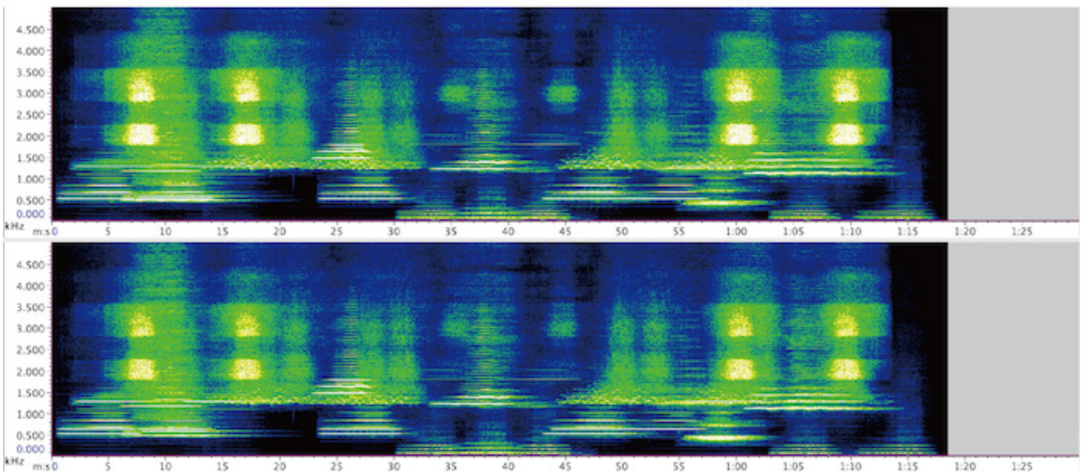
[Instrument]



[Instrument + Live electronics]



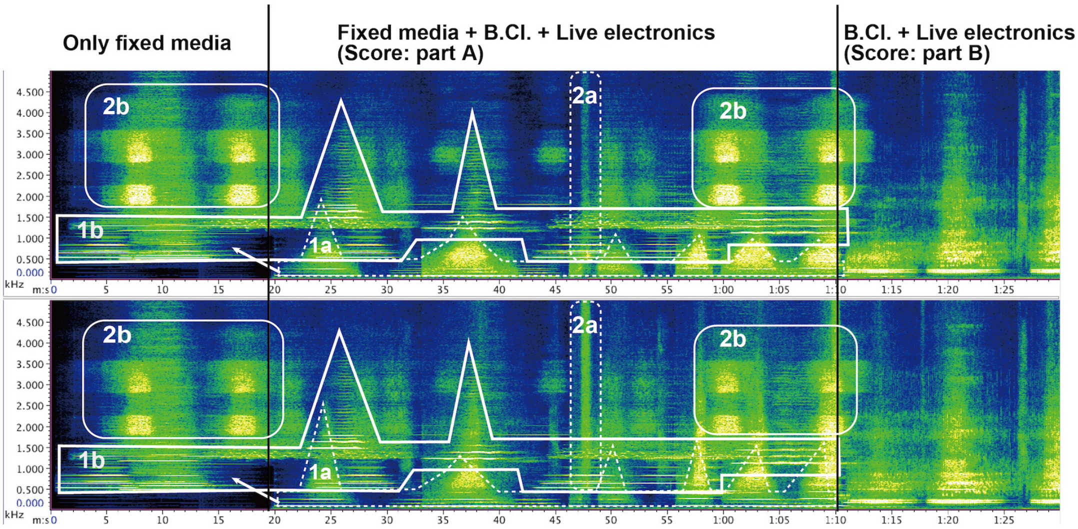
[Fixed material]



Picture 4.2: Spectral analysis (1A)

[Spectrum analysis at 0:00-1:30 (1B)]

[Instrument + Live electronics + Fixed material]



Picture 4.3: Spectral analysis (1B)

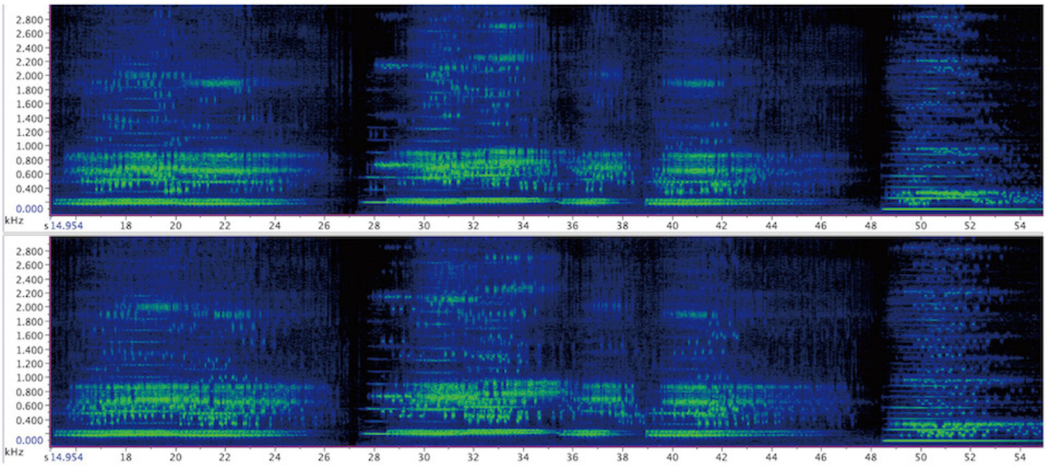
Picture 4.1 shows the spectral analysis of this composition. The spectral analysis at the beginning part between 0:00 and 1:30 up to the frequency of 5000Hz (Picture 4.2) exposes the similarities and differences that each medium expresses. The spectrogram of integrated media at the same point (Picture 4.3) proves how much different media are linked to each other and from the viewpoint of musical 'promotability', understood as reciprocal incentives across media to stimulate the sense of aural motion. For instance, this is seen in the expansion of spectral occupancy[37] (1b and 2b) based upon low long tones of the bass clarinet (1a) and air-current noise (2a and more)[38] in the fixed-media part, and following airy long tones of the instrument (1a and 2a). In the process of composing, the sound of the fixed part is derived from the instrumental sound world. However, the instrument somehow follows the fixed media by vaguely tracing it during performance.

[37] Although it is possible to explore extreme high pitch produced by the bass clarinet as an extended technique, I decided to use rather standard pitch in the instrument and passed such a high-pitched role to the electronic part. Informed by Sparnaay (2010, pp. 56-58)

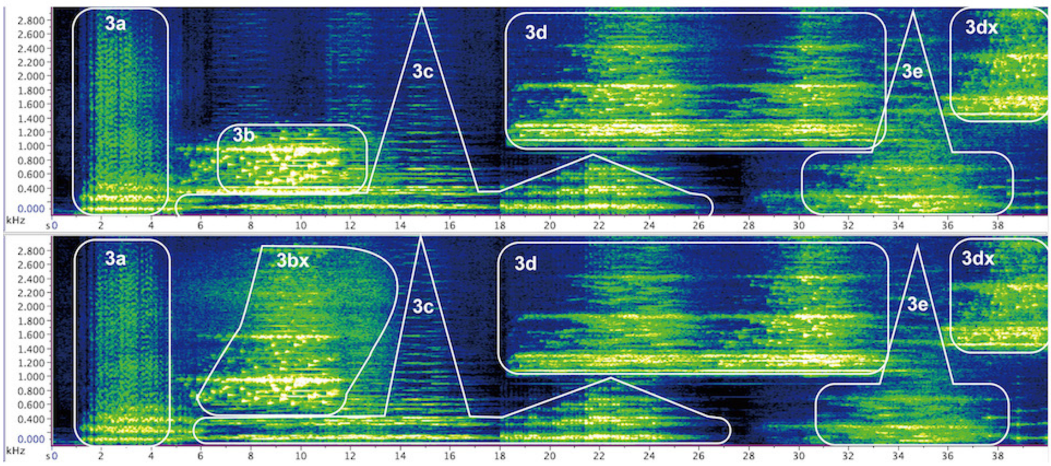
[38] Because there are series of long tones (part A in score) that include a lot of airy sound in the bass clarinet part, the air noise that forms materials in 2b includes different sources also. Similarly, it is not necessary to limit the link between air noise in fixed media part and live media as the picture shows: regardless of whether the noise is thick or thin, loud or quiet, we can still hear that there are many related air noises.

[Spectrum analysis at the part B-C]

[Instrument + Live elecronics: ca. 1:23~2:03]

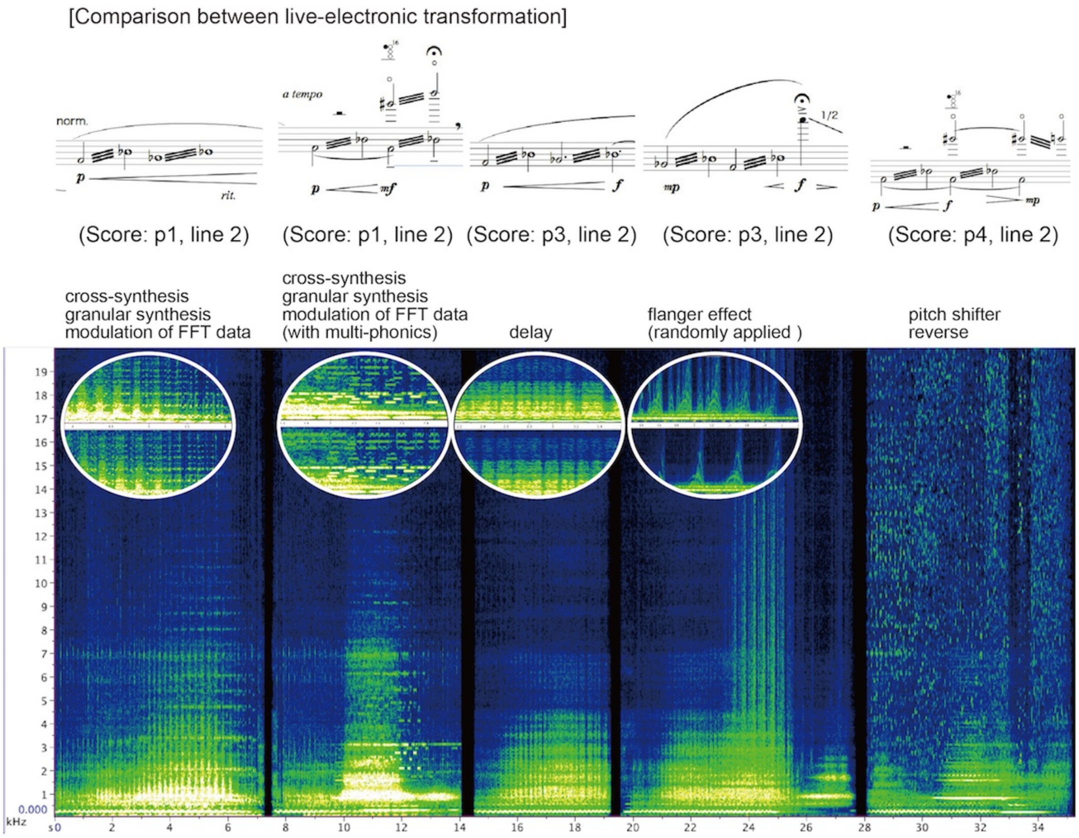


[Fixed material: ca. 2:05~2:45]



Picture 4.4: Spectral analysis at the part B-C

In the next scene (Picture 4.4), as the live electronic part introduces a bubbly-like sound to the bass clarinet (part B in score), the following fixed media section (part C in the score) tries to enhance such a gesture via the live electronics. It aims to musically expand its soundworld and expressiveness, while combining the particle-based sound (3a, 3b/3bx, 3d/3dx, 3e) and the airy-long-tone-based sound (3bx, 3c, 3d/3dx, 3e) which was introduced at the beginning.



Picture 4.5: Comparison between live-electronic transformations

The bass clarinet does not require dramatic changes across its writing. Instead, the sense of dramatic contrast is achieved in combination with different types of characteristic sounds produced by the live electronics; *i.e*. as seen in the section between D and F in the score. For example, what Picture 4.5 demonstrates is how similar sound materials can be transformed differently by the live electronics. At a glance, a few sonograms may look very similar, but when enlarging their graph details, it proves to demonstrate clear differences between them.

While the computer offers seamless/coherent relations between the instrument, the live electronics and the fixed media part (*e.g.* from the end of part C to D, and F to G in the score), it can also offer many different characteristic sounds (*e.g.* part A and C in the score) simultaneously. In this respect, one may say that the computer is working in partnership with the instrumentalist, while playing a number of diverse compositional strategies such as imitating and expanding materials, reinforcing one another's relationships, and introducing/producing new transformations: this is the pursued relationship. The audience may also perceive that, in many aspects, the computer somehow communicates with the performer, as another performer would do. Interestingly, however, this composition proposes a system where a 'second performer' is hidden on stage, as a result of having an off-stage electronic performer who operates the computer system.

Sonic materials explored in this piece create various sizes of particle-shaped sounds in combination with the sounds of the wooden instrument and the electronics. It works as a metaphor where fine particles scatter lights to cause a degree of optical blur in the visual world. It can also be described as a pursuit of microsound[39]. In particular, these ideas are mostly explored using air-current noise on the bass clarinet and its expansion by the electronics, or in various applications of sound-signal processing methods such as granular synthesis[40], cross-synthesis or frequency-domain pitch shifting. To research the method of combining electronic media and bass clarinet I analysed Rai's *Isolation*[41], which consists of two pre-recorded and untransformed bass clarinet voices for fixed media and live voice, and *Sparkle*[42] for bass clarinet and tape, as well as Matsuda's *Enlargement*[43] for bass clarinet and interactive multimedia computer system, which makes use of a live-camera to visualise musical gestures with the performer in real-time in addition to live electronics for the audio part.

List of Performances

New York City Electroacoustic Music Festival, 26th June, 2015, New York, USA
SON1CSPAC3S, 16th June, 2013, Utrecht, Netherlands
SON1CSPAC3S, 14th June, 2013, Den Haag, Netherlands

4.2 *Translucency II* for Computer and Live Image Processing

In *Translucency I* the fundamental relationship between the bass clarinettist, the bass clarinet and the sound has been greatly modified with fixed media and live electronic intermediates. In *Translucency II,* the approach for fixed media is to separate sound elements from the instrumental object and related gestures. Instead, extracted aural

[39] Roads (2004)
[40] Lippe (1994)
[41] Rai (1980)
[42] Rai (1989)
[43] Matsuda (2005)

elements look for a new instrument and gestures which could be applied onto them: computer keyboard and visualised information of sound. Hence, as the bass clarinet is played, their sounds are triggered by a keyboard, and their sonic characteristics as well as movements are visualised in real-time[44] (Diagram 8). While *Translucency I* is concerned with the instrumentalist's performative approach for controlling different media, *Translucency II* slightly undermines the importance of the figure of the performer. Text in that the performer can control many sonic attributes with personal interpretation, which can be seen across the portfolio[45]. The existence of a performer in this piece could be rather expressed as the need to have a live sound to feed the visual system. My rationale behind this is that the reason for diminishing the performer's presence and role (who is simply typing a computer, instead of performing the acoustic instrument) can highlight and benefit the relationships between sound and image. These two elements are heard and watched as the key outcomes, since this piece aims to construct the communicative relationship that exists between the two, which can make the information of performer's gestures, sound source and outcomes visible and audible.

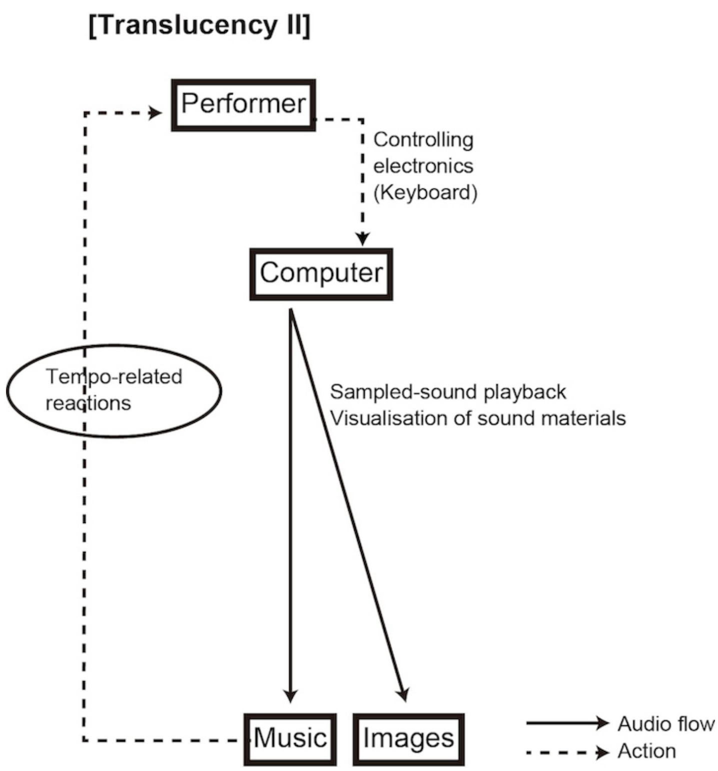


Diagram 8 : Human-Computer Interaction in *Translucency II*

[44] A plugin software of Max/MSP, DIPS (digital image processing with sound) is employed.
[45] *cf.* chapter 2.4

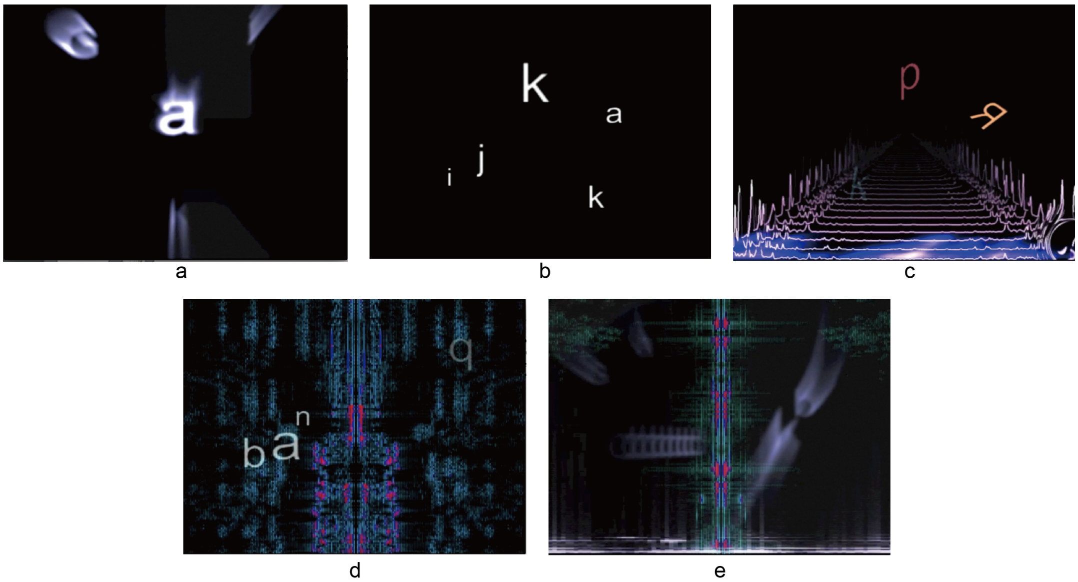
Methodology for Performance

In *Translucency II* the computer performer activates the music events by tapping in letters in a computer keyboard (using Max/MSP), and the computer plays back a one-letter-basis pre-assigned sound clip depending on the tapped letter. In the background, DIPS listens to the played-back sounds and interprets visual images as I had pre-programmed them. The computer performer has no control over the mapping (the notion of controlling is most likely to overlap with the notion of performing in this chapter)[46] and therefore, has no direct influence in the compositional progress in this respect, except for control of the output volume. However, it can control the pace and order of events. Therefore, the system design in *Translucency I* provides the live performer with a higher degree of control and musical expression than in *Translucency II,* but in the latter, the system allows the performer to behave more freely in choosing letters/sound materials and in controlling timing for triggering them. An alternative form of score for this piece is also necessary to support this type of role.

Image Processing for Representation of Communicative Relationship

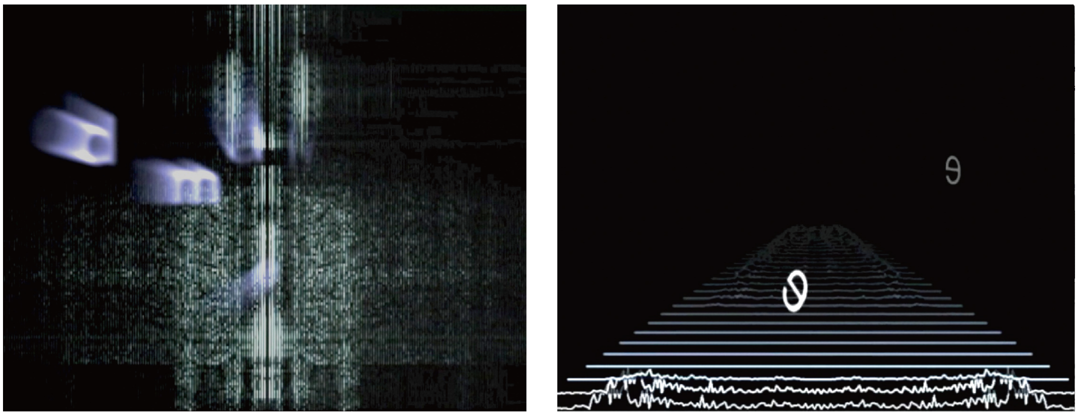
The computer's role of visualisation of sound aims to communicate different types of relationship, which can be described as conversational, communicable or demonstrative. In particular, because this piece does not have live sound generation, and because there is no performer to play something on stage (in front of the audience), I was primarily concerned about how images as media could convey the existence of a nearly transparent form of interpretation (and therefore, connecting the piece with the original theme). The metaphoric world of translucency is created through close communications between the aural and the visual media and its performance.

[46] *cf.* performing *FRISKOTO*, Chapter 7.



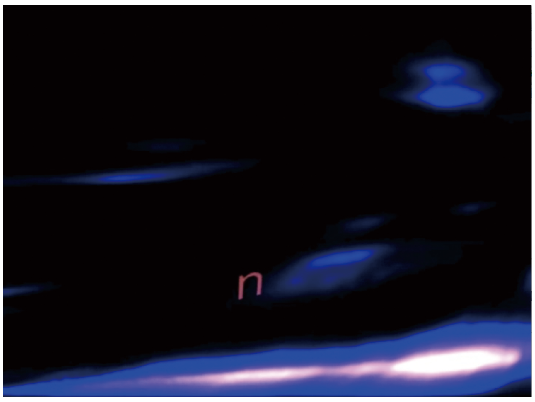
Picture 4.6: Different types of typographic effects

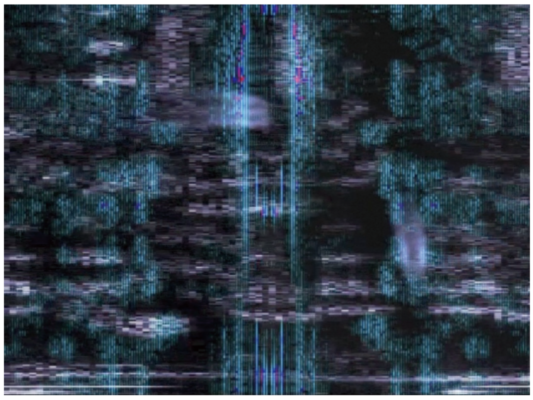
The introduction of live typographic illustrations aims to reinforce the dialogue between the performer, the music, and the images, since the letters embody the instrument. This visual effect is mostly used throughout the entire piece. However, the letters change their appearances and movement according to the different scenes and sound source. (Picture 4.6). In particular, the scene ca. 4:20-6:00 (score pp. 2-3, Picture 4.6 b) has a special focus of directing conversational relations between the performer and electronic media, as only a quick and motional typographic effect is employed.



Picture 4.7: Traced images of sonic and temporal information

It is important to demonstrate that the computer performer in *Translucency II* can provide interlinked communicative relationships between performer and electronics. In the sonogram and spectral effect above, it emphasises the performer's behaviour when operating the electronics by demonstrating how faithful the interlock is between the keyboard typing and the sonic images (ca. 3:02 and 6:47, score pp.2 and 3, Picture 4.7).





Picture 4.8: Images with a blur effect

The permeability of light and colours are very notable factors in translucency, and it is meaningful to explore them when sonic materials are transferred to visual materials. In particular, a blur effect is important in order to alter directly traceable sound materials and triggering events (eg. Picture 4.7) into abstract translucent imaginative shapes. Hence, a blur effect was used to represent the situation of communication and influence between a performer and a computer as visual images by combining the blur effect with other effects (typography and sonograms) and with colours (ca. 10:25 and 13:20, score pp.4 and 5, Picture 4.8), See also Picture 4.6 a and e for a blur effect.

List of Performance

International Festival for Artistic Innovation, 10th March, 2016, Leeds, UK

MANTIS Festival, 18th October, 2015, Manchester, UK

Chapter 5. Interactivity between Instruments and Multi-channel Fixed Media

Miriam for Piano and Fixed Media (8-channel)

The title, *Miriam* is based on a short story with the same name, written by the American novelist Truman Capote in 1945. In Capote's story, the name of *Miriam* is used to represent two females. One refers to an aged widow, Mrs. H. T. Miller and the other portrays an intelligent young girl. One day they meet each other by accident, and Mrs. Miller then starts to become obsessed about her. The story includes rich and detailed descriptions of scenes as well as of the inner worlds of Mrs. Miller, so that the reader cannot distinguish what may be real or unreal. However, in my musical interpretation I imagined that everything she experienced was real for Mrs. Miller, no matter what other people perceived. Therefore, the aural experience in my work is not something that always guarantees a direct correspondence with the original story. The composition also tries to express the relation between both Miriams through the instrument and the 8-channel fixed media sound, while inviting the listener to a soundworld experience which obscures the borders between real and imagined, and expressing a certain degree of interactive play between them.

A Device for *Miriam*

This composition tackles the challenge of reproducing the atmospheric sound world of *Miriam*; which is done through my own sonic interpretation of the story. For this composition, I felt like using electronics as a large device to expand instrumental music in different ways than I did in previous works: *i.e*. in a theatrical way. Thus, the introduction of an 8-channel loudspeaker system as well as a choice of sound materials were explored. For example, in a live-electronic composition *Rose* for soprano and computer[47] inspired by Oscar Wilde's novel, the composer successfully realises a theatrical world based on abstract texts and real-time sound modification. In particular, the composer is projecting the scary-feeling theatrical soundword by applying a long-durational (deep) reverb effect to lyric soprano voice (*i.e.* disjoining from the vocal sound in real-time). At the same time, the effect is expanding the vocal sound to harmonious timbres, and those modified sounds are

[47] Ito (1999)

combined with incoming poetic voices. Although there is no text and vocalist in *Miriam*, by adding environmental sound to the instrumental sound, I explored how to create a unique soundworld which had a more realistic view than the instrumental sound only. The spatial approach also comes from my interest in theatrical elements: the pianist cannot move across stage, and the performance space for instrumental music tends to be defined with the performer in its centre.[48] Thus, loudspeakers (electronics) expand the common performance space, and many replicated-like sound materials of the piano and the environmental sound aim to work as a large device, surrounding the pianist, as if they were to describe the existence of Mrs. Miller (piano) and her interaction with the girl (represented by the surrounding electronics).

Considering the above, the electronics in this piece utilise separated instrumental sounds from the original resources/gestures as a 'virtual existence' of themselves and combine them with environmental sound to create ordinary scenes for Mrs. Miller. These sound materials are linked to the performer's triggering gestures, creating the spatial distribution of materials based on original understanding of the story. Thus, compared with previous works, I thought about how to design the relationship between electronically produced/modified sound and the performers' behaviour, and it resulted in being less focused: connectivity in *Miriam* did not really suggest additional computer tasks or new performance styles. Instead, all the focus was in creating a theatrical piece with an expanded sound space, and it was preferred not to show alterations of connectivity[49] between the pianist and sound. For this piece, I preferred the audience listen with the similar attitude to when experiencing a fixed media work; in other words, being less conscious of the visual information of the performer.

A Computer for Performance and Composing

A dynamic score displayed on a laptop was introduced, not only for synchronising, but also for providing precise tempo to the pianist, allowing to exhibit temporal information visually instead of using a click sound as reference. This was one of my own performance developments for an instrumental work with electronics, where the equipment was simplified and integrated with the components required for performance (cf. Diagram 9).

[48] Emmerson (1998, pp. 146-164)
[49] *cf.* Chapter 2.3.

In this piece, a computer is also employed for creating a particular rhythmic pattern (4:24-5:20) using a Max/MSP patch. The patterns generated are recorded on the same patch, and transferred to a score for the piano part. This method is introduced to express my understanding of the sense of obsession in the narrative, avoiding an emotional (human-like) response to it. In other words, the emotional elements, which are usually portrayed through human performers, are passed onto the live-electronic performance.

[Miriam]

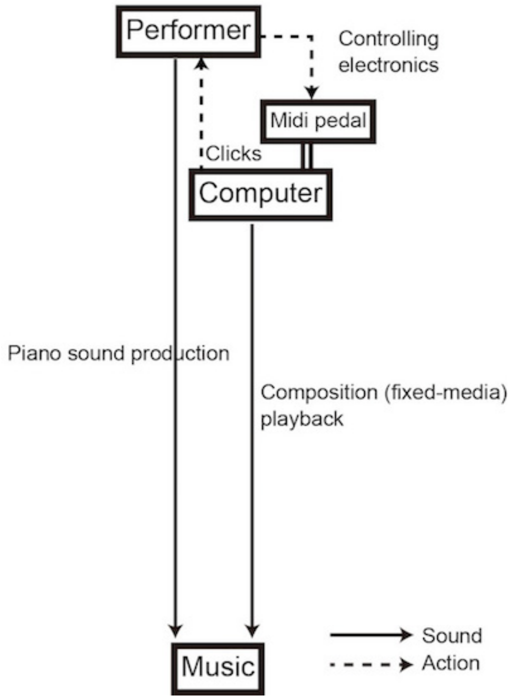


Diagram 9：Human-Computer Interaction in *Miriam*

Integrating Sound Materials and Mapping onto 8-Channel Loudspeakers

The original piano sound and its modified version aim to express the sort of existing relation between the two Miriams that exist in the world, which sounds quasi-illusional in the background layer and which is illustrated via environmental sounds. Young Miriam's personality becomes more ‘cheeky’ as the writing progresses and this is also reflected in the music. The fixed part also contains a lot of repetitions of the piano sound which evolve across time as if they were representing young Miriam’s behaviour.

Environmental sounds are often used to represent the scenery. For instance, a door-opening sound arrives at 1:53, to inform the appearance of young Miriam, aiming to transport the listener back to the reality of that moment. Other materials such as a crowd sound or the voice of a canary are also used to metaphorically interpret the world of the short story. In particular, the canary voice seems to be an emblematic sound from the compositional point of view, to portray Mrs. Miller's ordinary life. However, the material is also used at a less calm situation (3:39-4:48), to express the mixture of common and emerging tension in the life of the character.

Since in Capote's work it is not clearly described whether the young Miriam really had existed or not, leading the story to the end with a mysterious feeling, it has been interpreted that the existence of young Miriam was a ghost or a type of mirror for Mrs. Miller's subconscious. In my own interpretation, I decided to create some uneasy atmospheres to showcase the mysterious existence of the odd girl, expressing it more emphatically by drifting sound images constructed from the narrative into the 8-channel sound system (*e.g.* 0:00-1:10).

List of Performances

Toho Gakuen School of Music Computer Music Concert, 20th February, 2016, Tokyo, Japan

Chapter 6. Interactive Music and Structure: Myth, Exploring Form and Materials across Alternative Media and Forms of Interaction

'The Sleep of Reason Produces Monsters'
Francisco José de Goya y Lucientes, 1799.

Myth, was composed based on a concept that is derived from the painting *El Aquelarre* (1798) by Francisco José de Goya y Lucientes.[50] The painting has been seen as his protest against those who upheld and enforced the value of the Spanish Inquisition which had been active in witch hunting during the 17th century Basque witch trials. 'The sleep of reason' by a collective of people often produces myths and causes tragedies such as witch-hunts. I found a parallelism between Goya's thinking and contemporary Japan. In Japanese culture, there is also a myth of so-called 'Safety', and its mythical symbolism was used to allow my country Japan, which is well known for its highly seismic activity, to build 54 atomic power stations. In 2011 the myth fell apart, as a consequence of the terrible earthquake disaster. To date, we do not yet know the actual cost and impact of such a catastrophe.

A mix of derision and the complex feelings of anger, sadness, anxiety, despair, or warning are expressed in the piece of *Myth (I and II)* with unique exploration of solid textural sound which is mingled with different characterised sound materials, employing different musical forces.

Characteristics of *Myth*

Myth consists of two sections, *Myth (I) (El Aquelarre)* for musical instruments and *Myth (II) (Textile)* for fixed media. This is quite a unique experimental composition, involving different musical media within one work. Throughout the two sections of the piece, the composer pursues a sense of development in the density of sonic textures, which is visually-informed by concepts and ideas originated in *Aquelarre.* The same sonic materials are being interchanged between *Myth (I)* and *(II)*. Thus, *Myth* investigates transposability and expandability of its sonic materials between different compositional

[50] 1746-1828

media.

In both sections, sonic materials are treated as sonic textures that can portray a certain degree of density to the sound. In each section, the musical development and structure are not ignored, and there is concern about constructing in coherent manner a vehicle for connecting different types of aural resources across Myth *(I)* and *(II)*. Having said that, as a composer I wanted to provide consistency of sound materials across, informed and inspired by Varèse's attitude toward his compositions[51]. As a result, my method for positioning sound materials in the piece is dealt more carefully, and the musical landscape and development of *Myth* can be exposed when interlocking textural connections. A similar approach was taken when composing *Translucency*, but it was different in *Tints of July*. Throughout this work, the basic source of sound texture consists of mixed instruments, but also makes use of just one musical instrument as it is shared.

Experimenting extensively with the concept of electronic intermediation through this piece, let me return to some aspects of my research enquiry: What are the fundamental attributes in instrumental music and its performance? How is it possible to disjoin any elements and reconnect them for novel expression as interactive computer music? Over this large-scaled composition, the experiment was carried out taking into consideration the fundamental attributes of instrumental music and the performance. For instance, sound materials of *Myth (I)* were taken into *Myth (II)* as sound components, as a result of electronic intermediation. Fixed media has been already introduced in my previous works as an electronic intermediate force; however, this comparison between *Myth (I)* and (*II)* navigates across a wide degree of human interaction (from 100% to 0% so, extremely opposite). This urged my compositional thinking to reconsider the meaning of *performing* and to expand my sonic vision by understanding different attitudes of *performance* derived from the musical instruments.

6.1 *Myth (I) – Aquelarre* for Flute, Bassoon, Accordion, Percussion and Violoncello

Myth (I) was originally commissioned by *Chaotic.moebius* (Plattform für neue und experimentelle Musik in Basel**)** where I took part in '*Aquelarre* project'.

[51] *e.g.* Intégrales for wind and percussion (1924-1925), *Ionisation* for 13 percussion players (1929–1931), Déserts for wind, percussion and electronic tape (1950-1954) are referred.

In section *(I)* for acoustic instruments, the accordion occupies most of the sonic canvas, increasing the degree of density of the overall sound, and it is employed for the purpose of masking other instrumental voices, as well as for expressing certain colouristic details (*e.g*. mm. 1-44 in the score, 0:00-2:40 in the audio). I provided instruments with different characteristic motifs/patterns, ranging from sounds that have linear shapes, to some sounds which behave as particle shapes (*e.g*. bassoon from mm. 62-82), or some others which were informed by pattern-based images, where each sound was grasped with a certain texture size (*e.g.* via texture mapping, mm. 1-6 *et alia*). The middle part aims to project unstable timbral feel and it is expected to produce a prominent texture, exploring colours and details in the sound materials.

In *(I)* it navigates across a 4-4 time signature with tempo rubato, and the latter has an influence on the piece's musical expression and in the interaction between performers and materials, since it provides more flexibility. During performance, an instrumental player needs to conduct/cue the rest of the ensemble (Diagram 10). However, during tempo rubato indications, performers listen to each other more. As a personal impression, tempo rubato can illustrate drifting patterns of sound rather effectively with individual interpretation as well as delicate appropriate expression.

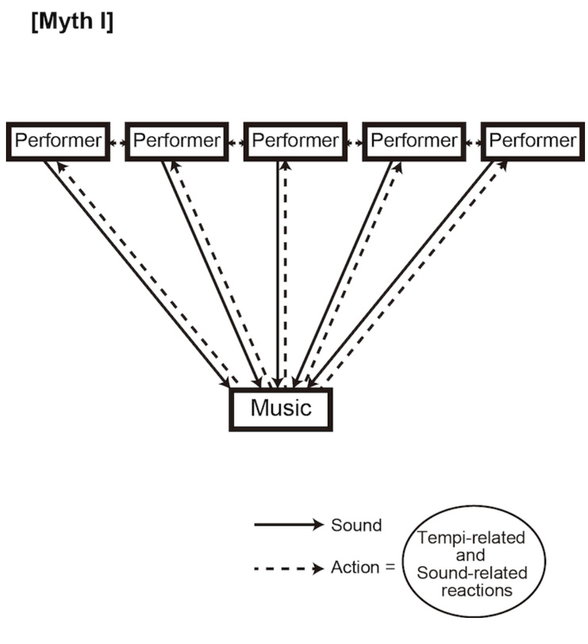


Diagram 10: Human-Computer Interaction in *Myth (I)*

List of Performances

AQUELARRE, 20th November, 2012, Basel, Switzerland

AQUELARRE, 19th November, 2012, Winterthur, Switzerland

6.2 *Myth (II) – Textile* for Fixed Media

Section II illustrates textural sound in electronic fixed media. In the latter section of *Myth*, I aimed to develop music from the prior section in the direction of thickness, involving multiple sound components such as electronically produced sound materials, percussive sampled sound materials as well as materials from the former section, *(I).* Thus, the second section seeks for thick and heavy textural sound like an oil painting, while sharing the same musical concepts found in (*I*); *i.e.* Goya's oil painting, *Aquelarre* as well as the complex feelings of anger, sadness, anxiety, despair, or warning.

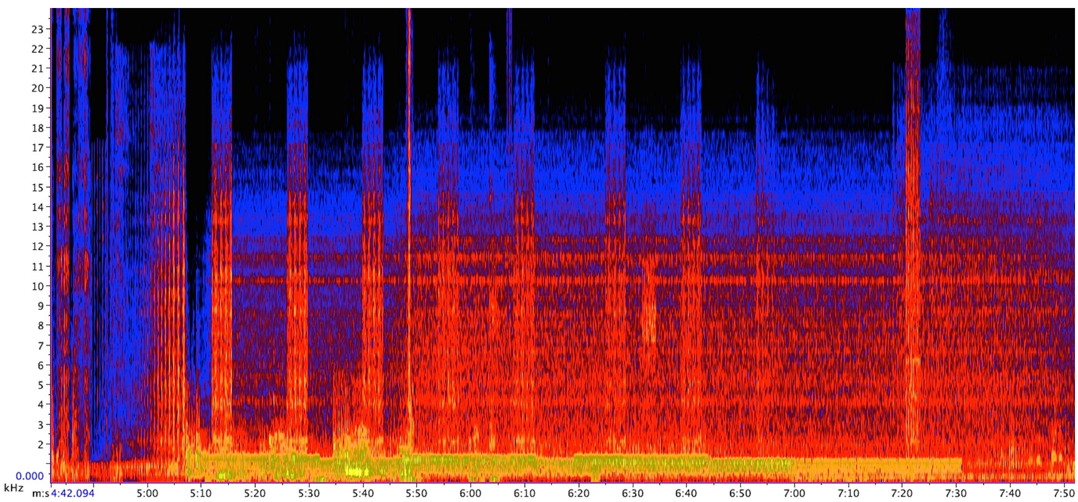
Texturising Sound Materials

In this piece, synthetic sound starting at 7:44 (in the audio *Myth I-II*) is one of the most heavily used materials throughout, synthesis is introduced as an imitative sound of an accordion and it is expected to behave like wefts of weaved cloth. Those sounds often play the role of smooth textures, but some modulated sine tones also appear in places (*e.g.* 10:27-10:50), with the purpose to texturally enrich the sonic image as they may sound like tangles of threads. In the context of the musical conception of the piece, those synthetic textures represent peaceful, calm, and fragile feelings. The use of metallic sounds, which are derived from a gong and have been electronically modified, as well as the use of percussive sounds, which are derived from a cup and a drum, are also integrated within the synthetic web. Those sound objects hold metaphorical meaning, aiming to portray the sense of collapse, deterioration and obsolescence. These elements enrich the spectral occupancy beyond the high-tone range of the synthetic texture (imitating the accordion high pitch) and metallic materials have a weft-like function, because they can camouflage among other materials (*e.g.* at 8:13,11:52 and 12:00), and push other constituents to the surface (*e.g.* 8:44-8:51). Sometimes they also have a warp-like role, because they can also assist the listener to distinguish a particular pattern from the background sound (*e.g.*

8:54-8:55).

These sonic foundations, which consist of synthesis and metallic tones, are interweaved with sound materials from *(I)*, providing a nostalgic feel effect when combining both. Most materials are fragmented while keeping the original sound properties so that the listener can recognise ideas emerging from (*I)*. Thus, the combination of materials (original and new) constructs the *Myth*, suggesting a number of relationships between (*I)* and *(II)*. For example, the tones of accordion around 7:48-7:55 comes from the beginning of *(I).* In the fixed media, the sound is mingled with sine tones illustrating a more complex sound character. Various accordion sounds are also used everywhere, while they are presenting consistent characteristics of this music. At around 8:35-8:50 we can hear a cello's long tone, which is working like a bridge to lead to sound expansion. The sound around 10:10-10:16 is based on cello, and the sound around 12:03-12:08 is based on flute, which are uniquely modified to give an accent. The material at 12:41 will recall your sound memory in (I), but immediately bring you back to more complex-texture and alternative sound world in (II).

Picture 6.1 is a *weaved* image of (*II)* (traced) between 4:42-7:50 (duration in *Myth II* only), illustrating that a metallic sound which has a regular pattern (rhythm) works as the warp (from around 5:10), while other metallic, instrumental and synthetic sounds are filling horizontal lines.



Picture 6.1: Extracted spectrum from *Myth (II)*

Performing and Diffusing Sound of *Myth (II)*

As a consequence of instrumental sound being separated from the performers' gestures and sounding objects via electronics, sound alone is integrated into the fixed-media composition, where we can hear any kinds of sound materials (*e.g.* gestural, textural, instrumental, objective) within one medium. On the other hand, it gave more flexibility for expressing the music on the spatial axis, which is not very easy to practice in instrumental music performance, since it can mean that performers need to move around, while they are playing music.

Performing this fixed-media work requires a totally different approach to performing it from performing instruments (with or without live electronics), and the focus is completely different. While we can observe a human factor, a kind of musicianship, or controllability in a performance of an instrumental work, we can also observe an alternative human factor for delivering fixed-media sound to multiple loudspeakers for achieving a sense of musical expression (Diagram 11).

For example, in the two performances[52] of *Myth (II)* at the *MANTIS Festival* and *Salford Sonic Fusion Festival* with the MANTIS sound diffusion system[53], the two interpretations of the piece (via sound diffusion) projected different shapes as audible outcomes: they were formed according to my performance behaviour, and consequently, the musical image I constructed was different each time. In other words, the audible outcome of each performance in the concert space demonstrates alternative degrees of human expression and interactive connections influenced by the behaviour of the interpreter during the performance of *Myth (II).* In the spatial domain, the control of the sonic thickness and the density provides a direct impact on the listener while delivering textural expression (in *Myth (II))*. Comparing degrees of human expression between the instrumental ensemble and fixed-media sound diffusion suggested interesting conclusions for my future research, which will examine methods of spatial movement in multi-channel fixed media works informed by the performer's behaviour.

[52] Comparing concerts in the *MANTIS festival* (2014) and the *Salford Sonic Fusion Festival* (2014).
[53] A multichannel sound diffusion system, developed by the NOVARS research centre, University of Manchester. http://mantisfestival.com

[Myth II]

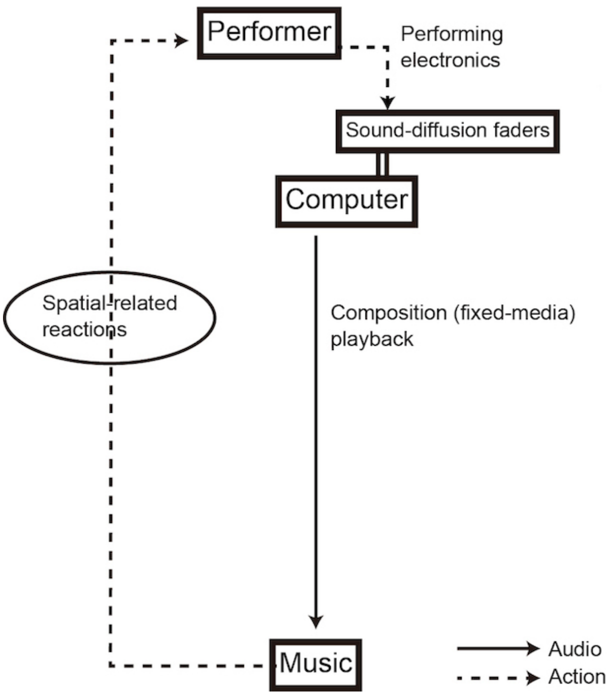


Diagram 11: Human-Computer Interaction in *Myth (II)*

List of Performances

Seoul International Computer Music Festival, 6th October 2014, Seoul, South Korea

Australasian Computer Music Conference, 10th June, 2014, Melbourne, Australia

Sound Sight Space Play (SSSP), 10th June, 2014, Leicester, UK

iscMME Student Conference on Music, Multimedia and Electronics, 10th June, 2014, Leeds, UK

New York City Electroacousitc Music Festival, 2nd June, 2014, New York, USA

Salford Sonic Fusion Festival, 3rd April, 2014, Salford, UK

MANTIS Festival, 2nd March, 2014, Manchester, UK

Chapter 7. Enhancing Interactivity with HCI–Human Computer Interfaces

FRISKOTO for Live Computer and Fixed Media (4-channel)

FRISKOTO presents an electronic system setup, which consists of a sensor device (Leap motion)[54] that supports hand gestures and a computer with an audio interface. It uses recording materials of the Koto instrument[55] made in collaboration with Koto player Sumie Kent.

This piece is distinct from my previous works, in terms of the methods for separating and rebuilding the relationships between the performer, the instrument and the musical output. These methods are aimed to be applied fully to alternative sound materials, by projecting different performing gestures to the musical world. Thus, my aim when composing *FRISKOTO* was to explore the synergic influence between human behaviour and the physicality of electronic sound. As a result, I developed new techniques for performing the (virtual) musical instrument, informed with Noh Japanese Theatre gestures. I investigated how to find a way to shape sound in performance, based on slow movement, while exploring a mutual relationship between the performance, materials and the audience's audiovisual engagement with the quasi-virtual interpretation of the piece.

Methodology

Instead of taking a live Koto sound input into the computer, pre-composed sound sources based on Koto instrument recordings are employed. Three initial stored materials (A, B, and C) were composed for four channel sound and the durations are 46, 40, and 38 seconds respectively. The aimed duration of this composition is ca. 14 minutes, which is roughly around 7 times the total length of the three core materials. In this work, my primary compositional question was how to reuse materials of limited length, while the performer is harmonising the spectrum, adding density to sound and extending the duration of the sound event with her/his physical movement. In addition, a spatial device, which means for example, one pattern of 4-channel fixed sound image re-mapped on different channels to

[54] Sensor input device to feed data into a computer. This supports hand and finger motions. https://www.leapmotion.com
[55] Koto is a traditional Japanese stringed instrument. Original Koto sounds for this composition are based on a professional player Ms. Kent Sumie.

create bouncy and expressive sound images, is introduced to arrange four-channel original/modified sound elements as follows.[56]

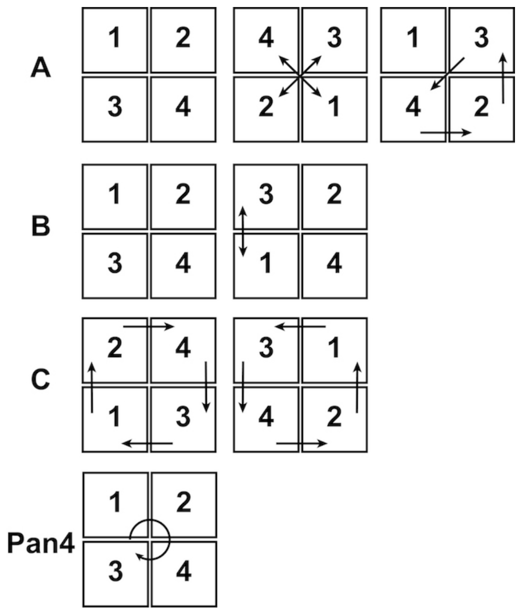


Diagram 12: Channel Allocation for Sound Materials

A mixture of three patterns constitutes the organisation for material A and of two patterns each for the organisation of materials B and C. A spiral-like sound transition is introduced via the Max/MSP object called Pan4 (Diagram 12) to provide joints to musical sections. These ideas aim to explore intriguing spatial effects and the diversity of possibilities of their representations by expanding the original spatial images to other multiple directions, as well as by recycling source materials. The conception may be comparable to one digital image which can create many different types of image patterns by altering transparency, contrast, colours, or rotating, reflecting, and deforming the original object.

The Electronic Instrument

The above-mentioned three sound materials are sent using Max/MSP to output channels directly or to DSP processes such as time-stretchers, pitch-shifters, flanger effects, and looping effects, then the transformed sounds are sent to predetermined output channels. The Leap Motion, which is the sensor interface device which tracks hand gestures,

[56] See also the score pp. V and IX.

provides a performative spatial area, immediately over the device. It can accurately sense a variety of motion gestures of the hands and fingers, or numbers of fingers; however, only a limited number of gestures have been compositionally adopted, in order to simplify the links between movement and sound for a much clearer perception and to avoid sending confusing data to the computer due to the overlapping of hands or fingers.

Mapping and The Process of Reconnecting Materials

Two patterns of actions (up/down and left/right) are applied to the left hand to mainly control volumes and three patterns of actions (up/down, left/right, and backward/forward) are applied to the right hand to change sound properties. These movements are converted to MIDI data by Geco software[59], and I use Max/MSP software to receive MIDI messages. The physical mapping of gesture to musical parameters is relatively straight forward, and the same gestures are often mapped to different musical parameters. Programmed in advance, the foot pedal supports the change of those mappings for every scene during performance. Therefore, the designed instrument consists of a computer and the sensor device is the one to be played with variations of five patterns of hand gestures and a foot pedal to control them.

Harmonising sound with the physical gesture

This composition forms a musical work with enlarged visual elements, because the action of performing, the behavior of a person itself, becomes incorporated into a visual performative medium. In other words, physical movement is equal to musical expression, though it is limited[61]. As with the first examples, the performer's approach to the musical interface must aim to produce sound texture *harmonicity* in the composition. Meanwhile, to increase and understand the meaning of the performer as *be-watched* medium, it requires to have a well-balanced relationship between musical and visual elements for performance. Consequently, the performer seeks not only textural sound harmony but also

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[59] A software for converting multi-dimensional hand gestures to MIDI expression. http://uwyn.com/geco/

[61] The so-called Performance Art, where physical factors compose music includes broad range of works/concepts from the action of improvisational sounding to theatrical works such as Cage's *untitled event* (1952) and the Happening. In FRISKOTO, the significance of performing action is increased compared to other works in the portfolio, but it is limited, and the method of performance is not given priority over sound.

sound-motion accordance[62] (see also diagram 13).

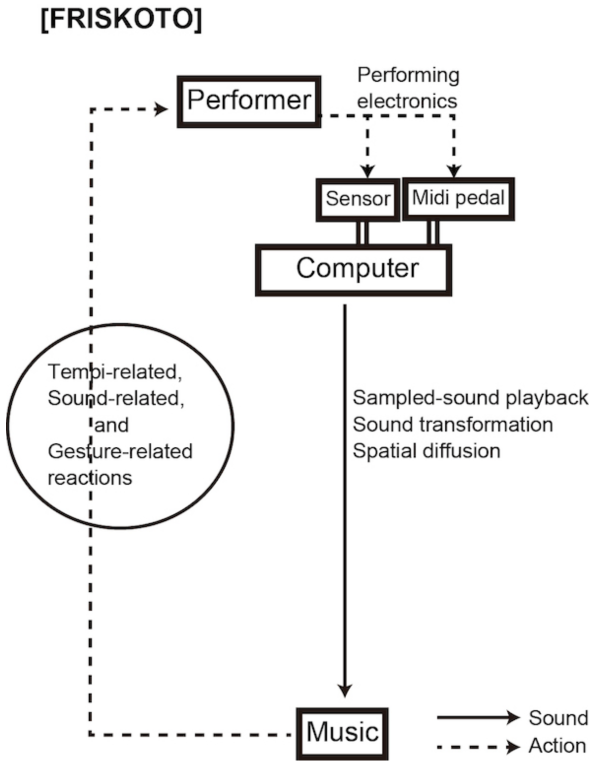

Diagram 13: Human-Computer Interaction in *FRISKOTO*

Strategies for Performance

In addition to the electronic instrument system, the score, which is based upon improvisational hand gestures[65], aims to suggest and seek sonic and gestural harmony. For this piece I developed physical expression and personal gestural ideas which I hope were reflected in the performance of FRISKOTO (Picture 7.1).

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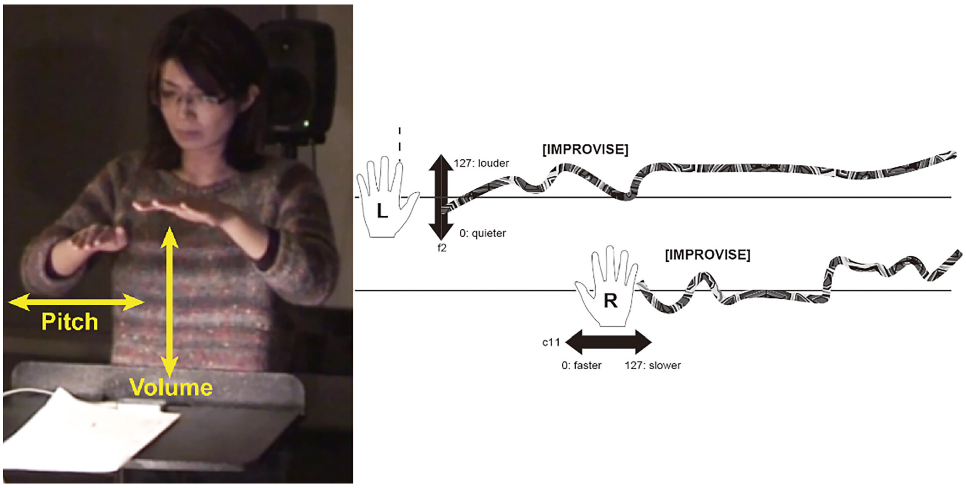
[62] From the viewpoint of sound mapping, Winkler (1995, p. 263) indicates that knowing physical rules of movement does not necessarily result in an obvious musical solution, and adds that '"unnatural" correlations [between movement and sound] makes motion all the more meaningful. My exploration of 'motion-sound accordance' also uses motion in order to create artistic/musical effects.

[65] Different types of scores were referred with *NOTATION 21*. Sauer (2009)

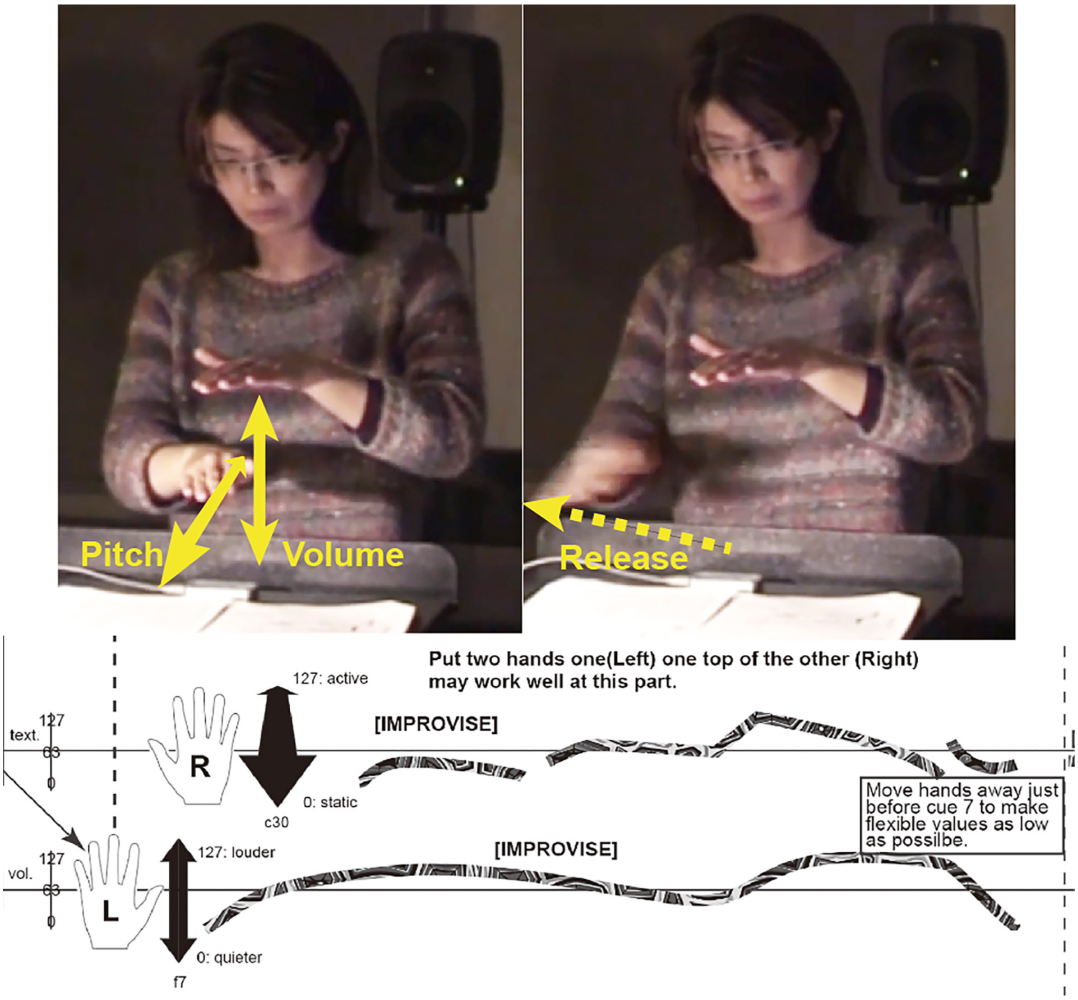


Pitcture 7.1: Performance Strategy (A)

In this example (picture 7.1/score p.1), the left hand controls amplitude of the sound materials that are being played, while the right hand controls their pitch. Since the movements of both hands are not precisely described in the score, a performer is required to further develop sound with her/his own idea within the notated instructions.

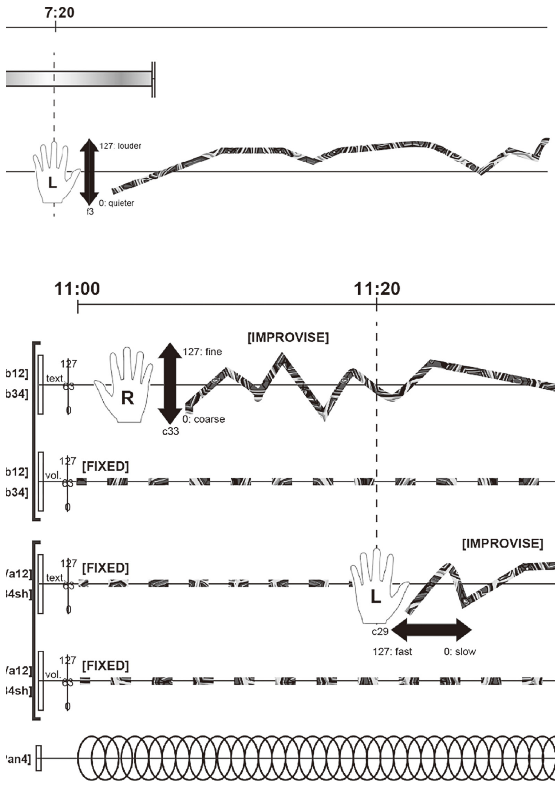
In particular, the significance of the movement length and the contrast (sharp black-and-white differences) in gestures was found after I was involved as a performer (Picture 7.2). I introduced *theatrical* gestural elements in the performance to manipulate sound vividly and to display the musical materials more effectively (Score 6). Such gestural attitudes of the performer can attract the attention of audiences and expand the meaning and understanding of the musical performance.[67]

[67] Theatrical elements will be always very effective and important to perform any kind of musical media in live performance, and it can change the understanding of a musical piece. For example, there is a part where two pianos chase phrases from one another in the middle part of *Mantra* (Stockhausen, 1970). The experience of live performance becomes totally different in meaning from the listening point of view when the work is seen live. *Angry Sparrow* (Miyama, 2009) consists of acrobatic gestures of hand displays well-linked motion and sounds and it informed some of the ideas in this performance



Pitcture 7.2: Performance Strategy (B)

In this example (picture 7.2/score p.2), the right hand interrupts the left hand, in order to hide the left hand from the sensor. This gesture can draw the hidden (background) sound to the surface and change smoothly the texture of sound (left picture). In addition to this, by suddenly releasing the right hand from the sensor, the performer can trigger dramatic changes in the character of sound (right picture).



Score 6: Performance Strategy (C)

The first example in Score 6 suggests to change the volume via notated hand gestures and according to the piece's rhythmic features so that this may project an effect as if the sound was approaching the listener. Similarly, the volume control suggests in the second example of score 6 that it is possible to add some theatrical elements to the performance: the right hand may look like acting as if it was releasing the sound (up) and stopping it (down).

Performer and Movement

The performance behaviour expected from the player can vary, depending on the media and the concept of the music being performed. However, the action that a performer aims to convey to shape musical expression can be considered or defined as groove[69] motion in music, through gestural interaction. My investigation consisted of trying to figure out how to improve the performance technique of the musical interface and the action of placing

[69] For example, Madison (2006, pp. 201-208) defines the groove phenomenon as "wanting to move some part of the body in relation to some aspect of the sound pattern", but the word here means a sort of an upsurge of emotion which could exist in any kind of music (eg. art music, ethnic music, folk music, and popular music) in their own fashion regardless of the feeling of beat or rhythm pattern. Groove also has the property of linking to physical pleasure. (Ogawa, 2012, pp. 1-14)

sound on the stage of space through gesture. I also investigated the concept of resonance in the system, and explored the harmony of the sound by improvisational means, in order to convey sounds in their own way to construct the motion.

The feeling of (groove) motion has the nature of propagation.[70] It may occur only between a performer and the musical medium at first, but the feeling is sharable with other performers and audiences throughout the performing act. My other exploration was to determine whether when these factors are shared with many people (audiences and performers), the sympathy level and understanding of the music could become higher or not.

As a starting point I needed some ideas to attempt to draw such moving-feelings from performers, as sometimes they project so.[73] Another aspect of the investigation was to study whether performers' behaviour could create elements of motion in their context in musical composition (in line or not with the composer's intention). And to try to understand when we may say that a composition has become a "performer's own" when the composer creates, at last, those elements in the music and the audience engages with them.

In a pure musical improvisation context, the performer's interpretation is the work itself. Similarly, physical improvisation can push too much supremacy in the decision-making of a composition, where a body gesture inflicts most of the musical expression, and governs the composition. Although they are very important, in this piece gestural performance needs to become a secondary element in compositional terms. I envisioned a certain degree of compromise between compositional meaning and the performer's need for shaping of the musical work via gestural motion. I aimed to design a system where a performer can enlarge the feeling of movement/motion in real-time, and included a system environment where such feeling can be propagated to audiences, while being the most supportive element of the performance.[74]

[70] *Musical body and performance* (Suzuki, 2007, pp. 122-137.) (In Japanese).
[73] For example, some lyrical passages are employed in *Tints of July*, and there is an obvious change in the middle in *Myth II*. These elements may support to empathize and give influences on some swings of tempi or pattern of sound diffusion. Conversely, elements that might lead to create grooves were intended to be excluded in *Translucency*.
[74] Bailey (guitarist and improviser) (1992, pp. 44-47) says 'The relationship between any music which is improvised and its audience is of a very special nature. Improvisation's responsiveness to its environment puts the performance in a position to be directly influenced by the audience.'

List of Performances

International Computer Music Conference, 30th September, 2015, Denton, USA

International Festival for Innovations in Music Production & Composition, 13th March, 2015, Leeds, UK

MANTIS Festival, 28th February, 2015, Manchester, UK

Denshi-Ongaku Now, 12th July, 2014, Kobe, Japan

Chapter 8. Conclusions

As stated in the introduction, this PhD thesis and portfolio have investigated intermediation of electronic media in acoustic instrumental music and performance, considering the concept of creativity in interactive music and media through multiple materials. This includes the creation of new compositions, presenting unique performance manners, and related discussions ranging from the definition of interaction and interactive behaviour, to the alternative roles that the composer can design as part of an interactive music system using computers and interfaces. It has studied the implementation of human-like or machine-like attitudes in electroacoustic music, and the conception of music scores for interactive media. It has also observed strategies for the presentation of interactive relationships between performers and machines, the configuration of devices for performance, and the interactive relationship between sound materials and subjects related to the aural-visual element and the instrumental-machinery. In particular, in *FRISKOTO* where the instrument becomes enhanced by extending its language through the use of spatial considerations in its musical aesthetics.

The research focus expanded the personal creative methodologies I had before I started the PhD, which were mostly focused on pure live interactive music processing. It broadened my compositional thinking towards multi-dimensionality, and enhanced conceptual aspects of interactive computer music in the following particular subjects which were either new or in many aspects enriched in relation to my prior compositional practice:

- Strategic usage of live-electronic sound transformations and fixed media especially for presenting unique connectivity between sound and performing gestures
- Enhanced creativity by assigning multiple roles to the computer interactive system (going beyond what I had experience before)
- Aural and visual expression throughout the interlocking of gesture and real-time materials (extending prior work)
- The creation of narrative imaginary worlds applying larger sound device to facilitate techniques for embracing instrumental and environmental resources
- Creating methods for utilising sound materials across media to enhance additional musical expression

- Employing alternative techniques for engaging movement with sound materials and for becoming a physical media which can derive harmonised gestural forms
- Expanding my exploration of a wide range of communicational assets between humans and machines in the composition and performance environment
- Devised new techniques for reproducing the various shapes of sound and the method of creating them as dynamic scores.

I reflected upon and absorbed all the above, with the hope to contribute to existing knowledge in the field throughout the portfolio of composition themselves.

Another distinctive aspect of this portfolio is my creative incorporation of the notion of the visual element to the sonic discourse (in several forms). For instance, imaginary scenery, variations of light, colours, or textures are interpreted and investigated based on aural concepts. Various methodological considerations on developing transitions from non-aural images to aural ones have encouraged me to increase the number of creative avenues for composing electroacoustic works.

This research has also brought me ideas and potential possibilities for further interactive-work pieces I want to compose in the future and which will contribute with the repertorie to further consolidate this field of live interactive music (and media). For example, by digging deeper into transforming a non-aural information (*e.g.* data) into aural (and visual) information, and combining the elements of interaction within it. At the same time, the performance can present an unique style of performance.

From the technical side, I can also conclude that this portfolio includes scores and computer programmes, which are the core of interactive computer music, and which demonstrate the feasibility of my musical compositions. I release them with the conviction that it will help to assist other composers, performers and musical analysts to understand more in depth what my contribution to this research strand has been. I have provided detailed evidences in the form of software, screencasting and scores to facilitate the understanding of my creative practice.

The final route in the portfolio of compositions was to study the use of gesture-based notation and devices to redefine compositional thinking and performance, employing a practice-based piece, as in *FRISKOTO*: a gestural interface is an entire full discipline under the umbrella of interactive music, and my intention was only to reflect upon observations found in my previous portfolio pieces when introducing gestural control to the Interactive System that I personally control. The importance of this piece is not so much in the introduction of the novel interface but the fact that it is a culmination in the refinement of my personal musical voice, which meets somewhere in between the style of my previous compositions in the portfolio and my own personal identity and culture, which clearly emerges in the last piece.

Finally, the composer also wanted to highlight the importance of the documentation of interactive musical works, to make interactive computer music notation and the computer programs sustainable beyond the time as a performative and reproducible musical force; however, of course, this problem which has not been fully solved in this field as yet.

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Score

Berio, L. (1987-1988) *Sequenza XI* for solo guitar

Takemitsu, T. (1981) *Toward the Sea* for alto flute and guitar

Rai, T. (1980) *Isolation* for bass clarinet and tape

Rai, T. (1989) *Sparkle* for bass clarinet and tape

Others (Audio/Video)

Ito, Y. (1999) *Rose* for soprano and computer

Lippe, C. (1994) *Music* for flute and ISPW

Matsuda, S. (1998) *Deep Blue* for piano and interactive multimedia system

Matsuda, S. (2005) *Enlargement* for bass clarinet and interactive multimedia computer system

Miyama, C. *Angry sparrow* (performance video)

Risset, J.C. (1982) *Passages* for flute and tape

Appendix Note: Resume of System Behaviours across Pieces

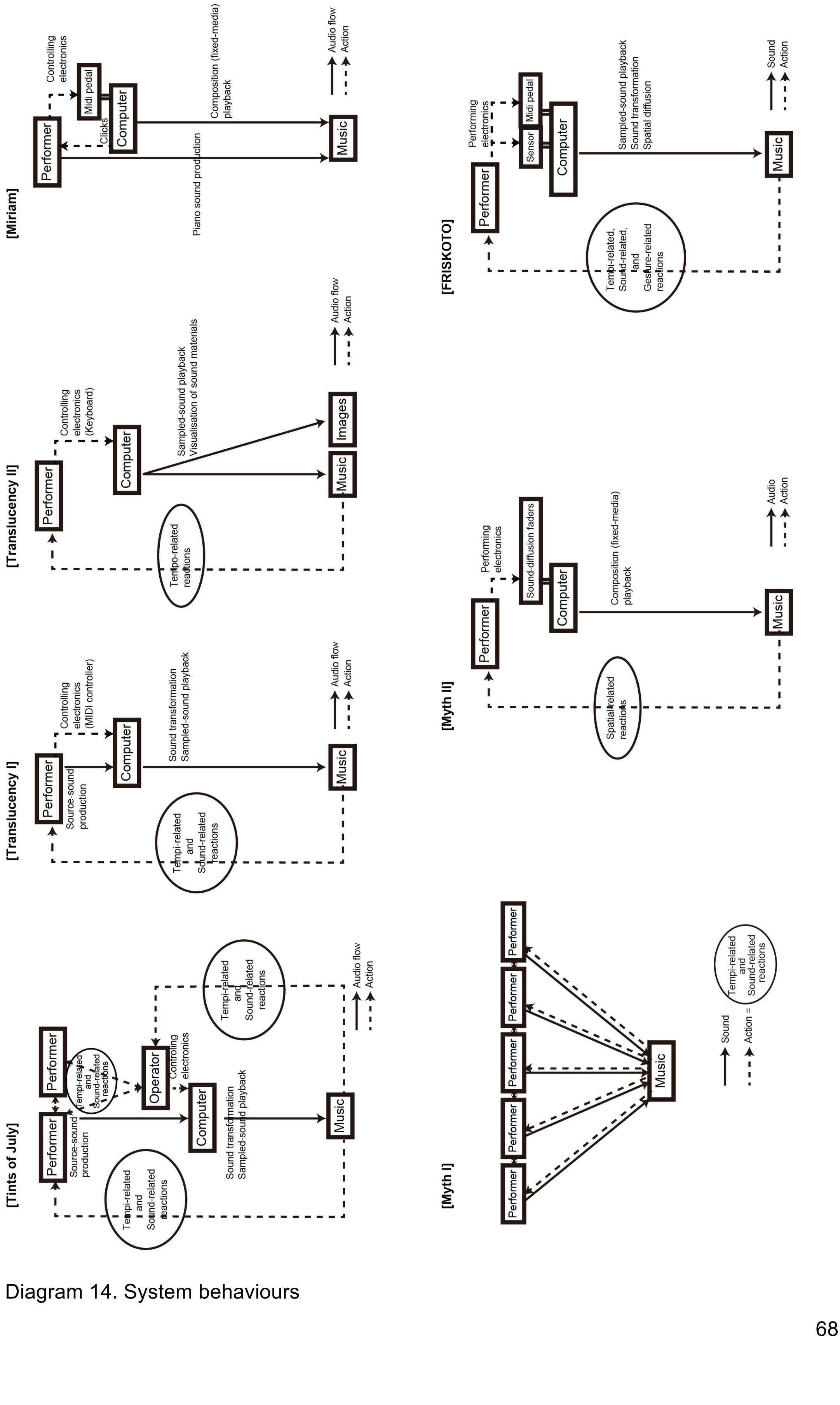

Diagram 14. System behaviours